



**CITY COUNCIL MEETING
Monday, July 20, 2020**

**5:30 PM – Regular Meeting
David B. Roberts Council Chambers**

In response to Governor’s Executive Order N-29-20 and the Resolution Declaring the Existence of a Local Emergency Relating to the COVID-19 Pandemic adopted by the City of Rancho Cordova, the City is following the state guidelines on social distancing including the requirement of wearing a face covering.

This meeting will also be available to the public via video/teleconferencing.

**City Hall
2729 Prospect Park Drive, Rancho Cordova**

Join the Meeting Via Zoom Link:

<https://cityofranchocordova.zoom.us/j/95829004554?pwd=UkozVExxQ0YrODh1QVlkSDBEWIVEQT09>

Join the Meeting via the Zoom Phone Number

Zoom Phone Number: US: +1 669 900 6833 or 888 475 4499 (Toll Free)

Webinar ID: 958 2900 4554

Password: 848379

Live video streams and indexed archives of meetings are also available via the Internet.

Visit the City’s official website at:

<https://ranchocordovaca.civicclerk.com/web/home.aspx>

Instructions to Make Public Comment

Members of the public who wish to provide public comment are encouraged to submit comments via email at CityClerk@cityofranchocordova.org no later than 3 p.m. on Monday, July 20, 2020. All comments submitted by 4:00 p.m. will be sent to the City Council for their review and may not be read during the meeting.

During the meeting, members of the public who wish to provide verbal comments during the meeting, may do so in-person by attending the City Council Meeting at Rancho Cordova City Hall or by video/teleconference. If you wish to provide verbal comments via video/teleconference, follow these instructions:

Listening to a Zoom Meeting by Zoom Video Conference

To make a public comment using the Zoom platform, please use the “raise hand” feature at the bottom center of the screen. Please make sure to enable audio controls once access has been given by the City Clerk’s office to speak. Please wait to be called upon by the City Clerk.

Listening to a Zoom Meeting by Phone Only

You can join a Zoom meeting via teleconferencing/audio conferencing using a cell phone or traditional landline phone. To request to make a public comment by phone press *9 to raise your hand. Please wait to be called upon by the City Clerk.

Please note that members of the public waiting to speak will be put in order by request to speak. All public comments will be limited to three-minutes.

If you have questions related to the City Council Meeting or the use of Zoom, please contact the City Clerk’s Office at (916) 851-8720 before 4:00 p.m.

AGENDA

1. REGULAR MEETING - CALL TO ORDER/ROLL CALL

Council Members Budge, Gatewood, McGarvey, Terry and Mayor Sander.

2. METRO CABLE TV TELEVISION ANNOUNCEMENT

The Clerk will announce the meetings video recording and playback schedules.

3. PLEDGE OF ALLEGIANCE

The Mayor will call on someone in attendance to lead the Pledge.

4. INVOCATION

There will be a moment of silence in lieu of an invocation.

5. PRESENTATIONS

- 5.1. New Employee Introductions: Alyssa Swanson, Assistant Civil Engineer by Byron Tang, Senior Civil Engineer; Leila Menor, Management Analyst II by Albert Stricker, Public Works Director; Dianne Pusateri, Senior Customer Service Representative by Michelle Mingay, Senior Finance Analyst.

6. PUBLIC COMMENT

Citizens wishing to address the Council for any matter not on the agenda may do so at this time by completing and submitting a Speaker Card to the City Clerk. For items on the agenda, speakers will be called up to the podium by the Mayor at the point on the agenda when the item will be heard. Speakers are encouraged to keep comments to three minutes or less and

to state name and community of residence. Under the provisions of the California Government Code, the City Council is prohibited from discussing or taking immediate action on any item not on the agenda unless it can be demonstrated to be of an emergency nature or the need to take immediate action arose after the posting of the agenda.

7. COUNCIL REPORTS

8. CITY MANAGER'S REPORT

9. CONSENT CALENDAR ITEMS - ROLL CALL VOTE

- 9.1. **Subject:** Meeting Minutes from the Regular City Council Meeting of July 6, 2020.

Recommendation: Adopt the Minutes.

- 9.2. **Subject:** Second Reading of Ordinance Levying a Special Tax Within Community Facilities District (CFD) No. 2020-1.

Recommendation: Waive second reading and adopt the Ordinance.

- 9.3. **Subject:** Collaborate with Sacramento Area Council of Governments (SACOG) Regarding the 2020 and Future Grant Funding Rounds to Streamline the Application Process, Facilitate Priority Projects and Identify Funding to Address Deferred Maintenance, while Maintaining a Competitive Approach that Facilitates Funding of Regional Priorities.

Recommendation: Authorize the City Manager or their designee to collaborate with SACOG regarding the 2020 and future grant funding rounds to streamline the application process, facilitate priority projects and identify funding to address deferred maintenance, while maintaining a competitive approach that facilitates funding of regional priorities as detailed in SACOG's July 9 webinar.

10. CONSENT PUBLIC HEARING ITEMS - ROLL CALL VOTE

11. PUBLIC HEARING ITEMS

- 11.1. **Subject:** California Northstate University Dormitory Conditional Use Permit and Major Design Review; Project No. DD9919.

Recommendation: Adopt the Resolution for California Northstate University Dormitory finding the project exempt from CEQA pursuant to Section 15183 and 15183.3 and approving the Conditional Use Permit and Major Design Review.

12. REGULAR CALENDAR ITEMS

- 12.1. **Subject:** Civic Center Master Developer Selection.

Recommendation: Adopt the Resolution authorizing the City Manager to execute an Exclusive Negotiating Rights Agreement with Griffin Swinerton.

- 12.2. **Subject:** Discussion and Potential Direction Regarding Tobacco Regulations in the City.

Recommendation: Receive information and provide direction.

- 12.3. **Subject:** Consideration and Feedback on Draft Multifamily Residential Property Smoking Prohibition Ordinance.

Recommendation: Provide feedback on proposed draft Ordinance.

- 12.4. **Subject:** Staff Presentation on Deferred Pavement Maintenance and 2020-2021 Road Rehabilitation Projects

Recommendation: Receive staff presentation summarizing deferred pavement maintenance

and 2020-2021 road rehabilitation projects and provide input.

13. COUNCIL REQUESTS FOR FUTURE AGENDA ITEMS

14. ADJOURNMENT

ADDITIONAL INFORMATION

SPECIAL MEETINGS LISTED BELOW ARE SUBJECT TO CHANGE/CANCELLATION WITHOUT FURTHER NOTICE.

UNLESS THE COUNCIL ADOPTS A MOTION TO EXTEND THE MEETING, ANY ITEM THAT IS NOT INITIATED BEFORE 11:00 PM WILL BE CONTINUED TO THE NEXT DAY AT 5:30 PM OR SCHEDULED ON THE NEXT REGULAR MEETING AGENDA OF THE COUNCIL.

Public documents related to items on the open session portion of this agenda, which are distributed to the City Council less than 72 hours prior to the meeting, shall be available for public inspection at the time the documents are distributed to the Council. Documents are available for inspection at the City Clerk's office located in Rancho Cordova City Hall.

The agenda items are accessible on the City's website at www.cityofranchocordova.org on Thursdays or Fridays prior to the Regular City Council Meeting.

UPCOMING MEETINGS

August 3, 2020	4:00 PM Special Meeting/Regular Meeting
August 17, 2020	5:30 PM Regular Meeting
August 25, 2020	5:30 PM Special Meeting/Work Session
September 8, 2020	4:00 PM Special Meeting/Regular Meeting
September 21, 2020	5:30 PM Regular Meeting
September 29, 2020	5:30 PM Special Meeting/Work Session
October 5, 2020	4:00 PM Special Meeting/Regular Meeting
October 13, 2020	5:30 PM Special Meeting/Closed Session

If you have any technical questions related to the agenda items, please contact City Hall at (916) 851-8700.

The Rancho Cordova City Council meeting will be videotaped in its entirety and will be cablecast without interruption on Metro Cable 14, the Government Affairs Channel on the Comcast, Consolidated Communications and AT&T U-Verse Systems. Closed Captioning will be available on the playback cablecast. A DVD copy is available from the City Clerk's Department and a webcast of this meeting will be available for viewing via video streaming from the City's website within 48 hours of adjournment of this meeting.

In compliance with the Americans with Disabilities Act, if you need a disability-related modification or accommodation, including auxiliary aids or services, to participate in this meeting, please contact the City Clerk's Office at (916) 851-8720 at least 48 hours prior to the meeting.

CERTIFICATION OF POSTING OF AGENDA

I, Stacy Leitner, City Clerk for the City of Rancho Cordova, declare that the foregoing agenda for the July 20, 2020 Regular Meeting of the Rancho Cordova City Council was posted and available for review on July 17, 2020 at City Hall of the City of Rancho Cordova, 2729 Prospect Park Drive, Rancho Cordova, California, 95670. The agenda is also available on the city website at www.cityofranhocordova.org.

Signed July 17, 2020 at Rancho Cordova, California.

A handwritten signature in blue ink that reads "Stacy Leitner". The signature is written in a cursive, flowing style.

Stacy Leitner, CMC
City Clerk

ITEM 9.1.

CITY OF RANCHO CORDOVA



CITY COUNCIL MEETING

4:00 PM – Special Meeting
David B. Roberts Council Chambers

5:30 PM – Regular Meeting
David B. Roberts Council Chambers

In response to Governor's Executive Order N-29-20 and the Resolution Declaring the Existence of a Local Emergency Relating to the COVID-19 Pandemic adopted by the City of Rancho Cordova, the City is following the state guidelines on social distancing until further notice. Please note that all members of the public that attend the meeting will be required to wear a face covering/mask.

Monday, July 6, 2020

City Hall
2729 Prospect Park Drive, Rancho Cordova

DRAFT MINUTES

1. SPECIAL MEETING - CALL TO ORDER/ROLL CALL

Mayor Sander called the Special meeting to order in the David B. Roberts Council Chambers at 4:06 p.m.

Council Members Present: Gatewood, McGarvey, Terry, and Mayor Sander

Council Members Absent: Budge

Staff Members Present: Cyrus Abhar, Adam Lindgren, Stacy Leitner and Persephonie Riley

2. PUBLIC COMMENT

Mayor Sander opened the public comment period. Seeing no speakers. Mayor Sander closed the public comment period.

ITEM 9.1.

Rancho Cordova City Council - DRAFT MINUTES
Meeting of Monday, July 6, 2020

3. SPECIAL MEETING ITEMS

3.1. **Subject:** Neighborhood Services Update.

Recommendation: Receive presentation. Council will not take any formal action on this item.

ACTION: Input was received regarding Neighborhood Services Update.

4. ADJOURNMENT OF SPECIAL MEETING

Mayor Sander adjourned the meeting at 4:57 PM.

5. REGULAR MEETING - CALL TO ORDER/ROLL CALL

Mayor Sander called the Regular meeting to order in the David B. Roberts Council Chambers at 5:38 p.m.

Council Members Present: Budge, Gatewood, McGarvey, Terry, and Mayor Sander

Council Members Absent: None

Staff Members Present: Cyrus Abhar, Adam Lindgren, Stacy Leitner and Persephonie Riley

6. METRO CABLE TV TELEVISION ANNOUNCEMENT

The City Clerk read the meetings recordings and playback schedule.

7. PLEDGE OF ALLEGIANCE

City Manager Cyrus Abhar led the pledge.

8. INVOCATION

There was a moment of silence in lieu of an invocation.

9. PRESENTATIONS

9.1. Introduction of Jasmeen Sandhu, Customer Service Representative and Craig Hall, Senior Animal Services Officer by Russell Ducharme, Neighborhood Services Manager.

10. PUBLIC COMMENT

Mayor Sander opened the public comment period. The following individuals addressed the Council:

1. Desseree Pritchett
2. Robert
3. Mark Matta
4. Michael Binangee
5. Robert Van Cleef

Mayor Sander closed the public comment period.

11. COUNCIL REPORTS

Council reported on events since the last meeting.

12. CITY MANAGER'S REPORT

City Manager Cyrus Abhar gave his report.

13. CONSENT CALENDAR ITEMS - ROLL CALL VOTE

ACTION: Motion to approve items 13.1 through 13.9 by Budge second by Terry;
Motion passed with a 5:0 vote

ITEM 9.1.

Rancho Cordova City Council - DRAFT MINUTES
Meeting of Monday, July 6, 2020

- 13.1. **Subject:** Meeting Minutes from the Regular City Council Meeting of June 15, 2020 and the Special Meeting of June 23, 2020.
Recommendation: Adopt the Minutes.
- 13.2. **Subject:** A Resolution Determining the Special Tax Levy and Authorizing the Levy of Special Taxes for Police Protection Services within the Rancho Cordova Special Police Tax Area for Fiscal Year 2020-2021.
Recommendation: Adopt the Resolution.
- 13.3. **Subject:** A Resolution of the City Council of the City of Rancho Cordova Adopting the Appropriations Limit for Fiscal Year 2020/2021 and Making the Annual Election for Adjustment Factors.
Recommendation: Adopt the Resolution.
- 13.4. **Subject:** A Resolution Authorizing the City Manager to Execute Cooperative Agreement No. 2020-73 with the California Department of Transportation (Caltrans) for the Zinfandel Drive Bicycle and Pedestrian Overcrossing Project.
Recommendation: Adopt the Resolution.
- 13.5. **Subject:** A Resolution Amending the 2020 Rancho Cordova City Council Meeting Schedule.
Recommendation: Adopt the Resolution.
- 13.6. **Subject:** A Resolution Authorizing the City Manager to Execute Contract Amendment No. 58-2017-3 with the Sacramento Tree Foundation to Extend the Contract Term from June 30, 2021 to June 30, 2022 and Increase the Contract Amount from \$171,750 to \$383,750.
Recommendation: Adopt the Resolution.
- 13.7. **Subject:** A Resolution Authorizing the City Manager to Execute Contract Change Order No. 2 in the Amount of \$48,000.00 with R&R Pacific Construction to Increase the Contract Amount from \$1,489,177.92 to \$1,537,177.92 for the Cordova Park Safe Routes to School Project.
Recommendation: Adopt the Resolution.
- 13.8. **Subject:** A Resolution Authorizing the City Manager to Execute Contract Amendment No. 211-2018-1 With Ross Campbell, Inc. for Public Education and Outreach Services to Extend the Contract Term from December 31, 2019 to June 30, 2022 and Increase the Contract from \$75,249 to an Amount not to Exceed \$221,919.
Recommendation: Adopt the Resolution.
- 13.9. **Subject:** A Resolution Authorizing the City Manager to Execute a Fourth Amendment to Memorandum of Understanding (MOU) with the Sacramento County District Attorney's Office for Community Prosecution Services for \$146,710.00 for the 2020-2021 Fiscal Year.
Recommendation: Adopt the Resolution.
14. **CONSENT PUBLIC HEARING ITEMS - ROLL CALL VOTE**
ACTION: Motion to approve items 14.1 through 14.2 by Budge second by McGarvey;
Motion passed with a 5:0 vote
- 14.1. **Subject:** A Resolution Authorizing Delinquent Residential Solid Waste Service Charges to be Collected on the 2020-2021 Property Tax Roll residents.
Recommendation: Adopt the Resolution.

ITEM 9.1.

Rancho Cordova City Council - DRAFT MINUTES
Meeting of Monday, July 6, 2020

- 14.2. **Subject:** A Resolution Adopting Senate Bill 743 Guidelines for the Analysis of Vehicle Miles Traveled Under the California Environmental Quality Act.
Recommendation: This item will be continued to a date uncertain.

15. PUBLIC HEARING ITEMS

- 15.1. **Subject:** California Northstate University Dormitory Conditional Use Permit and Major Design Review; Project No. DD9919.
Recommendation: Continue the item to July 20, 2020 regular City Council meeting.

ACTION: Motion to continue item 15.1. to July 20, 2020 by Budge second by Gatewood;
Motion passed with a 5:0 vote.

- 15.2. **Subject:** Action Items Related to the Formation of the City of Rancho Cordova Communities Facilities District No. 2020-1 (Landscape Maintenance).
Recommendation: Staff recommends Council adopt the following Resolutions:

1. A Resolution forming Community Facilities District (CFD) No. 2020-1 Landscape Maintenance) and levying a special tax within the District.
2. A Resolution calling for a special election in CFD No. 2020-1 (Landscape Maintenance)
3. A Resolution declaring election results of CFD No. 2020-1 (Landscape Maintenance)
4. Waive the first reading and introduce an Ordinance levying a special tax within CFD No. 2020-1 (Landscape Maintenance).

ACTION: Motion to adopt the Resolution for the Formation of the Community Facilities District by Budge second by McGarvey;
Motion passed with a 5:0 vote.

ACTION: Motion to adopt the Resolution calling Special Property Owner Election by McGarvey second by Budge;
Motion passed with a 5:0 vote.

ACTION: Motion to adopt the Resolution declaring the results of the Special Election and Directing the Recording of Notice of Special Tax Lien by Budge second by Terry;
Motion passed with a 5:0 vote.

ACTION: Motion to waive first reading and introduce the Ordinance Levying Special Tax within the Community Facilities District No. 2020-1 (Landscape Maintenance) by Budge second by Terry;
Motion passed with a 5:0 vote.

16. REGULAR CALENDAR ITEMS

- 16.1. **Subject:** Civic Center Master Developer Selection.

Recommendation: Adopt the Resolution allowing the City Manager to execute an Exclusive Right to Negotiate Agreement with Griffin Swinerton.
Mayor Sander opened the public comment period. The following individual addressed the Council:

1. Nancy Bui-Thompson

Seeing no additional speakers, Mayor Sander closed the public comment period.

ACTION: Motion to bring item back to Council on July 20, 2020 by Budge second by McGarvey;

ITEM 9.1.

Rancho Cordova City Council - DRAFT MINUTES
Meeting of Monday, July 6, 2020

Motion passed with a 5:0 vote.

- 16.2. **Subject:** Discussion and Direction Regarding a Proposed 150-Foot Communication Tower.

Recommendation: Receive a report on a potential new 150-foot communication tower and provide staff with direction or feedback that may be needed for a future submittal.

ACTION: Input was received regarding the Proposed 150-Foot Communication Tower.

- 16.3. **Subject:** Proposed amendments to chapter 6.21 of the Rancho Cordova Municipal Code Regarding Commercial and Multi-Family Recycling and Organics Collection Requirements in State Law.

Recommendation: Receive staff presentation and direct staff to draft amendments to Chapter 6.21 of the Rancho Cordova Municipal Code for City Council approval at a future date.

ACTION: Motion to approve item 16.3. by Budge second by Terry;
Motion passed with a 5:0 vote.

- 16.4. **Subject:** Discussion and potential direction regarding Commercial Real Estate signs and Home Owner's Associations.

Recommendation: Receive a report on existing requirements related to Home Owner's Associations and Commercial Real Estate Signs. Council insight and/or direction to City staff on current practices related with Home Owner's Associations and any potential code amendments related to Commercial Real Estate Signs.

ACTION: Input was received regarding Commercial Real Estate Signs and Home Owner's Associations.

- 16.5. **Subject:** A Resolution for the 180-Day Wait Period Exception for Hiring a Retiree as a Temporary Extra-Help Employee Under Government Code Sections 7522.56 and 21224.

Recommendation: Adopt the Resolution.

ACTION: Motion to approve item 16.5. by Budge second by Terry;
Motion passed with a 5:0 vote.

17. COUNCIL REQUESTS FOR FUTURE AGENDA ITEMS

None.

18. ADJOURN TO CLOSED SESSION

Mayor Sander adjourned to closed session at 9:34 p.m.

19. CLOSED SESSION CALL TO ORDER/ROLL CALL

Mayor Sander called closed session to order at 9:42 p.m.

Council Members Present: Budge, Gatewood, McGarvey, Terry, and Mayor Sander

Council Members Absent: None

Staff Members Present: Cyrus Abhar and Adam Lindgren

20. CLOSED SESSION ITEM

Council will meet in closed session to discuss the following item:

CONFERENCE WITH LEGAL COUNSEL- ANTICIPATED LITIGATION: Significant exposure to litigation pursuant to Government Code Section 54956.9(d)(2)(One Case).

21. OPEN SESSION - REPORT FROM CLOSED SESSION

City Attorney Adam Lindgren reported that Council was given updates and there was no

ITEM 9.1.

Rancho Cordova City Council - DRAFT MINUTES
Meeting of Monday, July 6, 2020

reportable action taken in closed session.

22. ADJOURNMENT

Mayor Sander adjourned the meeting in memory of Michael Spaich at 10:18 p.m.

Stacy Leitner, CMC
City Clerk

MEMORANDUM



ITEM 9.2.

DATE: July 20, 2020
TO: Honorable Mayor and Council Members
FROM: Elizabeth Sparkman, Community Development Director
SUBJECT: **SECOND READING OF ORDINANCE LEVYING A SPECIAL TAX
WITHIN COMMUNITY FACILITIES DISTRICT (CFD) NO. 2020-1**

RECOMMENDATION

Waive second reading and adopt the Ordinance.

RESULT OF RECOMMENDED ACTION

Adoption of the Ordinance authorizes the levy of the special tax within CFD No. 2020-1 (Landscape Maintenance) commencing in Fiscal Year 2020-2021 and each year thereafter.

BACKGROUND

On July 6, 2020 the City Council completed the formation of CFD No. 2020-1 (Landscape Maintenance) and waived the first reading and passed to a second reading the Ordinance levying a special tax within the CFD. The special tax collected within the CFD will contribute to the cost maintenance of the buffer landscaping on public land for the Creekside Commerce Center project.

FISCAL IMPACT AND FUNDING SOURCE

There is no fiscal impact to the general fund.

ATTACHMENT(S)

1. Ordinance

ORDINANCE NO. XX-2020

**AN ORDINANCE OF THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA,
STATE OF CALIFORNIA, LEVYING A SPECIAL TAX WITHIN COMMUNITY
FACILITIES DISTRICT****Community Facilities District No. 2020-1 (Landscape Maintenance)**

WHEREAS, the City Council of the City of Rancho Cordova ("City Council") adopted a resolution entitled "A Resolution of the City of Rancho Cordova of Intention to Establish a Community Facilities District and Future Annexation Area (the "Resolution of Intention"), has conducted proceedings (the "Proceedings") to establish City of Rancho Cordova Community Facilities District No. 2020-1 (Landscape Maintenance) (the "CFD"), pursuant to the Mello-Roos Community Facilities Act of 1982, Chapter 2.5 of Part 1 of Division 2 of Title 5, commencing with Section 53311, of the California Government Code (the "Act") to finance certain public services (the "Services") as provided in the Act; and

WHEREAS, pursuant to notice as specified in the Act, and as part of the Proceedings, the Council has held a public hearing under the Act relative to the determination to proceed with the formation of the CFD and the rate and method of apportionment of the special tax ("Special Tax") to be levied within the CFD to finance the Services and at such hearing all persons desiring to be heard on all matters pertaining to the formation of the CFD and the levy of the Special Tax were heard, substantial evidence was presented and considered by this Council and a full and fair public hearing was held; and

WHEREAS, upon the conclusion of the hearing, this City Council adopted its Resolution of the City Council of the City of Rancho Cordova of Formation of Community Facilities District (the "Resolution of Formation") pursuant to which it completed the Proceedings for the establishment of the CFD, the authorization of the levy of the Special Tax within the CFD and the calling of an election within the CFD on the propositions of levying the Special Tax and establishing an appropriations limit within the CFD, respectively; and

WHEREAS, on July 6, 2020, a special election was held among the landowner voters within the CFD at which such voters approved such propositions by the two-thirds vote required by the Act, which approval has been confirmed by resolution of this Council.

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA DOES ORDAIN as follows:

Section 1. By the passage of this Ordinance, the Council hereby authorizes and levies the Special Tax within the CFD pursuant to the Act, at the rate and in accordance with the rate and method of apportionment of Special Tax set forth in the Resolution of Formation which rate and method is by this reference incorporated herein. The Special Tax is hereby levied commencing in fiscal year 2020-21 and in each fiscal year thereafter to pay for the Services for the CFD, as contemplated by the Resolution of Formation and the Proceedings and all costs of administering the CFD.

Section 2. The Chief Financial Officer of the City or designee or employee thereof

of the City is hereby authorized and directed each fiscal year to determine the specific Special Tax to be levied for the next ensuing fiscal year for each parcel of real property within the CFD, in the manner and as provided in the Resolution of Formation.

Section 3. Exemptions from the levy of the Special Tax shall be as provided in the Resolution of Formation and the applicable provisions of the Act. In no event shall the Special Tax be levied on any parcel within the CFD in excess of the maximum tax specified in the Resolution of Formation.

Section 4. All of the collections of the Special Tax shall be used as provided in the Act and in the Resolution of Formation, including, but not limited to, the payment of costs of the Services, the payment of the costs of the City in administering the CFD, and the costs of collecting and administering the Special Tax.

Section 5. The Special Tax shall be collected in the same manner as ordinary ad valorem taxes are collected and shall have the same lien priority, and be subject to the same penalties and the same procedure and sale in cases of delinquency as provided for ad valorem taxes; provided, however, that the Council may provide for other appropriate methods of collection by resolution(s) of the Council. In addition, the provisions of Section 53356.1 of the Act shall apply to delinquent Special Tax payments. The Chief Financial Officer of the City is hereby authorized and directed to provide all necessary information to the auditor/tax collector of the County of Sacramento in order to effect proper billing and collection of the Special Tax, so that the Special Tax shall be included on the secured property tax roll of the County of Sacramento for fiscal year 2020-21 and for each fiscal year thereafter until no longer required to pay for the Services or until otherwise terminated by the City.

Section 6. If for any reason any portion of this ordinance is found to be invalid, or if the Special Tax is found inapplicable to any particular parcel within the CFD, by a court of competent jurisdiction, the balance of this ordinance and the application of the Special Tax to the remaining parcels within the CFD shall not be affected.

Section 7. The Mayor shall sign this Ordinance and the City Clerk shall cause the same to be published immediately after its passage at least once in a newspaper of general circulation circulated in the City.

Section 8. This ordinance shall go into effect immediately following its second reading and adoption, pursuant to Government Code section 36937.

THE FOREGOING ORDINANCE was adopted this 20th day of July, 2020 by the following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

David M. Sander, Mayor

ATTEST:

Stacy Leitner, CMC
City Clerk

MEMORANDUM



ITEM 9.3.

DATE: July 20, 2020

TO: Honorable Mayor and Council Members

FROM: Albert Stricker, Public Works Director

SUBJECT: **COLLABORATE WITH SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) REGARDING THE 2020 AND FUTURE GRANT FUNDING ROUNDS TO STREAMLINE THE APPLICATION PROCESS, FACILITATE PRIORITY PROJECTS AND IDENTIFY FUNDING TO ADDRESS DEFERRED MAINTENANCE, WHILE MAINTAINING A COMPETITIVE APPROACH THAT FACILITATES FUNDING OF REGIONAL PRIORITIES**

RECOMMENDATION

Authorize the City Manager or their designee to collaborate with SACOG regarding the 2020 and future grant funding rounds to streamline the application process, facilitate priority projects and identify funding to address deferred maintenance, while maintaining a competitive approach that facilitates funding of regional priorities as detailed in SACOG's July 9 webinar.

RESULT OF RECOMMENDED ACTION

The City Manager or their designee would collaborate with SACOG staff to streamline the grant application process, facilitate priority projects, and identify funding to address deferred maintenance, while maintaining a competitive approach that facilitates funding of regional priorities.

BACKGROUND

Sacramento Area Council of Governments (SACOG) staff have been collaborating with stakeholders in preparation for the 2020 funding round with the goal of balancing the infrastructure needs of the region. City staff has highlighted to SACOG staff the opportunities to simplify and streamline the funding process, facilitate priority projects and identify funding to address deferred maintenance.

Staff supports the regional approach detailed in SACOG's July 9 webinar. Staff recommends that City Council authorize the City Manager or their designee to collaborate with SACOG to identify opportunities to streamline the process, facilitate priority projects and identify funding to

address deferred maintenance while emphasizing a regional approach.

Staff does not recommend that the four-county regional funding should be allocated formulaically. Formulas can diminish the importance of a regional approach to allocating funding which should be based on performance measures and data. Pooling our funds over the four counties has allowed the region to maintain an excellent delivery record and set ambitious goals including GHG reduction and economic revitalization of commercial corridors.

FISCAL IMPACT AND FUNDING SOURCE

There is no impact to the general fund.

ATTACHMENT(S)

1. Resolution

CITY OF RANCHO CORDOVA

RESOLUTION NO. XX-2020

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA, STATE OF CALIFORNIA, AUTHORIZING THE CITY MANAGER TO COLLABORATE WITH THE SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) REGARDING THE 2020 AND FUTURE GRANT FUNDING ROUNDS TO STREAMLINE THE APPLICATION PROCESS, FACILITATE PRIORITY PROJECTS AND IDENTIFY FUNDING TO ADDRESS DEFERRED MAINTENANCE, WHILE MAINTAINING A COMPETITIVE APPROACH THAT FACILITATES FUNDING OF REGIONAL PRIORITIES

WHEREAS, the City of Rancho Cordova is a member agency of the Sacramento Area Council of Governments (SACOG); and

WHEREAS, SACOG is the designated Metropolitan Planning Organization and is also the Regional Transportation Planning Agency responsible for developing and implementing the long-range transportation plan for Sacramento County; and

WHEREAS, SACOG staff have been collaborating with stakeholders including the City of Rancho Cordova in preparation for the 2020 funding round with the goal of balancing the infrastructure needs of the region; and

WHEREAS, Staff supports the regional approach detailed in SACOG's July 9 webinar; and

WHEREAS, Staff does not recommend that the four-county regional funding should be allocated formulaically. Formulas can diminish the importance of a regional approach to allocating funding which should be based on performance measures and data. Pooling our funds over the four counties has allowed the region to maintain an excellent delivery record and set ambitious goals including GHG reduction and economic revitalization of commercial corridors;

NOW, THEREFORE, BE IT HEREBY RESOLVED THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA does authorize the City Manager or their designee to collaborate with SACOG to identify opportunities to streamline the process, facilitate priority projects and identify funding to address deferred maintenance while emphasizing a regional approach.

PASSED AND ADOPTED by the City Council of the City of Rancho Cordova on the 20th day of July, 2020 by the following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

David M Sander, Mayor

ITEM 9.3.

ATTACHMENT 1

ATTEST:

Stacy Leitner, CMC
City Clerk

MEMORANDUM



ITEM 11.1.

DATE: July 20, 2020
TO: Honorable Mayor and Council Members
FROM: Darcy Goulart, Planning Manager
SUBJECT: **CALIFORNIA NORTHSTATE UNIVERSITY DORMITORY
CONDITIONAL USE PERMIT AND MAJOR DESIGN REVIEW;
PROJECT NO. DD9919**

RECOMMENDATION

Adopt the Resolution for California Northstate University Dormitory finding the project exempt from CEQA pursuant to Section 15183 and 15183.3 and approving the Conditional Use Permit and Major Design Review.

RESULT OF RECOMMENDED ACTION

Adoption of the Resolution would approve the Conditional Use Permit and Major Design Review for the construction of a new student dormitory project for California Northstate University. Approval would allow the applicant to pursue necessary building permits for new construction.

BACKGROUND

The item was initially heard at the April 20th City Council meeting. Staff provided a brief overview of the project. However, the applicant requested that the item be continued to the May 18, 2020 City Council meeting in order to reevaluate the removal of some of the existing trees. The applicant provided an updated tree removal exhibit showing that additional trees along Prospect Park Drive and internal to the site will be saved and incorporated into the project. Additionally, the project was continued from the May 18th meeting to June 15th, then to July 6th and finally to July 20th in order to allow time for the preparation of a response to comment letters.

ANALYSIS

Since the April 20th City Council meeting, staff and the applicant team have been working on additional documentation in response to the various comment letters that were received on this project. Attachments to this staff report that further support the CEQA Exemptions 15183 and

15183.3 include the Infill Environmental Checklist, which includes additional information related to Energy Consumption and Green House Gases and Findings of Fact Related to CEQA Guidelines Section 15183 and 15183.3 Exemptions. Additionally, staff has included a consolidated response to all the comments that were received to date. Various issues were raised in the letters related to construction and project specific impacts. Due to the fact that some of the letters raised similar issues, a consolidated response was the most appropriate approach to address all concerns rather than preparing individual response letters to each person that submitted comments. Therefore, the consolidated response includes a heading for each issue area that was raised. The additional CEQA documentation and response to comments provided did not result in any modifications to the proposed project. The April 20th staff report has also been included as an attachment to this staff report in order to provide all the project related details.

FISCAL IMPACT AND FUNDING SOURCE

The City anticipates that this project will provide additional revenues from temporary construction jobs, and permanent employment.

ATTACHMENT(S)

1. April 20, 2020 City Council Staff Report
2. CNU Dorm Infill Final Checklist_07.08.2020
3. Resolution
4. Exhibit A to the Resolution - 15183 findings
5. Exhibit B to the Resolution - 15183.3 Findings
6. Exhibit C to the Resolution - Project Plans
7. Exhibit D to the Resolution - Conditions of Approval
8. Comment Letters
9. Conslidated Response to Comments
10. 500' Radius Map and Mailing Labels

MEMORANDUM

DATE: April 20, 2020

TO: Honorable Mayor and Council Members

FROM: Darcy Goulart, Planning Manager



SUBJECT: CALIFORNIA NORTHSTATE UNIVERSITY DORMITORY CONDITIONAL USE PERMIT AND MAJOR DESIGN REVIEW PERMIT; PROJECT NO. DD9919

PROPERTY OWNERS:
West Taron Holdings LLC
9700 W. Taron Drive
Elk Grove, CA 95757

APPLICANT/DEVELOPER:
CA Northstate University
2910 Prospect Park Drive
Rancho Cordova, CA 95670

PROJECT:	The applicant is requesting a Conditional Use Permit and Major Design Review for a new dormitory project for an existing college campus. The project includes two dormitory buildings that will house 400 dorms, a cafeteria with an additional 16 dorms and various onsite improvements associated with the development.
FILE:	DD9919
LOCATION:	Prospect Park Drive (intersection of Prospect Park Drive and Sun Center Drive);
APN:	072-0600-002-0000
ZONING:	Office Professional Mixed Use (OPMU)
PLANNER:	Darcy Goulart, Planning Manager

RECOMMENDATION That Council:

- 1) Determine the project Exempt per Section 15183, consistent with the Community Plan, General Plan, or Zoning of the CEQA Guidelines; and
- 2) Adopt the Resolution for California Northstate University Dormitory Conditional Use Permit and Major Design Review.

RESULT OF RECOMMENDED ACTION

Adoption of the Resolution would approve the Conditional Use Permit and Major Design Review for the construction of a new student dormitory project for California Northstate University. Approval would allow the applicant to pursue necessary building permits for new construction.

BACKGROUND

The project site is adjacent to the existing California Northstate University campus. The University is looking to expand their enrollment to include international students. In order to do so, they need to provide housing options. In early 2019, the Council approved a code amendment to allow dormitory housing as an accessory use to a public or private school upon approval of a conditional use permit (CUP).

PROJECT DESCRIPTION

The proposed project includes;

- Two, five-story buildings
 - Building A – 50,689 sq. ft. with 190 dorm rooms
 - Building B – 53,910 sq. ft. with 210 dorm rooms
- A two-story cafeteria building
 - 9,237 sq. ft
 - 16 dorm rooms on the second floor
- Courtyard with open space, landscaping and a patio area.

The 2.87 ac. site is relatively flat and currently developed as a parking lot for additional university parking.

Figure 1: Site Location



Surrounding Land Use

The following table provides the current use, General Plan, and Zoning

Table 1: Surrounding Designations and Existing Uses

Location	Existing Use	General Plan Designation	Zoning Designation
Subject site	Parking lot	Office Mixed Use	Office Professional Mixed Use
North	Office uses	Office Mixed Use	Office Industrial Mixed Use
East	Office uses	Office Mixed Use	Office Industrial Mixed Use
South	Office uses	Office Mixed Use	Office Professional Mixed Use
West	Office uses	Office Mixed Use	Office Professional Mixed Use

Figure 2: Zoning Map

*General Plan*

The project site is located within the Office Mixed Use designation. The proposed project is consistent with the General Plan designation with an approved CUP.

Zoning Ordinance

The project site is zoned Office Professional Mixed Use (OPMU) and a dormitory as an accessory use to a public or private school is permitted upon approval of a CUP.

ANALYSIS*Conditional Use Permit Review*

As described above, a dormitory is permitted as an accessory use to a public or private school upon approval of a CUP. California Northstate University, which is located on the parcel to the west of the project site, desires to offer living accommodations for their perspective students. Additionally, recruitment and interest from international students has increased. However, without housing, the options are limited for perspective students relocating from another country.

Locating the dormitory on a parcel adjacent to the existing university, provides students with the necessary housing they need in order to be close to the campus. Located in an area surrounded by office buildings, the proposed dormitory buildings as proposed meet all the requirements for uses within the OPMU zone, including height, setbacks, landscaping, lighting, and floor area ratio.

Table 2: Development Standards

Standard	Code Requirement	Project
Height	65 ft	54 ft. to 61 ft.
Floor Area Ratio	0.25 to 2	0.91
Setbacks	Front – 10 ft. Rear – 10 ft. Interior – 0 ft.	Front – 20 ft to 29 ft. Rear – 10 ft. Interior – 49 ft. to 50 ft.

The dormitory buildings offer one, two and three bed units on each floor. Other amenities offered for students include laundry facilities, a lounge and a recreation room. The cafeteria will offer dining options for students attending the campus and/or residing in the dorms. Along with on site parking, bicycle racks are also provided for the resident's use.

The CUP, as conditioned, adheres to the approval findings defined by Zoning Code section 23.134.070 as follows:

- A. *Finding: The site size, dimensions, location, topography, and access are adequate for the needs of the proposed use, considering the proposed building mass, parking, traffic, noise, vibration, exhaust/ emissions, light, glare, erosion, odor, dust, visibility, safety, and aesthetic considerations.*

Evidence: The 2.87ac. parcel is of a sufficient size to accommodate the proposed use. The two buildings, at a height ranging from 54 feet to 61 feet fit within the maximum height of 65 feet for the OPMU zone. While these buildings will be taller than many of the surroundings buildings, they are in keeping with other buildings in the immediate vicinity. Adequate parking for the dorms is provided through on site parking and shared parking with the university on the parcel to the west. The building materials will not create any glare and the new lighting meets the standards of the code and does not create off site impacts. During construction, there will be temporary construction impacts such as dust and noise. However, these are short term in nature and will adhere to existing local standards for construction emissions and noise. The site has adequate access from Prospect Park Drive and does not create any unsafe travel movements.

- B. *Finding:* The negative impacts of the proposed use on adjacent properties and on the public can be mitigated through application of other code standards or other reasonable conditions of approval.

Evidence: The project has been conditioned by all applicable departments and agencies to minimize any potential impacts to include lighting standards and required environmental surveys prior to grading the site. The project would not have any negative impacts on adjacent properties or the public.

- C. *Finding:* All required public facilities have adequate capacity to serve the proposal.

Evidence: The project has been reviewed and conditioned by all applicable departments and agencies to supply adequate facilities. All facilities to include electricity, water, and sewer are existing and in place. Therefore, all required public facilities are adequate to serve the proposed student dormitory project.

- D. *Finding:* The project meets the requirements of the zoning code including development standards, design guidelines, and special use provisions.

Evidence: The project complies with all applicable standards and guidelines included in the Rancho Cordova Municipal Code, including Title 23 Zoning. Required setbacks, height, parking, lighting, etc. for the OPMU zone and use have been adhered to through project design and layout.

- E. *Finding:* If structures and site plans are considered nonconforming, the elements of a project that are nonconforming have been brought into compliance with the zoning code, where feasible

Evidence: The proposed project has been reviewed in accordance with applicable sections of the Rancho Cordova Municipal Code, including Title 23 Zoning. The project is new construction and will be built in compliance with all code standards and would not be considered nonconforming.

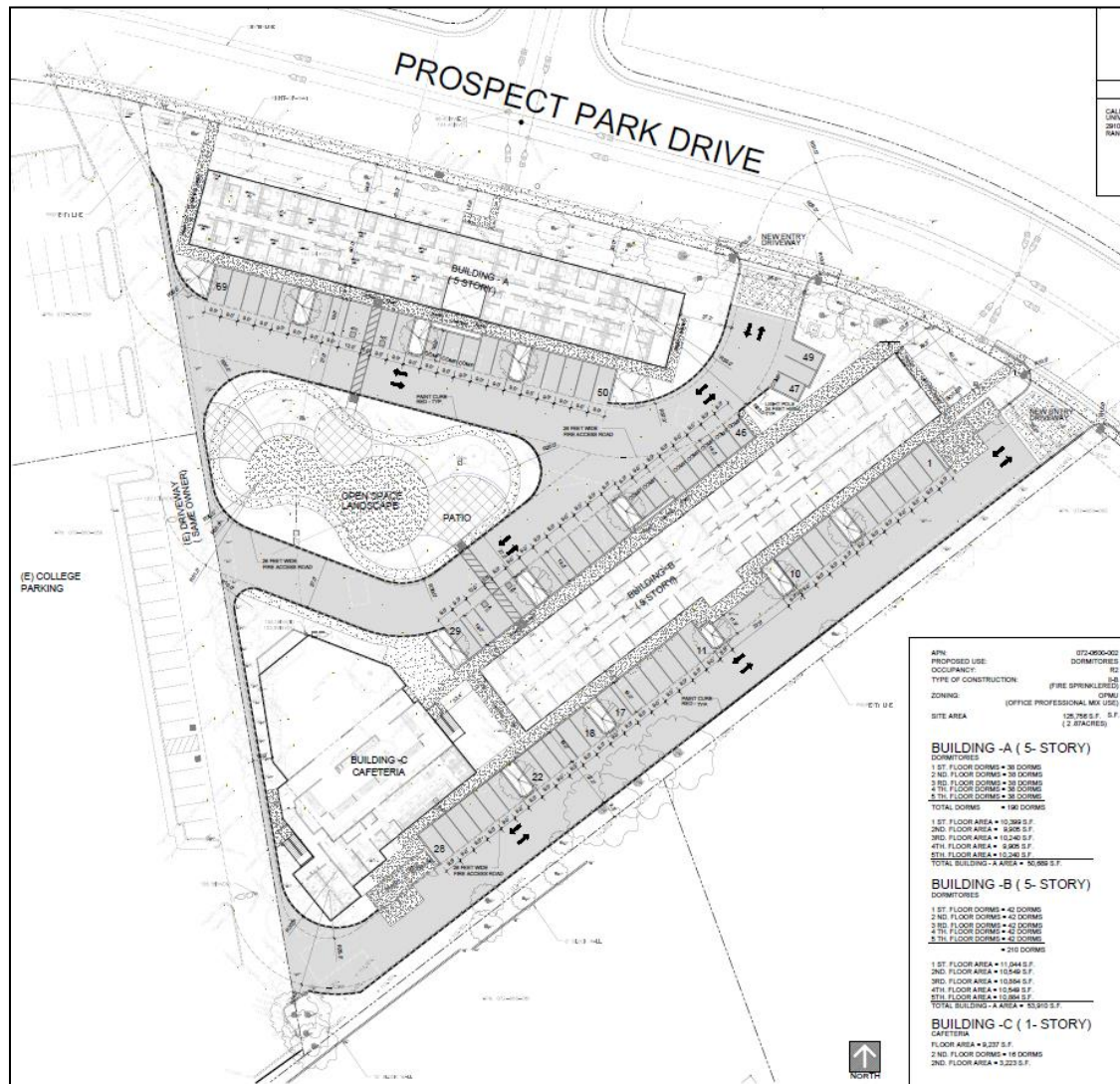
MAJOR DESIGN REVIEW:

Site Layout

The 2.87 acre project site is uniquely shaped as a triangle and has roadway frontage along one property line (Figure 3). As can be seen on the site plan, Building A has been pulled forward towards Prospect Park Drive. Building B runs perpendicular to the road, with the building situated between the two new drive isles. In between the two dorm buildings, is a large landscaped open space area with walking paths and various seating areas. This will serve as an amenity to the residents, students and faculty of the university. The new two-story cafeteria building sits to the southwest of Building B. This will provide dining options for residents, students and faculty. There are also 16 dorms located on the second floor of the cafeteria building.

The dorm buildings are planned to be five stories, which means that fire apparatus needed to fight a fire is larger and needs adequate space to set up on the site. As can be seen on the site plan, the layout provides adequate access throughout the site and around the buildings, with sufficient space for larger fire trucks to access the buildings. The applicant, staff and Sacramento Metro Fire staff have worked together to ensure that the fire, life and safety needs are met for the project.

Figure 3: Site Plan



Architecture

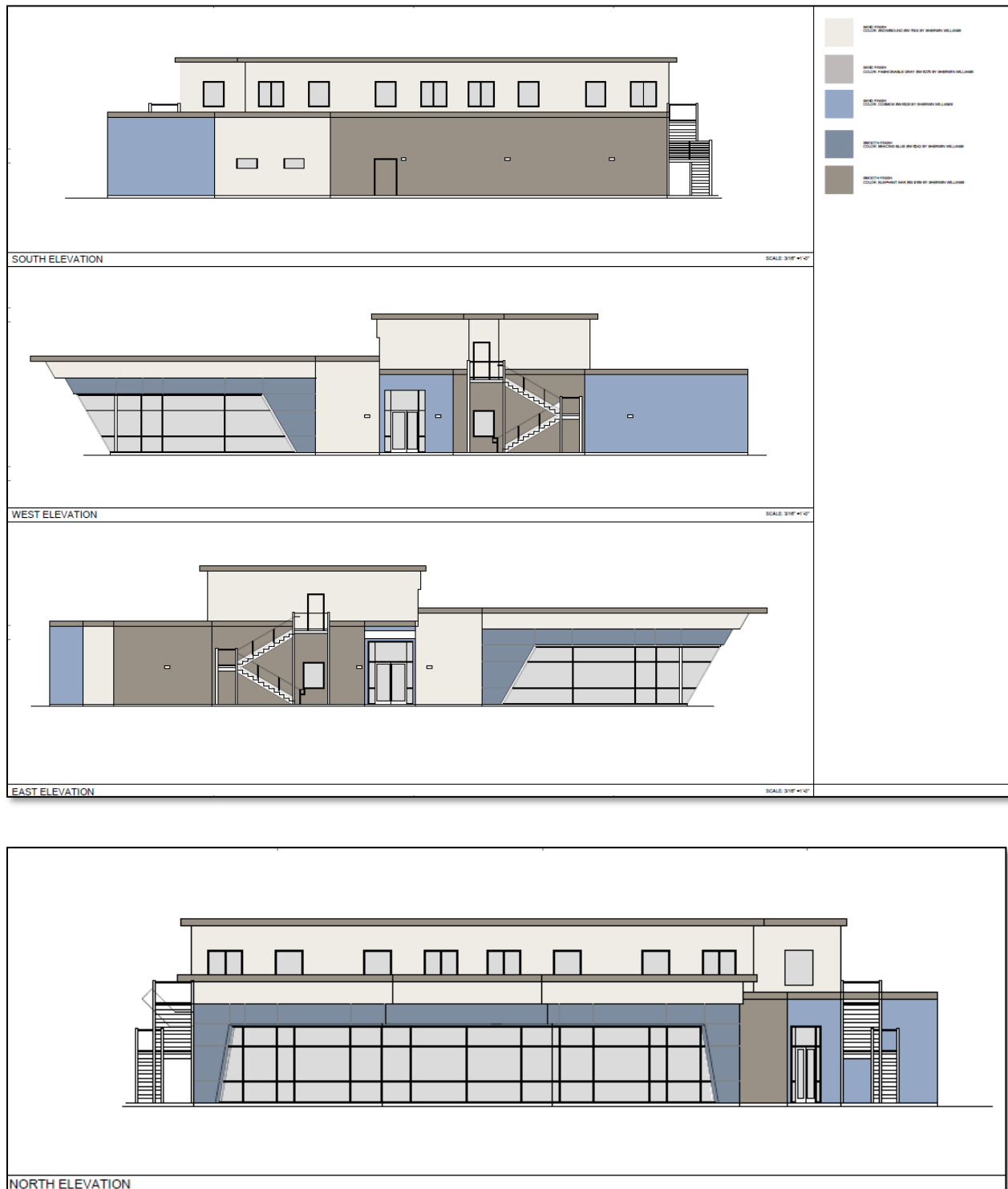
The proposed dorms will actually be modular construction that will be manufactured offsite and assembled together on the project site. The exterior of the building will then be constructed on the outside of the modular units once they are assembled together. This type of construction is unique to Rancho Cordova and has been used frequently in other jurisdictions for various housing types, including student housing.

The building design includes mixture of modern and traditional architecture that includes horizontal lines; roof line and canopies, hipped roofs, and varying wall planes. Proposed colors range from a light cream to a medium brown, with blue and gray tones mixed in. Materials include stucco, as well as aluminum panels. Canopies have also been included over the entrances of the buildings to provide some additional architectural enhancements and a covered entry.

Figure 4: Building Elevations
Buildings A & B are identical



Figure 5: Cafeteria Elevations

*Parking and Lighting*

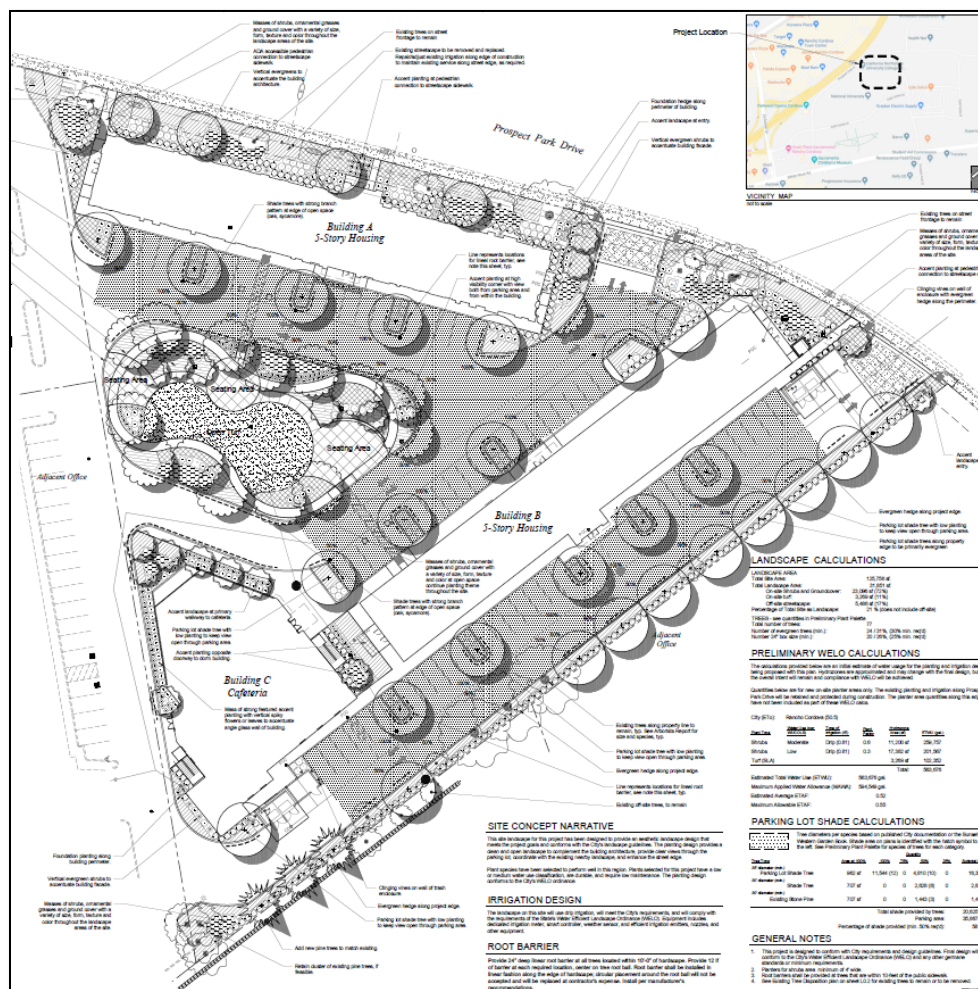
The proposed project includes a total of 140 parking spaces. The requirement is 1 space per 3 occupants. With the current occupancy a total of 147 parking spaces would be required.

However, with a reciprocal parking agreement, adjacent parking on the university property will be used if needed. The project site, along with adjacent site parking has more than adequate parking for the project. The proposed lighting plan includes parking lot lights and pedestrian scale lighting. The project lighting plan has been conditioned to be consistent with the zoning ordinance and does not create any off site glare or spill over lighting onto adjacent properties.

Landscaping

The project incorporates a significant amount of landscaping throughout the site. Landscaping along the street and internal to the site will be planted with a mixture of trees and shrubs. Most trees that are proposed to be planted on the site are 15-gallons, but the plan does incorporate some 24" box trees which have more growth/fullness. The parking lot shade calculation minimum is 50% and has been met with 58% of the parking lot shaded.

Figure 6: Landscape Plan

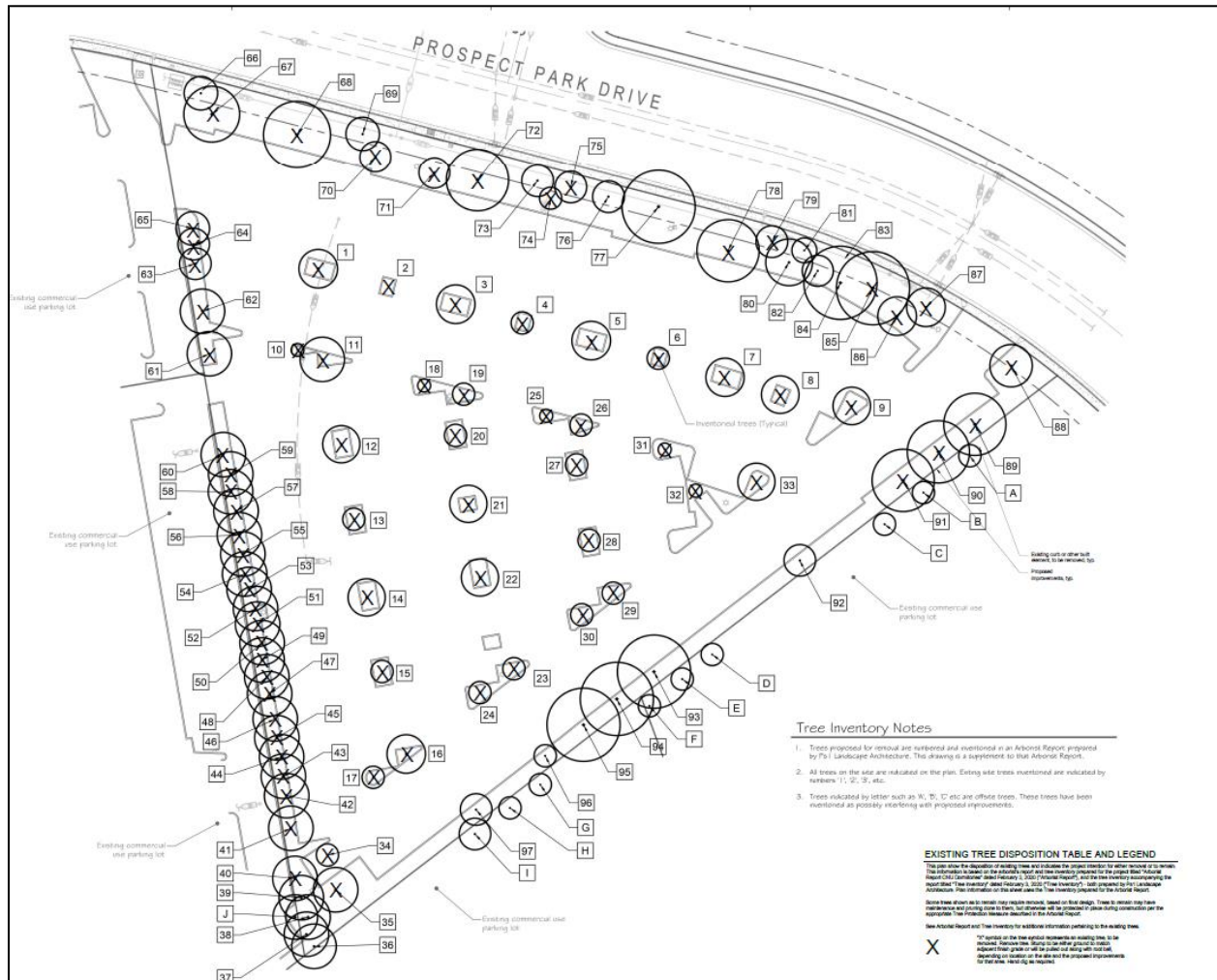


Tree Preservation

Chapter 19.12 of the RCMC discusses the preservation and protection of private trees. It is the City's policy to preserve as many trees as possible through the development review process. In the case of the project, which is considered to be a nonresidential project, any tree species with a trunk diameter of at least 12 inches or greater shall be preserved or mitigated. Mitigation

includes replacement at a 1:1 ratio or paying the in-lieu fee of \$165 per inch. In the case of the project, there are 49 protected on site trees ranging from 12 inches to 45 inches diameter at standard height proposed for removal totaling 1,013 inches. The project has been conditioned to replace by replanting trees or pay the in-lieu fee. Trees that are planted on site can be counted towards replacement of lost inches. Figure 7 indicates the trees to be removed with an X. Staff worked with the applicant to save as many trees as possible without compromising the foundation of the buildings.

Figure 7: Tree Removal Plan



MAJOR DESIGN REVIEW FINDINGS:

The Minor Design Review Permit, as conditioned, adheres to the approval findings defined by Zoning Code section 23.140.070, as follows:

- A. Finding: The proposed project is consistent with the objectives of the General Plan, complies with applicable zoning regulations, Specific Plan provisions, and special planning area provisions, and is consistent with the applicable Rancho Cordova design guidelines.

Evidence: The proposed project is consistent with the purpose and intent of adopted policies and regulations, including the General Plan, Zoning Code, and Design Guidelines with the approved Conditional Use Permit. The proposed buildings are consistent in height, setbacks, and the architecture is consistent with the surrounding area. The proposed project provides a housing opportunity for students currently attending and future students of California Northstate University.

- B. Finding: The proposed architecture, site design, and landscape are suitable for the purposes of the building and the site and will enhance the character of the neighborhood and community.

Evidence: The site design, building architecture, and landscape plan are consistent with the Zoning Code and City Design Guidelines. The proposed buildings are located in the most suitable location on the site that provides adequate emergency safety access to the buildings. The proposed project material and colors are consistent with the surrounding area and design guidelines and incorporate additional architectural character into the area.

- C. Finding: The architecture, including the character, scale, and quality of the design, relationship with the site and other buildings, building materials, screening of exterior appurtenances, exterior lighting and signing, and similar elements, establishes a clear design concept and is compatible with the character of existing or anticipated buildings on adjoining and nearby properties.

Evidence: The proposed project design is consistent with the surrounding buildings in the area. The design, color, and materials have been designed to integrate and compliment the surrounding buildings and area, but also provide additional architectural character to the area. Lighting plans have been provided showing minimum light spill out to the property line.

- D. Finding: The proposed project will not create conflicts with vehicular, bicycle, or pedestrian transportation modes of circulation.

Evidence: The proposed project will not substantially affect current traffic flows or existing modes of transportation circulation. One of the three driveways is existing. The new driveways have been placed in a location to not conflict with existing driveways in the area and meet the minimum distance separation requirements. Bike racks have been included in the site plan.

ENVIRONMENTAL REVIEW

The California Environmental Quality Act (Section 21000, et. seq. of the California Public Resources Code, hereafter CEQA) requires analysis of agency approvals of discretionary "Projects." A "Project," under CEQA, is defined as "the whole of an action, which has a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment." The proposed dormitory project is a project under CEQA.

Staff has reviewed the proposed action and has identified that no further analysis is required pursuant to CEQA Guidelines Section 15183 (Projects Consistent with a Community Plan or Zoning). CEQA Guidelines Section 15183 (Public Resources Code Section 21083.3) provides that projects that are consistent with the development density and intensity established by existing zoning, community plan, or general plan policies for which an environmental impact report (EIR) has been certified "shall not require additional environmental review, except as might be necessary to examine whether there are project-specific significant effects which are peculiar to the project or its site." The proposed project is consistent with the density established in the General Plan and analyzed in the General Plan EIR (State Clearinghouse # 2005022137).

The project site is designated Office Mixed Use in the General Plan and zoned Office Professional Mixed-Use (OPMU), which allows a minimum floor area ratio of 0.25 and a maximum floor area ratio of 2.0 (RCMC Section 23.313.040). The proposed project's floor area ratio is 0.92, which is within the allowed range for the site.

The project site is currently developed as a paved parking lot with landscaping, including trees. While the project site does not contain substantial natural habitat, nests of protected birds could be present onsite and could be negatively affected through project construction or tree removal. However, consistent with General Plan Action NR.1.1.4, the City will require a survey to be conducted if any construction activity or tree removal would occur during the nesting season. This will be included as a condition of approval for the project.

A vehicle trip generation analysis was conducted for the project that considered trips generated by the dorms, with reduction in trips for those students who currently drive to the campus but could live on site in the future. Based on that analysis, with the dorms fully occupied, the proposed project would generate a net increase of 644 daily trips, 6 A.M. peak hour trips, and 86 P.M. peak hour trips. Because this is below the City's threshold of 1,000 daily trips or 100 peak hour trips, no further analysis was required.

There are no sensitive receptors near the site that would be negatively affected by construction noise or construction emissions, such as toxic air contaminants. Because the proposed project is within the density assumed for the project site in the General Plan EIR, the emissions generated by project construction and operation would be within the emissions assumed in the EIR. With regard to greenhouse gas (GHG) emissions, the General Plan EIR did not evaluate GHG emissions in the Planning Area, as it was not required in the CEQA Guidelines at the time the EIR was prepared. Although the EIR did not include a GHG analysis, absent new information on related to climate change, a supplemental environmental analysis of GHG impacts cannot be required. (*Citizens for Responsible Equitable Environmental Development [CREED] v. City of San Diego*, [2011] 196 Cal.App.4th 515, 531.) Information on the effects of GHG emissions on climate have been generally known before the City approved the EIR (see Executive Order S-3-05, announced in June 2005). Thus, the effect of GHG emissions on climate could have been raised in 2006 when the City considered certification of the EIR. A challenge to an EIR must be

brought within 30 days of the lead agency's notice of determination. (Pub. Resources Code, § 21167[b].) Under Public Resources Code section 21166(c), an agency may not require a supplemental environmental review unless new information, which was not known and could not have been known at the time the EIR was approved, becomes available. After a project has been subjected to environmental review, the statutory presumption flips in favor of the project proponent and against further review. (*Moss v. County of Humboldt* [2008] 162 Cal.App.4th 1041, 1049-1050.) “[S]ection 21166 comes into play precisely because in-depth review has already occurred [and] the time for challenging the sufficiency of the original EIR has long since expired.” (*Id.*, 1050.) There is no competent evidence of new information of severe impact. Accordingly, the City finds that GHG impacts and climate change are not “new information” under Public Resources Code Section 21166 and, thus, further no review related to GHGs is required.

RECOMMENDED ACTIONS

Staff recommends that the City Council find the project categorically exempt from further CEQA review and adopt the Resolution approving the Conditional Use Permit, Tentative Parcel Map, and Major Design Review for the California Northstate University Dormitory project subject to the findings, Project Plans (Exhibit A) and Conditions of Approval (Exhibit B).

ATTACHMENTS

1. Resolution
2. Project Plans – Exhibit A to the Resolution
3. Conditions of Approval – Exhibit B to the Resolution
4. 500' Radius Map with Mailing Labels



California Northstate University Dormitory Infill Environmental Checklist for the City of Rancho Cordova

Prepared for:
City of Rancho Cordova
2729 Prospect Park Drive, 1st fl
Rancho Cordova, CA 95670

July 2020

Infill Environmental Checklist
for the
California Northstate University Dormitory Project

Prepared for:

City of Rancho Cordova
2729 Prospect Park Drive, 1st Floor
Rancho Cordova, CA 95670
916/851-8784

Contact: Darcy Goulart, Planning Manager

Prepared By:

Ascent Environmental, Inc.
455 Capitol Mall, Suite 300
Sacramento, California 95814
916/444-7301

Contact: Pat Angell

July 2020

TABLE OF CONTENTS

Section	Page
LIST OF ABBREVIATIONS	
INTRODUCTION.....	i
Organization of the Infill Environmental Checklist.....	i
Purpose of the Infill Environmental Checklist.....	i
SECTION I - BACKGROUND.....	1-1
SECTION II - SATISFACTION OF APPENDIX M PERFORMANCE STANDARDS	2-1
SECTION III – PROJECT DESCRIPTION	3-1
3.1 Introduction.....	3-1
3.2 Project Location	3-1
3.3 General Plan and Zoning.....	3-1
3.4 Existing and Adjacent Uses	3-1
3.5 Project Design	3-3
3.6 Project Construction.....	3-3
3.7 Actions.....	3-3
SECTION IV - INFILL ENVIRONMENTAL CHECKLIST	4-1
4.1 Aesthetics	4-1
4.2 Agriculture and Forest Resources.....	4-4
4.3 Air Quality	4-6
4.4 Biological Resources.....	4-14
4.5 Cultural Resources	4-17
4.6 Energy.....	4-19
4.7 Geology and Soils	4-22
4.8 Greenhouse Gas Emissions	4-25
4.9 Hazards and Hazardous Materials	4-30
4.10 Hydrology and Water Quality	4-33
4.11 Land Use and Planning.....	4-36
4.12 Mineral Resources.....	4-37
4.13 Noise.....	4-38
4.14 Population and Housing	4-41
4.15 Public Services.....	4-43
4.16 Recreation.....	4-46
4.17 Transportation.....	4-48
4.18 Tribal Cultural Resources	4-50
4.19 Utilities and Service Systems	4-52
4.20 Wildfire.....	4-54
4.21 Mandatory Findings of Significance.....	4-56
SECTION V - ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED	5-1
SECTION VI - DETERMINATION.....	6-1

Figures

Figure 1	Regional Location.....	3-2
Figure 2	Project Site Plan	3-5

Tables

Table 1	Modeled Daily Maximum Construction Emissions of Criteria Air Pollutants and Precursors	4-10
Table 2	Summary of Maximum Operational Emissions of Criteria Air Pollutants and Precursors.....	4-11
Table 3	Construction-Related Energy Use.....	4-20
Table 4	Operational Energy Use	4-20
Table 5	Construction-Generated Greenhouse Gas Emissions.....	4-26
Table 6	Operational Greenhouse Gas Emissions	4-28

LIST OF ABBREVIATIONS

AQMP	air quality mitigation plan
BACT	best available control technologies
BMP	best management practice
CAA	Clean Air Act
CAAQS	California ambient air quality standards
CARB	California Air Resources Board
CEQA	California Environmental Quality Act
CNEL	Community Noise Equivalent Level
CO ₂	carbon dioxide
CO ₂ e	carbon dioxide equivalent
CRPD	Cordova Recreation and Park District
CUP	conditional use permit
CVRWQCB	Central Valley Regional Water Quality Control Board
dBA	A-weighted decibel
EPA	US Environmental Protection Agency
FCUSD	Folsom Cordova Unified School District
FHSZ	Fire Hazard Severity Zone
HFTA	High Frequency Transit Area
lb/day	pounds per day
MT CO ₂ e	metric tons of carbon dioxide equivalent
MTP/SCS	Metropolitan Transportation Policy/Sustainable Communities Strategy
NAAQS	national ambient air quality standards
NO _x	nitrogen oxide
OPMU	Office Professional Mixed Use
PM ₁₀	respirable particulate matter
PM _{2.5}	fine particulate matter
ROG	reactive organic gas
SACOG	Sacramento Area Council of Governments
SIP	State Implementation Plan
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMUD	Sacramento Municipal Utility District
SVAB	Sacramento Valley Air Basin
TAC	toxic air contaminants
tpy	tons per year
US 50	US Highway 50
VMT	vehicle miles traveled

INTRODUCTION

This Infill Environmental Checklist has been prepared by the City of Rancho Cordova Planning Department, 2729 Prospect Park Drive, Rancho Cordova, CA 95670, pursuant to Public Resources Code section 21094.5 of the California Environmental Quality Act (CEQA) (Public Resources Code Sections 21000 et seq.), and implementing regulations in CEQA Guidelines (Title 14, Section 15000 et seq. of the California Code of Regulations), specifically Sections 15183.3 and Appendices M and N, as well as Section 15183.

ORGANIZATION OF THE INFILL ENVIRONMENTAL CHECKLIST

This Infill Environmental Checklist is organized into the following sections:

SECTION I – BACKGROUND: Provides summary background information about the project name, location, sponsor, and the date this Infill Environmental Checklist was completed.

SECTION II – SATISFACTION OF APPENDIX M PERFORMANCE STANDARDS: Includes description of project conformance to State CEQA Guidelines Appendix M standards and project eligibility for infill streamlining.

SECTION III – PROJECT DESCRIPTION: Includes a detailed description of the project.

SECTION IV – INFILL ENVIRONMENTAL CHECKLIST AND DISCUSSION: Reviews project and states whether the project would have additional significant environmental effects (project-specific effects) that were not evaluated in a prior EIR, or that are more significant than previously analyzed, or that uniformly applicable development policies would not substantially mitigate..

SECTION V – ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED: Identifies which environmental factors were determined to have additional significant environmental effects.

SECTION VI – DETERMINATION: States whether environmental effects associated with development of the project are significant, and what, if any, added environmental documentation may be required.

PURPOSE OF THE INFILL ENVIRONMENTAL CHECKLIST

Public Resources Code section 21094.5 (Senate Bill 226), along with its implementing regulations (Section 15183.3 and Appendices M and N of the CEQA Guidelines) (Infill Streamlining provisions) provide a streamlined CEQA process for projects that qualify as infill development.

In order to qualify for coverage under the Infill Streamlining provisions, a project site must either be in an urban area that has been previously developed, or the project site must have qualifying urban development, defined as one or a combination of residential, commercial, public institutional, transit or transportation passenger facility, or retail use on at least 75 percent of the site perimeter.

The CEQA Guidelines, in Appendix M, include a set of performance standards, as required by SB 226, which a qualifying project must satisfy in order to be eligible for the Infill Streamlining process.

If a project meets the Appendix M performance standards, the lead agency may prepare an environmental checklist based on CEQA Guidelines Appendix N. The Appendix N Infill Environmental Checklist provides a tool to evaluate a development project and provide substantial evidence of its eligibility to use the infill streamlining process. The Infill Environmental Checklist also assists the lead agency in identifying and summarizing project-specific effects and how those effects are or are not addressed in a prior programmatic level document, or by uniformly applicable development policies:

Once the lead agency has determined that a particular physical impact may occur as a result of an infill project, then the checklist answers must indicate whether that impact has already been analyzed in a prior EIR. If the effect of the infill project is not more significant than what has already been analyzed, that effect of the infill project is not subject to CEQA. The brief explanation accompanying this determination should include page and section references to the portions of the prior EIR containing the analysis of that effect. The brief explanation shall also indicate whether the prior EIR included any mitigation measures to substantially lessen that effect and whether those measures have been incorporated into the infill project.

For purposes of this Environmental Checklist, “uniformly applicable development policies or standards” include policies and standards adopted or enacted by the City of Rancho Cordova or State of California that reduce one or more adverse environmental impacts. Such policies and standards can include, without limitation, local and state building codes, design guidelines, impact fee programs, traffic impact fees, policies for the reduction of greenhouse gasses contained in adopted land use plans, policies or regulations and ordinances for the protection of trees or historic resources (see CEQA Guidelines Section 15183.3 (f)(7)).

This checklist identifies uniformly applicable development standards, such as measures set forth in a city’s municipal code or general plan, to substantially mitigate effects of the project. All general plan policies identified herein as applicable to the project would be implemented through project design or conditions of approval.

The City, as CEQA lead agency for the project, has determined, based on substantial evidence contained in the documents and records regarding the project, that the project is eligible for infill streamlining pursuant to Public Resources Section 21094.5. This Environmental Checklist confirms that the project qualifies for infill streamlining and provides documentation showing that the impacts of the project fall within the impacts evaluated in prior EIRs, in this case, the City of Rancho Cordova’s General Plan EIR, or can be substantially mitigated by uniformly applicable development policies or standards.

Additionally, because the City of Rancho Cordova’s General Plan EIR analyzed anticipated growth within the City, including development of the project site with Office Mixed Use, this checklist identifies potential environmental impacts that qualify for streamlined review under Section 15183 of the CEQA Guidelines. Section 15183 of the CEQA Guidelines states that, where a project is consistent with the use and density established for a property under an existing general plan for which a city has already certified an EIR, additional environmental review is not required “except as might be necessary to examine whether there are project-specific significant effects which are peculiar to the project or its site.” If such requirements are met, the examination of environmental effects is limited to those which the agency determines:

1. Are peculiar to the project or the parcel on which the project would be located;
2. Were not analyzed as significant effects in a prior EIR on the zoning action, general plan or community plan with which the project is consistent;
3. Are potentially significant off-site impacts and cumulative impacts which were not discussed in the prior EIR prepared for the general plan, community plan or zoning action; or
4. Are previously identified significant effects which, as a result of substantial new information which was not known at the time the EIR was certified, are determined to have a more severe adverse impact than discussed in the prior EIR.

Consistent with the requirements of CEQA Guidelines Section 15183, this checklist determined that the project would not result in significant impacts peculiar to the project or project site or any significant impacts that were not analyzed or discussed in the General Plan EIR and/or are substantially mitigated by the imposition of uniformly applied development policies or standards. Additionally, the project would not result in any potentially significant off-site or cumulative impacts that were not discussed in the General Plan EIR. Also, there are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Thus, the City may rely upon the analysis in the certified General Plan EIR, and no further CEQA review is required.

SECTION I - BACKGROUND

1. **Project Title:** California Northstate University Dormitory
2. **Lead Agency Name and Address:** City of Rancho Cordova
3. **Contact Person and Phone Number:** Darcy Goulart, Planning Manager
Community Development Department
City of Rancho Cordova
2729 Prospect Park Drive, 1st Floor
Rancho Cordova, CA 95670
(916) 851-8784
dgoulart@cityofranhocordova.org
4. **Project Location:** 2910 Prospect Park Drive
Rancho Cordova, CA 95670
5. **Project Sponsor's Name and Address:** California Northstate University
2910 Prospect Park Drive
Rancho Cordova, CA 95670
6. **General Plan Designation(s):** Office Mixed Use
7. **Zoning:** Office Professional Mixed Use (OPMU)
8. **Prior environmental document(s) analyzing the effects of the infill project (including State Clearinghouse number if assigned):**

Rancho Cordova General Plan EIR (SCH # 2005022137)

9. **Location of prior environmental document(s) analyzing the effects of the infill project:**

The City's General Plan EIR is available on the City of Rancho Cordova website:
<https://www.cityofranhocordova.org/i-want-to-/learn-about/general-plan>

10. **Description of Project:**

The project involves the construction and operation of 416 dorms rooms and a 9,237-square-foot cafeteria in three buildings on approximately 5.8 acres within an existing parking lot, adjacent to the existing California Northstate University. The project would also provide a courtyard with open space, landscaping, and a patio area for student residents. Offsite improvements would be limited to connecting to nearby water, stormwater, and electric utilities, with all other development occurring within the footprint of the project site. A detailed project description is included in Section III of this document.

11. **Surrounding Land Uses and Setting:**

Adjacent uses to the project site include professional office buildings to the north, west, and south, with office industrial uses to the east, across Prospect Park Drive. US 50 is located further to the northeast.

12. **Other public agencies whose approval is required:**

Approval of a construction activity stormwater permit, including a Stormwater Pollution Prevention Plan is required from the Central Valley Regional Water Quality Control Board (CVRWQCB).

This page intentionally left blank.

SECTION II - SATISFACTION OF APPENDIX M PERFORMANCE STANDARDS

This section provides information demonstrating that the proposed infill project satisfies the performance standards in Appendix M of the State CEQA Guidelines (California Code of Regulations, Title 14, Division 6, Chapter 3, Sections 15000-15387).

1. Does the non-residential infill project include a renewable energy feature? If so, describe below. If not, explain below why it is not feasible to do so.

The proposed project is a residential infill project.

2. If the project site is included on any list compiled pursuant to Section 65962.5 of the Government Code, either provide documentation of remediation or describe the recommendations provided in a preliminary endangerment assessment or comparable document that will be implemented as part of the project.

The project site is not included on any list compiled pursuant to Section 65962.5 of the Government Code.

3. If the infill project includes residential units located within 500 feet, or such distance that the local agency or local air district has determined is appropriate based on local conditions, a high volume roadway or other significant source of air pollution, as defined in Appendix M, describe the measures that the project will implement to protect public health. Such measures may include policies and standards identified in the local general plan, specific plans, zoning code or community risk reduction plan, or measures recommended in a health risk assessment, to promote the protection of public health. Identify the policies or standards, or refer the site specific analysis, below.

The proposed infill project includes residential units that would be located within 500 feet of a high volume roadway (US Highway 50) as defined in Appendix M. Project design would include ventilation system capable of achieving the protection from particulate matter (PM_{2.5}) equivalent to that of a Minimum Efficiency Reporting Value (MERV) 13 filtration (as defined by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 52.2). This filtration standard is used to capture particulate matter to protect public health. The City of San Francisco Municipal Code Section 3807 (Enhanced Filtration Requirement) uses this standard to address public health exposures to significant sources of air pollution.

4. For residential projects, the project satisfies which of the following?

☒ Located within a low vehicle travel area, as defined in Appendix M.

The project is anticipated to generate 644 new daily trips during the academic year, 891,294 vehicle miles traveled (VMT) per year, and 7.8 VMT per capita per day, based on an on-site population of 400 students. Regional VMT averages for residential uses are 17.91 VMT per capita per day (SACOG 2020). The project's VMT per capita represents 43 percent of the current regional average (a 57 percent reduction), in exceedance of the 15 percent target reduction recommended by the California Office of Planning and Research. Although the project increases on-site population, it locates students closer to their destination, thereby reducing VMT, consistent with regional efforts and the intent of residential infill development.

☒ Located within ½-mile of an existing major transit stop or an existing stop along a high quality transit corridor.

The project would be located along Regional Transit's Rancho Cordova Route 177 and is within one-half mile of an existing major transit stop (i.e., Regional Transit Cordova Town Center Light-rail Station).

☐ Consists of 300 or fewer units that are each affordable to low income households. (Attach evidence of legal commitment to ensure the continued availability and use of the housing units for lower income

households, as defined in Section 50079.5 of the Health and Safety Code, for a period of at least 30 years, at monthly housing costs, as determined pursuant to Section 50053 of the Health and Safety Code.)

5. For commercial projects with a single building floor-plate below 50,000 square feet, the project satisfies which of the following?

- ☐ Located within a low vehicle travel area, as defined in Appendix M. (Attach VMT map.)
- ☐ The project is within one-half mile of 1800 dwelling units. (Attach map illustrating proximity to households.)

The project is not a commercial project.

6. For office building projects, the project satisfies which of the following?

- ☐ Located within a low vehicle travel area, as defined in Appendix M. (Attach VMT map.)
- ☐ Located within ½ mile of an existing major transit stop or within ¼ mile of a stop along a high quality transit corridor. (Attach map illustrating proximity to transit.)

The project is not an office building project.

7. For school projects, the project does all of the following: (Briefly describe the project's surroundings.)

- ☐ The project complies with the requirements of Sections 17213, 17213.1 and 17213.2 of the California Education Code.
- ☐ The project is an elementary school and is within one mile of 50% of the student population, or is a middle school or high school and is within two miles of 50% of the student population. Alternatively, the school is within ½ miles of an existing major transit stop or an existing stop along a high quality transit corridor. (Attach map and methodology.)
- ☐ The project provides parking and storage for bicycles and scooters.

The project is not a school project.

8. For small walkable community projects, the project must be a residential project that has a density of at least eight units to the acre or a commercial project with a floor area ratio of at least 0.5, or both.

The project is not proposed as a small walkable community, and would not meet the criteria to be considered a small walkable community project because it is located within the boundary of SACOG, a metropolitan planning organization.

REFERENCES

SACOG. See Sacramento Area Council of Governments.

Sacramento Area Council of Governments. 2020. *Senate Bill 743*. Available: <http://sb743-sacog.opendata.arccgis.com/>. Accessed June 18, 2020.

SECTION III - PROJECT DESCRIPTION

3.1.1 Introduction

California Northstate University (project applicant) proposes to develop a new dormitory (project) for an existing college campus. The proposed development would include 400 dorms located within two standalone structures, an on-site cafeteria building with an additional 16 dorms, and a courtyard with open space, landscaping, and a patio area, on 5.8 acres of an existing parking lot for the university.

3.1.2 Project Location

The project site is located in the central portion of the City of Rancho Cordova, approximately 400 feet southeast of US Highway 50 (US 50). The project site includes Assessor's Parcel Number 072-0600-002-0000. The project site is 5.8 acres in size and is currently used by California Northstate University for student and faculty parking with direct access to Prospect Park Drive. The site is bounded by Prospect Park Drive to the north/northeast, California Northstate University to the west, and commercial office space to the south/southeast. Figure 1 shows the project location.

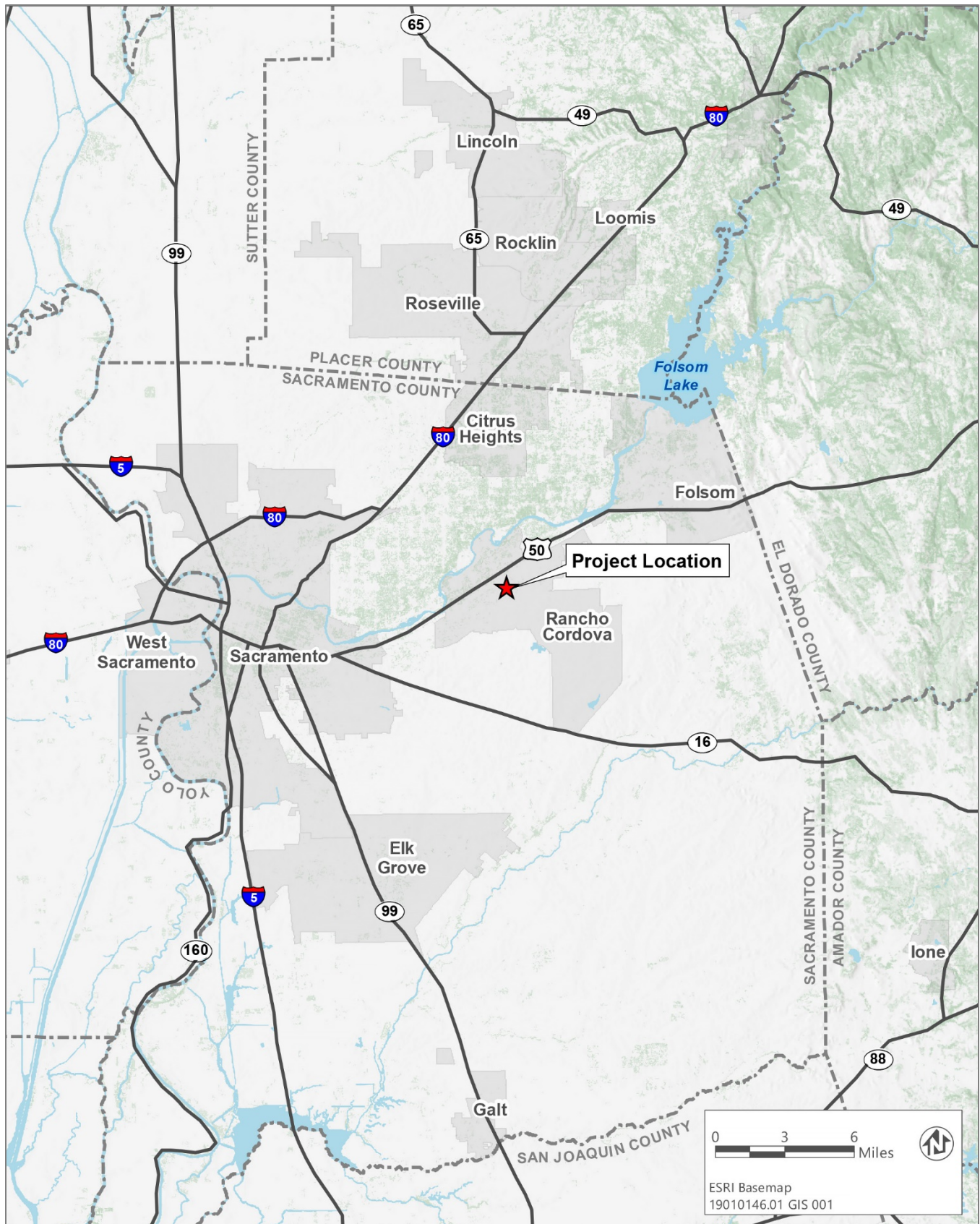
3.1.3 General Plan and Zoning

The project site is designated as Office Mixed Use in the City's General Plan Land Use Diagram. As described in the City's General Plan Land Use Element, this designation encourages the integration of commercial and/or residential use in conjunction with office use of a site. The project is consistent with the General Plan designation with an approved conditional use permit (CUP).

The project site is within the Office Professional Mixed Use (OPMU) zone. The purpose of the OPMU zone is to allow for the development of larger office buildings and business parks with supporting retail and service uses. The predominant use is office, but commercial, service and residential uses may be integrated into office buildings or located horizontally in freestanding buildings. This district also allows some standalone uses that are not traditional or predominant office uses, such as hospitals, banks/financial institutions, hotels/motels, and recreation, education, and public assembly uses. In this case, the proposed dormitory would be a supporting use integrated into overall campus operations for the university and is considered consistent with zoning requirements with approval of a CUP (Municipal Code Section 23.313.030, fn. 31).

3.1.4 Existing and Adjacent Uses

The project site is currently a paved parking lot. Adjacent uses to the project site are entirely office uses, with some office space occupied by educational uses (e.g., California Northstate University to the west and Chamberlain University College of Nursing to the north). As noted in Section I, US 50 is located less than 500 feet to the northwest of the project site.



Source: Adapted by Ascent Environmental in 2020

Figure 1 Regional Location

3.2 PROJECT DESIGN

On-site development would consist of three primary structures. Two of the structures (Buildings A and B) would be five stories in height and provide a total of 400 dorm rooms. Building A would be approximately 50,700 square feet (sf) in size and provide 190 dorm rooms, whereas Building B would be approximately 53,900 sf in size and provide 210 dorm rooms. Both structures would be approximately 55-60 feet (5 stories) in height and would provide laundry facilities, lounge space, and a recreation room. The third on-site structure would be a two-story cafeteria building, which would offer dining options for students attending the university and/or residing in the dorms. 16 additional dorm rooms would be provided within the cafeteria building (see Figure 2).

The proposed dorms would be modular construction (i.e., manufactured off-site and assembled together on the project site). The exterior of each building would then be constructed on the outside of the modular units once they are assembled together. This type of construction will be unique in Rancho Cordova and has been used frequently in other jurisdictions for various housing types, including student housing.

The current building design consists of a mixture of modern and traditional architecture that includes horizontal lines; roof line and canopies, hipped roofs, and varying wall planes. Proposed colors range from a light cream to a medium brown, with blue and gray tones mixed in. Materials include stucco, as well as aluminum panels. Canopies have also been included over the entrances of the buildings to provide some additional architectural enhancements and a covered entry.

Project design would include ventilation system capable of achieving the protection from particulate matter (PM_{2.5}) equivalent to that of a Minimum Efficiency Reporting Value (MERV) 13 filtration (as defined by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 52.2). This filtration standard is used to capture particulate matter to protect public health. The City of San Francisco Municipal Code Section 3807 (Enhanced Filtration Requirement) uses this standard to address public health exposures to significant sources of air pollution.

3.2.1 Landscaping

In between the Buildings A and B, a large landscaped open space area would be provided with walking paths and various seating areas. This would serve as an amenity to the residents, students and faculty of the university.

Additional landscaping along the street and internal to the site would be installed, consisting of a mixture of trees and shrubs. Most trees that are proposed to be planted on the site would be 15-gallons, with some larger 24" box trees to provide greater initial shade and variation in landscape aesthetic. The City's requirement for percentage of parking lot shade is a minimum of 50 percent coverage. As currently proposed, the project would provide shade over 58 percent of the proposed on-site parking areas.

3.2.2 Circulation

The existing ingress/egress point along Prospect Park Drive would be maintained with implementation of the project. 140 parking spaces would be provided on-site, and residents would be permitted to utilize the adjacent parking lot to the west for the university. Walkways and sidewalks would be provided within the site to provide greater connections between on-site structures and the California Northstate University campus to the west. Additionally, bicycle racks would be provided for residents use.

3.3 PROJECT CONSTRUCTION

The project would be constructed over a period of 14 months, beginning in late 2020. On-site activities would consist of site preparation, construction (modular assembly and building facades), paving, and painting of the proposed structures. In addition, connection to existing utility lines located within Prospect Park Drive would be necessary.

3.4 ACTIONS

The project requires the following planning approvals from the City of Rancho Cordova:

- ▶ Conditional Use Permit
- ▶ Major Design Review



Source: Adapted by Ascent Environmental in 2020

Figure 2 Project Site Plan

SECTION IV-INFILL ENVIRONMENTAL CHECKLIST

4.1 AESTHETICS

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
I. Aesthetics.					
Except as provided in Public Resources Code section 21099, would the project:					
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☒	☐	☐
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☒	☐	☐
c) In non-urbanized areas, substantially degrade the existing visual character or quality of public views of the site and its surroundings? (Public views are those that are experienced from publicly accessible vantage points.) If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?	☐	☐	☐	☒	☒
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒	☒

4.1.1 Environmental Setting

The project area consists of developed business park area of the City. The project site consists of a paved parking lot, located within a developed commercial business park. Curbed islands of grass, landscape trees, and ornamental bushes are scattered throughout the central portion of the project site. Mature trees line the project boundary with pine trees along the project site's southern border, fir trees along the western border, and a mix of mature evergreen and deciduous trees along the northern boundary of the site. Topography on the project site and in the vicinity of the project site is predominantly flat.

Office buildings occupy the parcels surrounding the site. These include California Northstate University of Health Sciences, National University's Rancho Cordova campus, and Chamberlain University College of Nursing's California Campus. The majority of the buildings surrounding the area are 2 to 4 stories tall, and are primarily situated in the center of their lots, surrounded by surface parking and other open space. Views of the project site from US Highway 50 (US 50) are largely obscured by existing buildings and mature trees.

Similarly, views of existing buildings from the project site are largely obscured by existing trees and other barriers. On the northern border of the project site, the roadway is visible below the branches of the trees; however, the canopy on both sides of Prospect Park Drive block views of existing buildings.

US 50 is not designated scenic highways within the City of Rancho Cordova (City of Rancho Cordova 2006).

4.1.2 Discussion

a, b. No Impact. The project site is located within a fully developed business park, with well-established trees along all major roads in the vicinity and bordering each parcel. US 50 is not a designated scenic highway within the City. Due to the relatively flat topography of the area and the presence of numerous landscape trees on the project site and adjacent parcels, no scenic resources or vistas are visible from the project site, nor are there any nearby scenic resources or vistas that have views of the project site. While the project would replace the existing paved parking lot with several buildings, on-site structures would be consistent in massing, scale, and architectural style with existing structures in the area. Therefore, further environmental review is not required for this topic.

c. Analyzed in Prior EIR and Substantially Mitigated by Uniformly Applicable Development Policies. Implementation of the project would involve the replacement of the existing surface parking lot with several dormitory structures, which would result in a change in visual character of the project site. However, these changes were anticipated in the General Plan EIR since the project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. The General Plan EIR only anticipated significant impact arising from new high rise development or the conversion of rural environments. The project would not involve either as the project site is located within a developed/urbanized area, is surrounded by multi-story buildings, and the type and scale of development proposed at the project site is considered to be conditionally acceptable under the City of Rancho Cordova's zoning regulations. Additionally, City staff have determined that the project is consistent with the purpose and intent of adopted policies and regulations, including the General Plan, Zoning Code, and Design Guidelines (City of Rancho Cordova 2020). The proposed buildings are consistent in height, setbacks, and the architecture is consistent with the surrounding area. The design, color, and materials have been designed to integrate and compliment the surrounding buildings and area, but also provide additional architectural character to the area. The building design includes mixture of modern and traditional architecture that includes horizontal lines; roof line and canopies, hipped roofs, and varying wall planes. Proposed colors range from a light cream to a medium brown, with blue and gray tones mixed in. Materials include stucco, as well as aluminum panels. Canopies have also been included over the entrances of the buildings to provide some additional architectural enhancements and a covered entry. The General Plan EIR determined implementation of development standards and design guidelines would mitigate impacts related to visual character (General Plan EIR, pp. 4.13-9 – 4.13-13).

Because this impact was analyzed in the General Plan EIR and would be substantially mitigated by uniformly applicable development policies, no further environmental review is required.

d. Analyzed in Prior EIR and Substantially Mitigated by Uniformly Applicable Development Policies. Currently the project site has existing lighting, associated with security lighting for the existing surface parking lot. With implementation of the project, on-site buildings would include interior and exterior lighting. These changes were anticipated in the General Plan EIR since the project is consistent with the site's General Plan land use designation and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. Exterior lighting would be required to comply with the lighting standards in Municipal Code Chapter 23.725, Outdoor Lighting, and would be angled down and away from adjacent uses and US 50 to avoid light spillover. Further, due to the presence of adjacent landscaping and taking into consideration the existing, adjacent development and its associated lighting, the project would not represent a substantial or substantively different source of light or glare compared to existing development in the area or lighting from lighting for other uses that would be allowed by right on the project site. Additionally, there are no neighboring residential properties that would be impacted by sleep disturbance or other nuisance caused by nighttime spillover lighting. Because this impact was analyzed in the General Plan EIR and would be substantially mitigated by uniformly applicable development policies, no further environmental review is required.

4.1.3 Mitigation Measure

None required.

4.1.4 General Plan Consistency Analysis

Impacts related to aesthetics have been adequately addressed in Chapter 4.13 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006).

As stated above, no impacts are anticipated to scenic vistas or resources.

Further, the project will comply with the City's development standards and design guidelines to ensure the project is compatible with the character of and integrates into the surrounding area. City staff have determined that the project is consistent with the purpose and intent of adopted policies and regulations, including the General Plan, Zoning Code, and Design Guidelines (City of Rancho Cordova 2020). The proposed buildings are consistent in height, setbacks, and the architecture is consistent with the surrounding area. The design, color, and materials have been designed to integrate and compliment the surrounding buildings and area, but also provide additional architectural character to the area.

Additionally, the project will comply with Municipal Code sections, such as Chapter 23.725. regarding lighting and glare to ensure the project will not result in significant impacts. Since the project site is surrounded by office uses, there will be no impact from nighttime spillover lighting interrupting sleeping patterns or otherwise causing a nuisance to neighboring residents (see General Plan DEIR, p. 4.13-13).

There are no significant effects related to aesthetics peculiar to the proposed project or project site; additionally, there are no significant aesthetic impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.1.5 References

City of Rancho Cordova. 2006 (March). *General Plan Draft EIR*. State Clearinghouse No. 2005022137. Prepared by the City of Rancho Cordova.

———. 2020. (April). Memorandum to the City Council Regarding the California Northstate University Dormitory Conditional Use Permit and Major Design Review Permit; Project No. DD9919.

4.2 AGRICULTURE AND FOREST RESOURCES

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
II. Agriculture and Forest Resources.					
Would the project:					
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☒	☐	☐
b) Conflict with existing zoning for agricultural use or a Williamson Act contract?	☐	☐	☒	☐	☐
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?	☐	☐	☒	☐	☐
d) Result in the loss of forest land or conversion of forest land to non-forest use?	☐	☐	☒	☐	☐
e) Involve other changes in the existing environment, which, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use?	☐	☐	☒	☐	☐

4.2.1 Environmental Setting

The project site is located in a developed business park within City, on an existing parking lot. The business park is fully developed, and unlikely to become agricultural land in the future. The city of Rancho Cordova General Plan There are no agricultural lands or forest lands on or adjacent to the project site.

4.2.2 Discussion

a-e. No Impact. The project site is a paved parking lot located in a developed business park, zoned for Office Professional Mixed-Use. There are no agricultural lands, timberlands, forest lands, lands under a Williamson Act contract, or non-disturbed environments on or adjacent to the proposed project site. Neither the proposed project nor the construction of the proposed project would impact agricultural lands, timberlands, forest lands, lands under a Williamson Act contract, or non-disturbed environments. Because the project would have no agricultural-related impacts, no further environmental review is required.

4.2.3 Mitigation Measure

None required.

4.2.4 General Plan Consistency Analysis

The potential for buildout of the General Plan to result in Agricultural impacts was adequately addressed in Chapter 4.13 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006).

As stated above, there are no agricultural lands, timberlands, forest lands, lands under a Williamson Act contract, or non-disturbed environments on or adjacent to the proposed project site. Neither the proposed project nor the construction of the proposed project would impact agricultural lands, timberlands, forest lands, lands under a Williamson Act contract, or non-disturbed environments. Thus, the project would have no agricultural-related impacts. Accordingly, no further environmental review is required.

4.3 AIR QUALITY

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
III. Air Quality.					
Where available, the significance criteria established by the applicable air quality management district or air pollution control district may be relied on to make the following determinations. Would the project:					
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒	☐
b) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard?	☐	☐	☐	☐	☒
c) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐	☐
d) Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people?	☐	☐	☒	☐	☐

4.3.1 Environmental Setting

The project is located in the Sacramento Valley Air Basin (SVAB), which includes the counties of Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, and Yuba. Ozone, respirable particulate matter (PM₁₀), and fine particulate matter (PM_{2.5}) are the criteria air pollutants of primary concern in this analysis because of their nonattainment status with respect to the applicable national ambient air quality standards (NAAQS) and California ambient air quality standards (CAAQS) in the SVAB.

The Sacramento Metropolitan Air Quality Management District (SMAQMD) is the primary agency responsible for planning to meet NAAQS CAAQS in Sacramento County. SMAQMD works with other local air districts in the Sacramento region to maintain the region's portion of the State Implementation Plan (SIP) for ozone. The SIP is a compilation of plans and regulations that govern how the region and State will comply with the Clean Air Act (CAA) requirements to attain and maintain the NAAQS for ozone. The Sacramento region has been designated as a "moderate" 2015 8-hour ozone nonattainment area with an extended attainment deadline of June 15, 2019 (EPA 2019). The 2018 Sacramento Regional 2008 8-Hour Ozone Attainment and Further Reasonable Progress Plan was approved by the California Air Resources Board (CARB) on November 16, 2017. The previous 2013 Update to the 8-Hour Ozone Attainment and Reasonable Further Progress Plan was approved and promulgated by US Environmental Protection Agency (EPA) for the 1997 8-Hour Ozone Standard. EPA has not released a notice of approval and promulgation of the 2017 SIP (CARB 2017).

SMAQMD has developed a set of guidelines for use by lead agencies when preparing environmental documents. The guidelines contain thresholds of significance for criteria pollutants and toxic air contaminants (TACs), and also make recommendations for conducting air quality analyses. After SMAQMD guidelines have been consulted and the air quality impacts of a project have been assessed, the lead agency's analysis undergoes a review by SMAQMD. SMAQMD submits comments and suggestions to the lead agency for incorporation into the environmental document.

For the purposes of this analysis, emissions that exceed the following SMAQMD emissions thresholds would be considered to lead to a violation or contribute to a violation of the ambient air quality standards for ozone (O₃) precursors (reactive organic gases [ROG] and nitrogen oxide [NO_x]), PM₁₀ and PM_{2.5}:

- ▶ During construction
 - 85 pounds per day (lb/day) for NO_x,
 - 80 lb/day or 14.6 tons per years (tpy) for PM₁₀ (if best available control technologies [BACT] and best management practices [BMPs] are applied to construction), and
 - 82 lb/day or 15 tpy for PM_{2.5} (if BACT and BMPs are applied to construction).
- ▶ During operation
 - 65 lb/day for ROG and NO_x,
 - 80 lb/day or 14.6 tpy for PM₁₀ (if operation-related BACT and BMPs are applied), and
 - 82 lb/day or 15 tpy for PM_{2.5} (if operation-related BACT and BMPs are applied).

All projects are subject to adopted SMAQMD rules and regulations in effect at the time of construction. Specific rules applicable to the construction of the proposed Project may include but are not limited to the following:

- ▶ **Rule 201: General Permit Requirements.** Any project that includes the use of equipment capable of releasing emissions to the atmosphere may be required to obtain permit(s) from SMAQMD before equipment operation. The applicant, developer, or operator of a project that includes an emergency generator, boiler, or heater should contact SMAQMD early to determine whether a permit is required, and to begin the permit application process. Portable construction equipment (e.g., generators, compressors, pile drivers, lighting equipment) with an internal combustion engine greater than 50 horsepower must have a SMAQMD permit or CARB portable equipment registration.
- ▶ **Rule 202: New Source Review.** The purpose of this rule is to provide for the issuance of authorities to construct and permits to operate at new and modified stationary air pollution sources and to provide mechanisms, including emission offsets, by which authorities to construct such sources may be granted without interfering with the attainment or maintenance of ambient air quality standards.
- ▶ **Rule 207: Federal Operating Permit.** The purpose this rule is to establish an operating permitting system consistent with the requirements of Title V of the United States Code and pursuant to 40 FR Part 70. Stationary sources subject to the requirements of this rule are also required to comply with any other applicable federal, state, or SMAQMD orders, rules and regulations, including requirements pertaining to prevention of significant deterioration pursuant to Rule 203, requirements to obtain an authority to construct pursuant to Rule 201, or applicable requirements under SMAQMD's new source review rule in the SIP.
- ▶ **Rule 402: Nuisance.** A person shall not discharge from any source whatsoever such quantities of air contaminants or other materials which cause injury, detriment, nuisance or annoyance to any considerable number of persons or the public, or which endanger the comfort, repose, health or safety of any such persons or the public, or which cause or have natural tendency to cause injury or damage to business or property.
- ▶ **Rule 403: Fugitive Dust.** The developer or contractor is required to control dust emissions from earthmoving activities or any other construction activity to prevent airborne dust from leaving the project site. Fugitive dust controls include the following:
 - Water all exposed surfaces two times daily.
 - Cover or maintain at least two feet of free board on haul trucks transporting soil, sand, or other loose material on the site.
 - Use wet power vacuum street sweepers to remove any visible trackout mud or dirt onto adjacent public roads at least once a day.

- Limit vehicle speeds on unpaved roads to 15 miles per hour.
- All roadways, driveways, sidewalks, parking lots to be paved should be completed as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.
- Minimize idling time either by shutting equipment off when not in use or reducing the time of idling to 5 minutes.
- Maintain all construction equipment in proper working condition according to manufacturer's specifications.
- ▶ **Rule 442: Architectural Coatings.** The purpose of this rule is to limit the emissions of volatile organic compounds from the use of architectural coatings supplied, sold, offered for sale, applied, solicited for application, or manufactured for use within Sacramento County.
- ▶ **Rule 902: Asbestos.** The developer or contractor is required to notify SMAQMD of any regulated renovation or demolition activity. Rule 902 contains specific requirements for surveying, notification, removal, and disposal of material containing asbestos.

In addition, if modeled construction-generated emissions for a project are not reduced to levels below SMAQMD's mass emission threshold (of 85 lb/day for NO_x, 80 lb/day or 14.6 tpy for PM₁₀, and 82 lb/day or 15 tpy for PM_{2.5}) after the standard construction mitigation is applied, then SMAQMD requires purchasing an off-site construction mitigation fee to purchase off-site emissions reductions. Such purchases are made through SMAQMD's Heavy Duty Incentive Program, through which select owners of heavy-duty equipment in Sacramento County can repower or retrofit their old engines with cleaner engines or technologies (SMAQMD 2019).

AIR QUALITY MANAGEMENT PLANS

For land use development projects that will exceed SMAQMD's operational emissions thresholds of significance for ROG, NO_x, or PM, it is recommended that the project applicant develop an air quality mitigation plan (AQMP) describing how the project will reduce operational emissions. SMAQMD recommends that if a project exceeds these thresholds, mitigation must be identified to reduce on-road mobile source emissions by 15 percent if the project is within the current State Implementation Plan (SIP), or by 35 percent if not within the SIP. SMAQMD's Recommended Guidance for Land Use Emission Reductions provides guidance in developing an AQMP to achieve the necessary reductions through emissions reductions strategies.

TOXIC AIR CONTAMINANTS

At the local level, air districts may adopt and enforce CARB control measures for TACs. Under SMAQMD Rule 201 ("General Permit Requirements"), Rule 202 ("New Source Review"), and Rule 207 ("Federal Operating Permit"), all sources that possess the potential to emit TACs are required to obtain permits from SMAQMD. Permits may be granted to these operations if they are constructed and operated in accordance with applicable regulations, including New Source Review standards and air toxics control measures. SMAQMD limits emissions and public exposure to TACs through a number of programs. SMAQMD prioritizes TAC-emitting stationary sources based on the quantity and toxicity of the TAC emissions and the proximity of the facilities to sensitive receptors. Sensitive receptors are people or facilities that generally house people (e.g., schools, hospitals, residences) that may experience adverse effects from unhealthful concentrations of air pollutants.

ODORS

Although offensive odors rarely cause any physical harm, they can be very unpleasant, leading to considerable stress among the public and often generating citizen complaints to local governments and SMAQMD. SMAQMD's Rule 402 (Nuisance) regulates odorous emissions.

SENSITIVE RECEPTORS

Sensitive receptors are generally considered to include those land uses where exposure to pollutants could result in health-related risks to sensitive individuals, such as children or the elderly. Residential dwellings, schools, hospitals, playgrounds, and similar facilities are of primary concern because of the presence of individuals particularly sensitive to pollutants and/or the potential for increased and prolonged exposure of individuals to pollutants. There are no sensitive receptors located within 1,500 feet of the project site.

4.3.2 Discussion

a. **Analyzed in Prior EIR.** The project site is currently designated by the City of Rancho Cordova General Plan as Office Mixed Use (OMU). This designation encourages the integration of commercial and/or residential use in conjunction with office use; however, it also allows for public/quasi-public uses (City of Rancho Cordova 2006). Therefore, the proposed project would be consistent with the existing land use designations for the site. Further, as noted above in Section II, "Satisfaction of Appendix M Performance Standards," The project is anticipated to generate 644 daily trips. Because classes are in session at CNU only 275 days per year, average annual daily trips were estimated as 486 trips new daily trips during the academic year, 891,294 VMT per year, and 7.8 VMT per capita per day, based on an on-site population of 400 students. Regional VMT averages for residential uses are 17.91 VMT per capita per day (SACOG 2020). The project's VMT per capita represents 43 percent of the current regional average (a 57 percent reduction), in exceedance of the 15 percent target reduction recommended by the California Office of Planning and Research. Although the project increases on-site population, it locates students closer to their destination, thereby reducing VMT, consistent with regional efforts and the intent of residential infill development. Further, operation of 100,000-square-foot office use on the project site would generate approximately 1,103 daily vehicle trips. Therefore, the proposed dormitory facilities would have fewer trips than a similarly-sized office use and would generate proportionately fewer emissions. Furthermore, the project site is located on an infill parcel in an urbanized area of the city. This aspect of the project would result in the generation of a reduced amount of air pollutants relative to the land use assumed in the General Plan. According to the EPA (2011), infill developments produce 32 to 57 percent less air pollutant emissions per capita relative to conventional developments. This is because the number of daily vehicle trips and daily VMT associated with infill tend to be lower compared with development on greenfield land (EPA 2011).

The project would not result in a change in a designated land use as evaluated in the City's General Plan EIR, and would not substantially increase VMT beyond that accounted for in the regional emissions inventories contained in the applicable regional air quality control plans. Therefore, the project would not conflict with the applicable air quality plans. The impact was adequately analyzed in a prior EIR. Therefore, no further environmental review is required.

b. **Substantially Mitigated by Uniformly Applicable Development Policies.** As noted above, Sacramento County is currently designated nonattainment with respect to the ozone, PM₁₀, and PM_{2.5} California ambient air quality standards. For the purposes of this analysis, emissions that exceed the SMAQMD's construction and operational emissions would be considered to lead to a violation or contribute to a violation of the ambient air quality standards for ozone precursors (ROG and NO_x), PM₁₀ and PM_{2.5}.

CONSTRUCTION EMISSIONS

Development of the project would result in construction activities that would generate emissions of criteria air pollutants and precursors, including ROG, NO_x, PM₁₀, and PM_{2.5}, from site preparation (e.g., excavation, clearing), off-road equipment, material delivery, worker commute trips, and other miscellaneous activities (e.g., building construction, asphalt paving, application of architectural coatings). Typical equipment used during construction activities could include all-terrain forklifts, cranes, pick-up and fuel trucks, compressors, loaders, backhoes, excavators, dozers, scrapers, pavement compactors, welders, concrete pumps, concrete trucks, and off-road haul trucks, as well as other diesel-fueled equipment, as necessary. Fugitive dust emissions of PM₁₀ and PM_{2.5} are associated primarily with site

preparation and vary as a function of soil silt content, soil moisture, wind speed, acreage of disturbance, and mobile sources. Emissions of ozone precursors are emitted in the exhaust of construction equipment and on-road vehicles. Paving and the application of architectural coatings also results in off-gas emissions of volatile organic compounds. PM₁₀ and PM_{2.5} are also contained in equipment and vehicle exhaust. Construction activities were estimated to occur between 2020 and 2021. Construction-related emissions of criteria air pollutants and precursors were estimated using the California Emissions Estimator Model (CalEEMod) Version 2016.3.2 computer program (SCAQMD 2017) and are shown below in Table 1.

Table 1 Modeled Daily Maximum Construction Emissions of Criteria Air Pollutants and Precursors

Construction Phase	Emissions Summary				
	NO _x (lb/day)	PM ₁₀ (lb/day)	PM ₁₀ (tpy)	PM _{2.5} (lb/day)	PM _{2.5} (tpy)
2020	28.9	8.2	0.1	4.2	0.1
2021	24.8	4.5	0.4	1.9	0.2
Maximum Daily Emissions	28.9	8.2	0.4	4.2	0.2
SMAQMD Thresholds	85	82 ¹	15 ¹	80 ²	14.6 ²
Exceed Significance Threshold?	No	No	No	No	No

Notes: CO = carbon monoxide; lb/day = pounds per day; tpy = tons per year; NO_x = oxides of nitrogen; PM_{2.5} = fine particulate matter; PM₁₀ = respirable particulate matter; ROG = reactive organic gases; SMAQMD = Sacramento Metropolitan Air Quality Management District.

¹ So long as all feasible BACT/BMPs are applied.

² So long as all feasible BACT/BMPs are applied.

See Appendix C for detailed input parameters and modeling results.

Source: Modeling performed by Ascent Environmental in 2019.

According to the SMAQMD guidance, projects that do not implement SMAQMD's BMPs must meet a zero peak daily and annual emission threshold for PM₁₀ and PM_{2.5}. With implementation of the City's General Plan policies and actions (specifically, Policy AQ.1.2 and Action 1.2.3 related to incorporation of emission-reducing features (i.e., BACT and BMPs consistent with SMAQMD requirements), the SMAQMD's peak daily and annual thresholds of 80 lb/day or 14.6 tpy of PM₁₀ and 82 lb/day or 15 tpy of PM_{2.5} would apply to the project. Condition of Approval 18 would require water quality controls during construction that would include the control of exposed soils that could generate dust emissions. As shown above, construction activities at the project site would not generate emissions in excess of established maximum daily or annual emissions thresholds for NO_x, PM₁₀, and PM_{2.5}. As a result, the project would not cause construction-generated criteria air pollutant or precursor emissions to exceed the SMAQMD-recommended thresholds through implementation of uniformly applicable development policies and implementation of City of Ranch Cordova General Plan Policies and Actions, as evaluated in the 2005 General Plan EIR.

OPERATION

Regional air pollutant emissions associated with project operations include area source emissions, energy-use emissions, and mobile source emissions. Area source emissions comprise emissions from fuel combustion from space and water heating, landscape maintenance equipment, evaporative emissions from architectural coatings and consumer products, and unpermitted emissions from stationary sources. Energy-use emissions comprise emissions from on-site natural gas usage, and mobile source emissions comprise emissions from automobiles (e.g., trucks, cars, parking lot sweepers).

Operational area source emissions, energy-use emissions, and mobile source emissions for the proposed project were calculated using the CalEEMod air quality model. According to the SMAQMD guidance, projects that do not implement SMAQMD's BMPs must meet a zero peak daily and annual emission threshold for PM₁₀ and PM_{2.5}. With implementation of SMAQMD's BMPs, the SMAQMD's peak daily and annual thresholds increase to 80 lb/day or 14.6

tpy of PM₁₀ and 82 lb/day or 15 tpy of PM_{2.5}. As the project would comply with Title 24 energy efficiency requirements (adopted by Municipal Code section 16.26.030), all applicable rules adopted by SMAQMD related to the control of operational PM and NO_x emissions, and would comply with idling requirements for any commercial vehicles associated with on-site operations (e.g., deliveries associated with cafeteria operations), the adjusted thresholds are considered applicable to the project.

As shown in Table 2 below, operational activities associated with implementation of the project would not generate emissions that would exceed SMAQMD-established thresholds. As a result, the project, which would implement uniformly applicable development policies, would not result in a significant operational impact related to criteria pollutant emissions. Accordingly, no further environmental review is required.

Table 2 Summary of Maximum Operational Emissions of Criteria Air Pollutants and Precursors

Source Type	Maximum Daily Emissions (lb/day)			
	ROG	NO _x	PM ₁₀	PM _{2.5}
Area	4.0	0.4	0.2	0.2
Energy	0.1	1.2	0.1	0.1
Mobile	0.9	2.8	1.9	0.5
Total	5.1	4.4	1.9	0.8
SMAQMD Threshold	65	65	80	82
Exceed Significance Threshold?	No	No	No	No

Notes: Total values may not add correctly due to rounding.

lb/day = pounds per day; NO_x = oxides of nitrogen; PM₁₀ = respirable particulate matter; PM_{2.5} = fine particulate matter; ROG = reactive organic gases; SMAQMD = Sacramento Metropolitan Air Quality Management District.

Source: Modeling performed by Ascent Environmental in 2020.

c. No Impact. Construction-related activities and operation of the project site would generate air pollutant emissions, but the project site is located over 1,500 feet from nearby sensitive receptors. The degree to which pollutant emissions can affect receptors is largely affected by the distance between source and receptor. For example, diesel PM is highly dispersive (e.g., diesel PM concentrations decrease by 70 percent at 500 feet from the source) (Zhu et al. 2002b:1032), and receptors must be in close proximity to emission sources to result in the possibility of exposure to concentrations of concern. Given the locations of potential receptors relative to potential emission sources at the project site, including during construction, the concentrations and durations of any air quality pollutant exposure would be limited. Therefore, considering the relatively low level of emissions that would be generated as a result of project implementation, the distance to the nearest off-site sensitive receptors, and the highly dispersive properties of air quality pollutants, project-related emissions would not expose sensitive receptors to substantial pollutant concentrations. Further, the types of uses proposed as part of the project are not considered to be associated with the generation of substantial TAC emissions, and as such, their operation would not result in substantial pollutant concentrations at nearby receptors.

Project design would include ventilation system capable of achieving the protection from particulate matter (PM_{2.5}) equivalent to that of a Minimum Efficiency Reporting Value (MERV) 13 filtration (as defined by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 52.2). This filtration standard is used to capture particulate matter to protect public health. The City of San Francisco Municipal Code Section 3807 (Enhanced Filtration Requirement) uses this standard to address public health exposures to significant sources of air pollution.

As a result, no impact is anticipated, and no further environmental review is required.

d. No Impact. The occurrence and severity of odor impacts depends on numerous factors, including: the nature, frequency, and intensity of the source; wind speed and direction; and the sensitivity of the receptors. While offensive odors rarely cause any physical harm, they still can be very unpleasant, leading to considerable distress among the public and often generating citizen complaints to local governments and regulatory agencies. Projects with the

potential to frequently expose a substantial number of members of the public to objectionable odors would be deemed to have a significant impact.

Minor odors from the use of heavy duty diesel equipment and the laying of asphalt during project-related construction activities would be intermittent and temporary, and would dissipate rapidly from the source with an increase with distance. Taking into consideration the distance between the project site and nearby sensitive receptors (i.e., at least 1,500 feet) the potential for odors from construction activities at the project site would be minimal and temporary.

SMAQMD has developed a list odor sources of concern as well as screening distances for each facility type to be used in the environmental review process to identify any potential odor issues. The list includes wastewater treatment plants, sanitary landfills, composting facilities, recycling facilities, petroleum refineries, chemical manufacturing plants, painting operations, rendering plants, and food packaging plants (SMAQMD 2016). The potential residential uses associated with the project do not include any land uses (e.g., industrial) that are typically associated with substantial odors or included in the SMAQMD's odor sources list. Therefore, project implementation would not result in any major sources of odor as it is not proposed to include any features or facilities known to produce objectionable odors (e.g., landfill, wastewater treatment plant, compost facility). Diesel exhaust from the use of on-site construction equipment would be intermittent and temporary, and would dissipate rapidly from the source with an increase in distance. Thus, neither construction nor operation of the project would create objectionable odors affecting a substantial number of people. No impact would occur. Accordingly, no further environmental review is required.

4.3.3 Mitigation Measure

None required.

4.3.4 General Plan Consistency Analysis

Impacts related to air quality have been adequately addressed in Chapter 4.6 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006).

The project will not conflict with or obstruct implementation of any applicable air quality plan. As an infill site, it would produce 32 to 57 less air pollutant emission per capita, according to the EPA. It is also projected to result in a 57 percent reduction in per capita VMT, which will reduce vehicle emissions. Additionally, it will not lead to a violation or contribute to a violation of the ambient air quality standards for O₃ precursors (ROG and NO_x), PM₁₀ and PM_{2.5}. The project site zoned Office Professional Mixed-Use (OPMU), which allows a minimum floor area ratio of 0.25 and a maximum floor area ratio of 2.0 (Municipal Code § 23.313.040). The project's floor area ratio is 0.85, which is less than half of the floor area allowed in the General Plan. Because the project is consistent with the development density established in the General Plan, the operational effects of development of the site would have been considered in the EIR, including vehicle trips on US50 and the emissions associated with those trips. For this reason and those discussed above, the project would not result in impacts related to the exposure of sensitive receptors to pollutants or result in other emissions, such as odors.

There are no significant effects related to air quality peculiar to the proposed project or project site; additionally, there are no significant air quality impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.3.5 References

- California Air Resources Board. 2017. Sacramento Region Air Quality Plans. Available: <https://ww2.arb.ca.gov/our-work/programs/california-state-implementation-plans/nonattainment-area-plans/sacramento-region>. Accessed May 13, 2020.
- CARB. See California Air Resources Board.
- City of Rancho Cordova. 2006. (March) *General Plan Draft EIR*. State Clearinghouse No. 2005022137. Prepared by the City of Rancho Cordova.
- EPA. See U.S. Environmental Protection Agency.
- Rancho Cordova. See City of Rancho Cordova.
- SACOG. See Sacramento Area Council of Governments.
- Sacramento Area Council of Governments. 2020. *Senate Bill 743*. Available: <http://sb743-sacog.opendata.arcgis.com/>. Accessed June 18, 2020.
- Sacramento Metropolitan Air Quality Management District. 2016. CEQA Guide Chapter 7: Odors. Available: <http://www.airquality.org/businesses/ceqa-land-use-planning/ceqa-guidance-tools>. Accessed June 16, 2020.
- . 2019 (April). Chapter 3 Appendix, "Off-Site Construction Mitigation Fees." In *Guide to Air Quality Assessment in Sacramento County*. Available: <http://www.airquality.org/LandUseTransportation/Documents/Ch3Off-SiteMitigationFeesFinal4-2019.pdf>. Accessed October 23, 2019.
- SCAQMD. See South Coast Air Quality Management District.
- SMAQMD. See Sacramento Metropolitan Air Quality Management District.
- South Coast Air Quality Management District. 2017. California Emissions Estimator Model Version 2016.3.2. Available: <http://www.caleemod.com/>. Accessed June 16, 2020.
- U.S. Environmental Protection Agency. 2011. Air and Water Quality Impacts of Brownfield Redevelopment.
- . 2019. 8-Hour Ozone (2015) Nonattainment Areas. Available: <https://www3.epa.gov/airquality/greenbook/jnc.html>. Data current as of September 30, 2019.
- Zhu, Y., W. C. Hinds, S. Kim, and C. Sioutas. 2002 Concentration and Size Distribution of Ultrafine Particles Near a Major Highway. *Journal of the Air & Waste Management Association* 52(9):1032–1042.

4.4 BIOLOGICAL RESOURCES

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
IV. Biological Resources.					
Would the project:					
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or the U.S. Fish and Wildlife Service?	☐	☐	☐	☒	☒
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations or by the California Department of Fish and Wildlife or the U.S. Fish and Wildlife Service?	☐	☐	☒	☐	☐
c) Have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☐	☒	☒
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☐	☒
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☒	☐	☐

4.4.1 Environmental Setting

The project is located within a developed commercial business park within the City. The project site is a paved parking lot with green islands containing ornamental trees and shrubs, Mature deciduous, fir, and pine trees line most of the border of the project site. The entirety of the project site and surrounding areas are developed and do not contain natural habitat or wetland features. The American River is located across Hwy 50 from the project site, 1.8

miles to the northwest. During nesting season, there is the potential for protected birds to be temporarily present due to migratory and nesting habits.

4.4.2 Discussion

a. Analyzed in Prior EIR and Substantially Mitigated by Uniform Applicable Development Policies. The project site is currently a paved parking lot within a developed business park, with trees located on and surrounding the site. During nesting season, there is the potential for candidate, sensitive, special-status, or otherwise protected birds to be temporarily present on the project site due to migratory and nesting habits. The project would adhere to Action NR.1.1.4 in the Rancho Cordova General Plan and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance as part of implementation of Condition of Approval 10. If nesting activity is observed, consultation with a certified biologist shall be conducted in order to determine the appropriate steps to be taken in order to ensure the project meets the standard of no impacts to nesting birds. The certified biologist's opinion shall be submitted to the City of Rancho Cordova Planning Department for review and approval. Because this impact was analyzed in the General Plan EIR and would be substantially mitigated by uniformly applicable development policies, no further environmental review is required.

b, c. No Impact. The project site is comprised of a paved parking lot in a developed business park, and no wetlands, waterways, riparian habitats, or other sensitive natural communities are located on or downslope of the project site. The nearest natural waterway is the American River 1.90 miles north of the project site. Construction activities conducted as a result of this project would also have no effect on these resources. As such, the project would have no impact on any federally protected wetlands.

d. Analyzed in Prior EIR and Substantially Mitigated by Uniform Applicable Development Policies. The project site is currently a paved parking lot within a developed business park, with trees located on and surrounding the site. During nesting season, there is the potential for candidate, sensitive, special-status, or otherwise protected birds to be temporarily present on the project site due to migratory and nesting habits. The project would adhere to Action NR.1.1.4 in the Rancho Cordova General Plan and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance as part of implementation of Condition of Approval 10. If nesting activity is observed, consultation with a certified biologist shall be conducted in order to determine the appropriate steps to be taken in order to ensure the project meets the standard of no impacts to nesting birds. The certified biologist's opinion shall be submitted to the City of Rancho Cordova Planning Department for review and approval. Because this impact was analyzed in the General Plan EIR and would be substantially mitigated by uniformly applicable development policies, no further environmental review is required.

e. Substantially Mitigated by Uniform Applicable Development Policies. The project is located within a developed commercial business park within the city of Rancho Cordova. The project site is a paved parking lot with green islands containing ornamental trees and shrubs. Mature deciduous, fir, and pine trees line most of the border of the project site. The project proposes removal of some of the mature trees on the site, and would comply with the City's requirements regarding protected trees (Chapter 19:12 of the City of Rancho Cordova Municipal Code) under Condition of Approval 19. The City's Tree Ordinance requires that the removal of trees with a diameter at breast height 12" or more be replaced at a minimum ratio of 1:1 or otherwise compensated through payment into the City's tree program fund.

f. No Impact. There are no nearby or onsite conservation areas that would be or potentially be impacted by the project or construction activities associated with the project.

4.4.3 Mitigation Measure

None required.

4.4.4 General Plan Consistency Analysis

Impacts related to biological resources have been adequately addressed in Chapter 4.10 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006).

As discussed above, the project will not result in any impacts related to wetlands, waterways, riparian habitats, or other sensitive natural communities because none are located on or downslope of the project site. Further, it would not conflict with provisions of any habitat conservation plan. Potential impacts to migratory and nesting birds were analyzed in the General Plan EIR and would be substantially mitigated by Action NR.1.1.4 in the Rancho Cordova General Plan, implemented by Condition of Approval 10. Additionally, the project would comply with the City's Tree Ordinance to mitigate any impacts to mature trees on the project site.

There are no significant effects related to biological resources peculiar to the proposed project or project site; additionally, there are no significant biological impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.5 CULTURAL RESOURCES

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
V. Cultural Resources.					
Would the project:					
a) Cause a substantial adverse change in the significance of a historical resource pursuant to Section 15064.5?	☐	☐	☒	☐	☐
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064.5?	☐	☐	☐	☒	☐
c) Disturb any human remains, including those interred outside of dedicated cemeteries?	☐	☐	☐	☒	☐

4.5.1 Environmental Setting

The project site is comprised of a paved parking lot in a developed business park with no existing buildings on site, while the surrounding area has been developed with office and commercial uses. The City's General Plan Cultural and Historic Resources Element lists the city's identified historic resources and properties. None of these features occur in the project area. Most of the prehistoric sites are located along the American River and creeks, and some of the sites are known to contain human remains (City of Rancho Cordova 2006). General Plan Draft EIR Figure 4.11-1 identifies that there are no archaeological or culturally sensitive areas in the project area (City of Rancho Cordova 2006).

4.5.2 Discussion

- a. **No Impact.** There are no historic buildings or resources on the project site. Therefore, further environmental review is not required for this topic.
- b. **Analyzed in Prior EIR.** As noted above, the project area is not located within archaeological or culturally sensitive areas identified in the General Plan EIR. The project would be required to comply with Condition of Approval 10 that implements Action CHR 1.3.2 that protects cultural resources accidentally discovered during construction. Because this impact was previously analyzed in the General Plan EIR, no further environmental review is required.
- c. **Analyzed in Prior EIR.** As noted above, the project area is not located within archaeological or culturally sensitive areas identified in the General Plan EIR. The project would be required to comply with California Health and Safety Code Sections 7050.5 and 7052 and California Public Resources Code Section 5097, as reinforced by General Plan Action CHR 1.3.2, which prescribes procedures for the treatment and protection of human remains accidentally discovered during construction. Because this impact was previously analyzed in the General Plan EIR, no further environmental review is required.

4.5.3 Mitigation Measure

None required.

4.5.4 General Plan Consistency Analysis

Impacts related to cultural resources have been adequately addressed in Chapter 4.11 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006). As shown above, there are no historic resources on the project site. The project area is not located within archaeological or culturally sensitive areas identified in the General Plan EIR. If cultural resources or human remains were accidentally discovered during construction, the project would implement Action CHR 1.3.2. There are no significant effects related to cultural resources peculiar to the proposed project or project site; additionally, there are no significant cultural resources impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic.

4.5.5 References

City of Rancho Cordova. 2006. (March) *General Plan Draft EIR*. State Clearinghouse No. 2005022137. Prepared by the City of Rancho Cordova.

4.6 ENERGY

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
VI. Energy.					
Would the project:					
a) Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?	☐	☐	☐	☐	☒
b) Conflict with or obstruct a state or local plan for renewable energy or energy efficiency?	☐	☐	☐	☐	☒

4.6.1 Environmental Setting

Electrical and natural gas service in the project area is provide by the Sacramento Municipal Utility District (SMUD) and Pacific Gas & Electric, respectively. Currently, on-site energy consumption is limited to on-site security lighting associated with the existing surface parking lot.

4.6.2 Discussion

a, b. Substantially Mitigated by Uniformly Applicable Development Policies. Appendix F of the State CEQA Guidelines requires the consideration of the energy implications of a project. CEQA requires mitigation measures to prevent or reduce “wasteful, inefficient and unnecessary” energy usage (Public Resources Code Section 21100, subdivision (b)(3)). Neither the law nor the State CEQA Guidelines establish thresholds that define when energy consumption is considered wasteful, inefficient and unnecessary.

CONSTRUCTION ENERGY USE

During construction, it is assumed that diesel fuel would be used in construction equipment and both diesel and gasoline fuels would be used in on-road vehicles for hauling trips and worker commute trips. Diesel fuel use from off-road construction equipment was estimated based total off-road greenhouse gas (GHG) emissions estimates and a factor of 10.21 kilograms carbon dioxide (CO₂) per gallon of diesel (The Climate Registry 2019). Diesel and gasoline fuel use from on-road construction haul trucks and worker commute trips were estimated using: 1) VMT calculated from model default trip rates and lengths and 2) fuel efficiency factors (in miles per gallon) for light duty vehicles and heavy-duty trucks in Sacramento County in 2022 from EMFAC2017. Total construction-related energy use during the entire construction period is shown in Table 3.

The dormitories would be of modular construction, which provides for efficiency of construction and reduced waste. Less waste results in less energy demand for raw materials. Modular construction also results in less construction equipment on the project site compared to typical construction assumed in the General Plan EIR.

Table 3 Construction-Related Energy Use

Project Component	Total Gallons
Gasoline Consumption by Worker Commute Trips	155
Diesel Consumption by Haul Truck Trips	2,185
Diesel Consumption by Off-Road Construction Equipment	28,280
Total Gasoline Consumption	155
Total Diesel Consumption	30,465

See Attachment A for detailed input parameters and modeling results.

Sources: CalEEMod Version 2016.3.2.; Modeled by Ascent Environmental in 2020

OPERATIONAL ENERGY USE

During project operations, energy would be used by building operations and through fuel used in vehicle trips generated by the project. Annual energy use during project operations was calculated using CalEEMod Version 2016.3.2 software and calculated off-model from CalEEMod outputs, as noted under Greenhouse Gas Emissions, below. With respect to building energy, the project would result in the use of electricity and natural gas on-site as part of normal operations for space and water heating, indoor and outdoor lighting, cooking, and powering appliances. With respect to vehicle fuel use during operation, the project would result in an annual increase of up to 486 new daily trips during the academic year or 891,294 VMT per year. Table 4 shows the total annual energy consumption for the project.

Table 4 Operational Energy Use

Project Component	Electricity (MWh/year)	Natural Gas (MMBtu/year)	Gasoline (gal/year)
Dormitories (Apartments, Mid-Rise)	1,707	3,085	—
Cafeteria (High Turnover Restaurant)	378	1,600	—
Parking Lot	15	—	—
Vehicle Trips	—	—	30,238
Total Consumption	2,100	4,685	30,238

See Attachment A for detailed input parameters and modeling results.

Sources: CalEEMod Version 2016.3.2.; Modeled by Ascent Environmental in 2020

Structures built as part of the proposed project would be subject to Titles 20 and 24 of the California Code of Regulations, which serve to reduce demand for electrical energy by implementing energy-efficient standards for residential and non-residential buildings. The City's General Plan includes Policies LU.2.7, H.4.1, NR.7.1, NR.7.2, NR.7.3, and NR.7.4 to encourage the development of more energy efficient structures, increase overall energy conservation citywide, and reduce the consumption spread of energy-efficient technology by offering rebates and other incentives to commercial and residential developers. As the project would be required to adhere to current energy efficiency standards as well as provide infill development that would reduce student vehicle miles traveled from the provision of on-site housing, it would not be considered to result in the wasteful, inefficient, or unnecessary consumption of energy nor would it conflict with applicable planning efforts related to energy efficiency. In addition, Sacramento Area Council of Governments' (SACOG) 2020 Metropolitan Transportation Policy/Sustainable Communities Strategy (MTP/SCS) concluded that per capita energy consumption will decrease as a result of implementation of the MTP/SCS. The proposed Project is located in an area identified by the 2020 MTP/SCS as a High Frequency Transit Area (HFTA) for Sacramento County. These are areas located within one-half mile of a major transit stop (including an existing or planned light rail, streetcar, or train station) or an existing or planned high-quality transit corridor. The proposed Project is consistent with the MTP/SCS in that it locates housing in an area designated as a High Frequency Transit Area for Sacramento County. At least 45 percent of the electricity provided by SMUD would be from renewable

sources or renewable energy, so the project would not conflict with applicable planning efforts related to renewable energy. No further environmental review is required.

4.6.3 Mitigation Measure

None required.

4.6.4 General Plan Consistency Analysis

As discussed above, the project would not result impacts due to wasteful, inefficient, or unnecessary consumption of energy resources and would not conflict with or obstruct a local plan for renewable energy or energy efficiency. The Project is an infill development and would reduce diesel and gasoline fuel consumption on a regional basis by reducing total student generated VMT. Housing students on the campus would reduce VMT compared to students commuting from various locations in the region, thereby reducing fuel consumption and greenhouse gas emissions. In addition, the dormitories would likely be more energy-efficient than housing options available to students off campus, resulting in less energy demand per capita. Further, the new buildings would be required to comply with the Building Energy Efficiency Standards (California Code of Regulations, Title 24, Parts 6 and 11), which provide minimum efficiency standards related to various building features, including appliances, water and space heating and cooling equipment, building insulation and roofing, and lighting. Implementation of these standards would significantly reduce energy usage from the project. The Project is consistent with the 2020 MTP/SCS, which would reduce per capita energy consumption. Additionally, at least 45 percent of the electricity provided by SMUD would be from renewable sources. Further, the dormitories would be of modular construction, which provides for efficiency of construction and reduced waste. Less waste results in less energy demand for raw materials. Modular construction also results in less construction equipment on the project site compared to typical construction assumed in the General Plan EIR. The project would not result in any unusual characteristics that would result in excessive operational energy consumption. The proposed project would not place a substantial demand on regional energy supply or require significant additional capacity; significantly increase peak and base period electricity demand; cause wasteful, inefficient, and unnecessary consumption of energy during project construction, operation, and/or maintenance; or preempt future energy development or future energy conservation. Thus, consumption associated with construction and operational energy demand of the project would not be considered inefficient, wasteful, or unnecessary in comparison to other similar developments in the region. No further analysis is required.

4.6.5 References

California Air Resources Board. 2020. EMFAC2017 computer program, Version 1.0.2 (web-based). Sacramento, CA. Available: <https://arb.ca.gov/emfac/>. Accessed May 29, 2020.

CARB. See California Air Resources Board.

The Climate Registry. 2019 (May). 2019 Default emission factors. Available: <https://www.theclimateregistry.org/wp-content/uploads/2019/05/The-Climate-Registry-2019-Default-Emission-Factor-Document.pdf>. Accessed June 2, 2020.

SCAQMD. See South Coast Air Quality Management District.

South Coast Air Quality Management District. 2017. California Emissions Estimator Model (CalEEMod) Version 2016.3.2. Available: <http://www.caleemod.com/>. Accessed June 1, 2020.

4.7 GEOLOGY AND SOILS

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
VII. Geology and Soils.					
Would the project:					
a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:					
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? (Refer to California Geological Survey Special Publication 42.)	☐	☐	☒	☐	☐
ii) Strong seismic ground shaking?	☐	☐	☒	☐	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☒	☐	☐
iv) Landslides?	☐	☐	☒	☐	☐
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	☐	☒
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994, as updated), creating substantial direct or indirect risks to life or property?	☐	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☒	☐	☐
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☒	☐

4.7.1 Environmental Setting

The City, including the project site, is located within the Great Valley (Valley) geomorphic province of California. The geology of the Valley is characterized by thick, Jurassic through Holocene aged sedimentary deposits. The California Geological Survey and the US Geological Survey have mapped a large portion of the valley as being underlain by

Quaternary-aged Riverbank formation. The Riverbank formation represents alluvial fans, or fan-shaped areas of sediment carried by a watercourse. These geological deposits are generally composed of alluvial gravel, sand, and silt derived from the western slopes of the Sierra Nevada Range. The valley province is bounded by the Klamath and Cascade mountain ranges to the north, the Sierra Nevada Mountains to the east, and the California Coast Mountain Range to the west. The Valley is generally considered to be an elongated sedimentary trough, approximately 450 miles long and 50 miles wide, which has been filled by a thick sequence of Jurassic to Holocene continental and marine sediments. The Valley province is further divided into four geomorphic subunits: the Delta, River Floodplain, Alluvial Floodplain, and Low Foothills. Surface elevations within the Great Valley generally range from several feet below mean sea level to more than 1,000 feet above sea level. The major topographical feature in the Sacramento Valley is the Sutter Buttes (a volcanic remnant), which rises approximately 1,980 feet above the surrounding valley floor (City of Rancho Cordova 2006).

As noted above, the project area is developed with office and commercial uses. The project site's topography is generally level with little variation in elevation.

4.7.2 Discussion

No Impact. The City of Rancho Cordova has a relatively flat topography, and is not located within an Alquist-Priolo Earthquake Fault Zone or in the immediate vicinity of an active fault. However, strong groundshaking has the potential to occur during a major earthquake on any of the major regional faults. The project would adhere to all local, state, and federal construction and earthquake design standards and regulations.

It is also important to note that environmental impact analyses under CEQA generally are not required to analyze the impact of existing environmental conditions on a project's future users or residents unless the proposed project might cause or risk exacerbating environmental hazards or conditions that already exist (CEQA Guidelines § 15126.2(a)). In those specific instances, it is the project's impact on the environment and not the environment's impact on the project that compels an evaluation of how future residents or users could be affected by exacerbated conditions (*California Building Industry Association v. Bay Area Air Quality Management District* [2015] 62 Cal. 4th 369). Project construction and operation would not create new seismic events or exacerbate existing seismic hazards, because the project improvements would involve limited excavation that is not expected to alter seismic and fault conditions in the region. Further environmental review is not required for this topic.

b. Substantially Mitigated by Uniformly Applicable Development Policies. Project construction would result in the disturbance of soils. Condition of approval 17 would require water quality controls during construction that would include the control of exposed soils in compliance with City's Improvement Standards and Land Grading and Erosion Control Ordinance. Further discussion of issues related to erosion are discussed in section 3.10, "Hydrology and Water Quality."

c. Substantially Mitigated by Uniformly Applicable Development Policies. The City has adopted 2019 California Building Code (CBC), Part 2, Title 24 of the California Code of Regulations, incorporating the International Building Code. The project would comply with all design and construction requirements in the CBC pertaining to geologic stability.

d. Substantially Mitigated by Uniformly Applicable Development Policies. As noted above, the City has adopted 2019 CBC. The CBC's accepted engineering practices require special design and construction methods for dealing with any expansive soils that the project is subject to.

e. No Impact. The project would connect to the public wastewater conveyance system adjacent the project site and not would use an on-site septic system.

f. Analyzed in Prior EIR. The project would be required to comply with Condition of Approval 10 that implements General Plan Action CHR 1.3.2 that protects paleontological resources accidentally discovered during construction.

4.7.3 Mitigation Measure

None required.

4.7.4 General Plan Consistency Analysis

Impacts related to geology and soils have been adequately addressed in Chapter 4.8 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006).

The City of Rancho Cordova has a relatively flat topography, and is not located within an Alquist-Priolo Earthquake Fault Zone or in the immediate vicinity of an active fault. The project would adhere to all local, state, and federal construction and earthquake design standards and regulations. The City has adopted 2019 CBC. The project would comply with all requirements in the CBC related to geologic stability, and construction on any expansive soils. There would be no impacts related to septic systems because the project would connect to the public wastewater conveyance system. The project would implement General Plan Action CHR 1.3.2 that protects paleontological resources accidentally discovered during construction.

There are no significant effects related to geology and soils peculiar to the proposed project or project site; additionally, there are no significant geology and soils impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.7.5 References

City of Rancho Cordova. 2006. (March) *General Plan Draft EIR*. State Clearinghouse No. 2005022137. Prepared by the City of Rancho Cordova.

4.8 GREENHOUSE GAS EMISSIONS

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
VIII. Greenhouse Gas Emissions. Would the project:					
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	☐	☐	☐		☒
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	☐	☐	☒	☐	☐

4.8.1 Environmental Setting

Addressing GHG generation impacts requires an agency to make a determination as to what constitutes a significant impact. The amendments to the CEQA Guidelines specifically allow lead agencies to determine thresholds of significance that illustrate the extent of an impact and are a basis from which to apply mitigation measures. This means that each agency is left to determine whether a project's GHG emissions will have a "significant" impact on the environment. The guidelines direct that agencies are to use "careful judgment" and "make a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate" the project's GHG emissions (14 California Code of Regulations Section 15064.4(a)).

The assessment of GHG emissions in this analysis is based on guidance from the SMAQMD. The SMAQMD has developed "bright-line" GHG thresholds in order to provide a uniform scale to measure the significance of land use development projects in its jurisdiction.

- ▶ For the evaluation of construction-related emissions, the SMAQMD recommends using the mass emission threshold of 1,100 metric tons of carbon dioxide equivalent (CO₂e) per year.
- ▶ For the evaluation of operational emissions, the SMAQMD recommends a two-tier approach:
 - Tier I. Operational emissions of a project would not have a significant impact on the environment if they are less than 1,100 metric tons of CO₂e per year.
 - Tier II. Projects with operational emissions that exceed 1,100 metric tons of CO₂e per year, but are able to demonstrate a 21.7 percent reduction from a "No Action Taken" scenario compared to the proposed project operating in 2020 would not conflict with CARB's Scoping Plan.

4.8.2 Discussion

a. **Substantially Mitigated by Uniformly Applicable Development Policies.** The project implements and complies with SMAQMD's screening thresholds for evaluating whether the project will result in GHG emissions that may have a significant impact on the environment. SMAQMD's screening thresholds are designed to determine whether a project would impair the State's achievement of GHG emission reductions mandated under Senate Bill 32, as outlined in CARB's Climate Change Scoping Plan. Projects that do not exceed the thresholds are determined not to result in significant impacts related to GHG emissions. Projects that exceed the thresholds are required to apply specified tiers of BMPs to mitigate GHG emissions from the project to satisfy required CEQA review. Because the City does not have

a Climate Action Plan and has not established its own GHG emission thresholds, SMAQMD's thresholds, guidelines, and requirements function as uniformly applicable development policies for projects within the City.

The following technical analysis is based on the *California Northstate University College of Health Sciences Dormitory Project Greenhouse Gas and Energy Analysis Memorandum* (Ascent 2020).

GHG emissions were modeled using the California Emissions Estimator Model (CalEEMod) (Version 2016.3.2) software, as recommended by the Sacramento Metropolitan Air Quality Management District. In CalEEMod, mid-rise apartment, high-turnover restaurant, city park, and parking lot land uses were used to represent the proposed uses on the project site. Based on CalEEMod estimates of the project land uses, construction would last 14 months. As a conservative approach, it was assumed that the existing parking lot on site would be removed as part of the demolition phase of the project.

CONSTRUCTION

Based on the modeling conducted, approximately 740 metric tons of carbon dioxide equivalent (MT CO₂e) would be generated by construction activity during the 14-month construction period (2020-2021). A maximum¹ of 651 MT CO₂e/year would be emitted in 2021, as shown in Table 5.

Table 5 Construction-Generated Greenhouse Gas Emissions

Year	Total MT CO ₂ e
2020	89.1
2021	651
Total Construction GHG Emissions	740
Maximum Annual GHG Emissions (MT CO ₂ e/year)	651
SMAQMD Construction Threshold (MT CO ₂ e/year)	1,100
Threshold Exceeded?	No

Notes: Total may not equal sum of individual components due to rounding.

MT CO₂e = metric tons of carbon dioxide equivalent; GHG = greenhouse gas; SMAQMD = Sacramento Metropolitan Air Quality Management District.

See Attachment A for detailed input parameters and modeling results.

Sources: SMAQMD 2020a; CalEEMod Version 2016.3.2.; Modeled by Ascent Environmental in 2020

Based on the maximum annual emissions of 651 MT CO₂e/year calculated for construction in 2021, GHG emissions generated would not exceed SMAQMD's threshold of 1,100 MT CO₂e/year for GHG construction emissions (SMAQMD 2020a). Given that emissions of GHGs during construction are short-term, temporary, and below SMAQMD thresholds, construction of the project would not generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.

OPERATION

Long-term operational emissions of GHGs were calculated using CalEEMod, as recommended by SMAQMD. Based on CalEEMod estimates of the project construction duration, operations would begin in 2022.

With respect to GHG emissions generated by the project's on-site energy use, Sacramento Municipal Utility District (SMUD) GHG emissions factors for 2022 were calculated and applied based on SMUD's latest 2018 Power Content Label and natural gas power plant emission factors from the Emissions & Generation Resource Integrated Database.

¹ The Project is proposed to be constructed using modular construction which would likely result in fewer construction haul trips and worker trips than traditional construction. However, CalEEMod default values for construction inputs typical of traditional construction were used in order to ensure a conservative approach. Because the analysis does not account for the trip reductions associated with modular construction, the Project would likely result GHG emissions lower than what was modeled.

2022 SMUD emission factors were interpolated based on SMUD's 2018 power mix and the anticipated achievement of the State's carbon neutrality target by 2045 under Senate Bill 100. CalEEMod's default energy intensity factors for the proposed land uses were adjusted to account for the 2019 Building Energy Efficiency Standards (California Code of Regulations Title 24, Part 6). Under these standards, applicable residential and commercial energy use would be 33 and 5 percent more efficient, respectively, than the 2013 standards, which are used in the current version of CalEEMod and result in reduced GHG emissions associated with energy use. Compliance with all 2019 energy standards requirements, as required by law, was assumed when adjusting parameters in the CalEEMod model.

KD Anderson & Associates completed a traffic study for the purposes of analyzing level of service (LOS) impacts to study area transportation facilities associated with implementation of the project. However, this study did not address vehicle miles traveled (VMT). Therefore, due to the fundamental differences in the LOS and VMT transportation analysis metrics the KD Anderson & Associates study did not address how the project would affect existing travel patterns for the college as it relates to VMT. The project would serve the current student body and capacity for additional student enrollment. Therefore, the project may help induce enrollment of new students and result in new trips, but it would also reduce existing student trips. By locating student housing in close proximity to the existing classroom facilities it is likely that the number of existing student trips would decrease, and trips and associated length of travel generated by both existing and new students would be shorter than if the project were not to occur. Additionally, the project would be located along Regional Transit's Rancho Cordova Route 177 and is within one-half mile of an existing major transit stop (i.e., Regional Transit Cordova Town Center Light-rail Station). In addition, the Project is located in an area identified by SACOG in the 2020 MTP/SCS as an HFTA for Sacramento County. These are areas located within one-half mile of a major transit stop (including an existing or planned light rail, streetcar, or train station) or an existing or planned high-quality transit corridor. Therefore, the Project would likely be more VMT efficient based on its proximity to transit.

In the interest of providing a conservative analysis, vehicle trip data obtained from the KD Anderson & Associates traffic study was used to determine operational mobile source emissions. This study indicated that, when the dormitories are fully occupied, the project could result in a net increase of 644 daily trips. Because classes are in session at California Northstate University only 275 days per year, average annual daily trips were estimated as 486 trips/day or 1.17 trips/day per student.

Annual operational GHG emissions were evaluated against SMAQMD-recommended threshold of significance for land use development projects, as discussed above. Because dormitories function differently from apartments in terms of trip generation (i.e., dormitory residents live on or near campus and do not commute to school), vehicle trip rates were applied from KD Anderson Traffic Study results, while other vehicle trip parameters (e.g., trip length, vehicle mix) in CalEEMod were based on the university land use category, which is appropriate for students and allows for more accurate emissions estimates. Additionally, because CalEEMod uses the 2014 version of CARB's Emission Factor model as the default source of mobile source emissions factors, these values were updated based on CARB's more recent EMFAC2017 (Version 1.0.2) model to provide additional improvement in accuracy of emissions estimates.

Based on modeling conducted and as shown in Table 6, the project would emit 1,051 MT CO₂e/year during operations, which does not exceed SMAQMD's operational screening threshold of 1,100 MT CO₂e (SMAQMD 2020b). In SMAQMD's threshold justification report, projects that fall under the screening level of 1,100 MT CO₂e/year are anticipated to only account for less than two percent of annual emissions in the county. Projects exceeding this threshold would be required to apply best management practices prescribed by SMAQMD, which have been demonstrated to reduce the County's emissions in line with CARB's Climate Change Scoping Plan (SMAQMD 2020a). Thus, operation of the project would not generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.

Table 6 Operational Greenhouse Gas Emissions

Emissions Sector	Annual MT CO ₂ e
Area	7.2
Energy	474
Mobile	378
Solid Waste	151
Water and Wastewater	41
Total Operational GHG Emissions	1,051
SMAQMD Operational Screening Threshold (MT CO₂e/year)¹	1,100
Threshold Exceeded?	No

Notes: Total may not equal sum of individual components due to rounding.

MT CO₂e = metric tons of carbon dioxide equivalent.

¹ Projects that exceed 1,100 metric tons/year must implement SMAQMD-prescribed best management practices. (SMAQMD 2020a)

See Attachment A for detailed input parameters and modeling results.

Sources: Modeled by Ascent Environmental in 2020

CONCLUSION

SMAQMD considers a project to have a significant impact if its GHG emissions exceed its annual mass emissions threshold of significance for construction or operations. As discussed above, project-generated construction and operational GHG emissions would not exceed SMAQMD's construction and operational GHG thresholds. Thus, the project would not generate substantial GHG emissions, either directly or indirectly, that would have a significant impact on the environment. Accordingly, no further environmental review is required.

b. **No Impact.** As shown above, the project would not exceed SMAQMD's thresholds of significance for GHGs. As discussed in section 3.3.2a, the project would result in a 57 percent reduction in per capita VMT compared to current regional average. This Exceeds the 15 percent reduction target recommend by the California Office of Planning and Research. The modular construction is anticipated to require less energy and reduced vehicle trips during construction, which would reduce construction-related GHG emissions. The project would comply with Title 24 energy efficiency requirements which will reduce operational GHG emissions. Accordingly, the project would not conflict with any plan, policy, or regulation for the purpose of reducing GHG emissions, and no further review is required.

4.8.3 Mitigation Measure

None required.

4.8.4 General Plan Consistency Analysis

While the General Plan did not analyze greenhouse gas emissions, the above analysis shows there would be no significant impacts related to emission of GHGs and the project would not conflict with any plan, policy, or regulation for the purpose of reducing GHG emissions. There are no significant effects related to GHG emissions peculiar to the proposed project or project site. Additionally, as detailed above, the project would result in per capita VMT reductions, would comply with Title 24 energy efficiency requirements, and would utilize modular construction—all of which will reduce GHG emissions. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.8.5 References

Ascent Environmental. 2020. (June) *California Northstate University College of Health Sciences Dormitory Project Greenhouse Gas and Energy Analysis Memorandum*. Prepared By Ascent Environmental. Sacramento, CA.

SACOG. See Sacramento Area Council of Governments.

Sacramento Area Council of Governments. 2020. *2020 Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS)*. Prepared by SACOG.

4.9 HAZARDS AND HAZARDOUS MATERIALS

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
IX. Hazards and Hazardous Materials.					
Would the project:					
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐	☐
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and/or accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☐	☒
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☒	☐	☐
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☒	☐	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	☐	☐	☒	☐	☐
f) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☒	☐	☐
g) Expose people or structures, either directly or indirectly, to a significant risk of loss, injury, or death involving wildland fires?	☐	☐	☒	☐	☐

4.9.1 Environmental Setting

The project site is currently a paved parking lot with landscaping, primarily along the perimeter. No hazardous materials are currently used or stored at the project site. The site is not listed as a previous hazardous materials site, and the California State Water Resources Control Board's GeoTracker did not reveal any cleanup sites within 1,000 feet of the project site (CWRCB 2020).

4.9.2 Discussion

- a. **No Impact.** The project would consist of the operation of student housing and would not involve the routine transportation, use, or disposal of hazardous materials.
- b. **Substantially Mitigated by Uniformly Applicable Development Policies.** Activities associated with the construction of the project could include hazardous materials standard to construction activities such as fuels, lubricants, paint, and solvents. The project would adhere to the applicable local, state, and federal regulations on the use, storage, and transport of these materials.
- c. **No Impact.** Only construction activities have the potential to result in the release of hazardous materials, and would comply with all applicable local, state, and federal regulations and policies regarding the safe handling and storage of all hazardous or acutely hazardous materials. There are no public schools within 0.25 miles of the site.
- d. **No Impact.** The project site is not on a previous hazardous materials site, and the California State Water Resources Control Board's GeoTracker did not reveal any cleanup sites within 1,000 feet of the project site (CWRCB 2020).
- e. **No Impact.** The project site is located approximately two miles northeast of the Mather Airport. However, the project site is not located within the 60 A-weighted decibels (dBA) Community Noise Equivalent Level (CNEL) contour for Mather Airport (Sacramento County 2020), and as such, on-site residences would not be exposed to airport-related noise in excess of City standards. Additionally, the site is not located within the Mather Airport safety zone.
- f. **No Impact.** The project would not propose or alter any major roadways or travel routes used for evacuations or emergency response, and thus would have no impact on emergency response or emergency evacuation.
- g. **No Impact.** The project site is within an urbanized area in the City that is not adjacent to or intermixed with wildlands.

4.9.3 Mitigation Measure

None required.

4.9.4 General Plan Consistency Analysis

Impacts related to hazards and hazardous materials have been adequately addressed in Chapter 4.4 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006).

By complying with State and federal regulations, General Plan policies, and Municipal Code sections relating to the proper handling of potentially hazardous materials, the proposed project would not create a hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials beyond that analyzed in the General Plan EIR. The proposed project is not within 0.25 of any public school and is not on a hazardous materials site designated by Government Code Section 65962.5. It will not result in any safety hazard or excessive noise related to its proximity to Mather Airport. The project would not propose or alter any major roadways or travel routes used for evacuations or emergency response, and thus would have no impact on emergency response or emergency evacuation. The project site is within an urbanized area in the City that is not adjacent to or intermixed with wildlands.

There are no significant effects related to hazards and hazardous materials peculiar to the proposed project or project site; additionally, there are no significant impacts related to hazards and hazardous materials that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.9.5 References

California State Water Resources Control Board. 2020. GeoTracker. Available: <http://geotracker.waterboards.ca.gov/>. Accessed June 23, 2020.

Sacramento County. 2020. Land Use Compatibility Planning Noise Contours. Available: https://sacramento.aero/scas/environment/noise/mather_airport_mhr/noise_contours2. Accessed June 22, 2020.

CWRCB. See California State Water Resources Control Board.

4.10 HYDROLOGY AND WATER QUALITY

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
X. Hydrology and Water Quality.					
Would the project:					
a) Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality?	☐	☐	☐	☐	☒
b) Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin?	☐	☐	☐	☒	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner which would:					
i) Result in substantial on- or offsite erosion or siltation;	☐	☐	☐	☐	☒
ii) Substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or offsite;	☐	☐	☐	☐	☒
iii) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or	☐	☐	☐	☐	☒
iv) Impede or redirect flood flows?	☐	☐	☐	☐	☒
d) In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation?	☐	☐	☒	☐	☐
e) Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?	☐	☐	☐	☐	☒

4.10.1 Environmental Setting

The project site consists of a paved parking lot in a developed business park, with trees located on and surrounding the site. The site is comprised of impervious paved surfaces and islands of pervious surfaces in the parking lot and around the border of the site. No natural waterways or drainage features occur on the site. The City Municipal Code provides specific regulations and requirements for stormwater and runoff reduction for projects and operations.

The project is located within the South American Subbasin that is bounded on the east by the Sierra Nevada Mountains, on the west by the Sacramento River, on the north by the American River, and on the south by the Cosumnes and Mokelumne Rivers. Sacramento County Groundwater Association (SCGA) manages groundwater in the Central Basin portion of the South American Subbasin. SCGA was formed in 2006 through a joint powers agreement signed by the Cities of Elk Grove, Folsom, Rancho Cordova, and Sacramento and Sacramento County. SCGA is preparing a Groundwater Sustainability Plan for submittal to California Department of Water Resources (DWR) by January 31, 2022.

4.10.2 Discussion

- a. **Substantially Mitigated by Uniformly Applicable Development Policies.** Construction of the project would involve ground disturbing activities, which would expose soils to erosion from wind and surface water runoff. The project would adhere to the City's Standard Construction Specifications for Erosion and Sediment Control and the City's Municipal Code (Chapters 16.44 and 15.12) to reduce potential impacts of construction activities on water quality and runoff to less than significant. The project would comply with Rancho Cordova's Municipal Code Chapter 16.44 Land Grading and Erosion Control requirement for BMP's to prevent runoff and pollution primarily through the open space area and landscaping. Additionally, with the increased permeable surface area from the landscaping, the project would not substantially alter or negatively impact the drainage patterns or runoff rates or volumes to the city stormwater system. No further review is required.
- b. **Analyzed in Prior EIR.** The project site primarily consists of impervious surface associated with the parking lot. The project would create pervious surfaces as part of its drainage and water quality control features that would provide groundwater recharge opportunities. The project would obtain public water service from Golden State Water Company and would not involve the construction of a new well. Golden State Water Company uses both surface and groundwater to meet water demands. The proposed project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. Thus, the project is consistent with the overall growth anticipated in the General Plan and the associated water demands and groundwater impacts addressed in the General Plan EIR. Accordingly, no further environmental review is required.
- c. **Substantially Mitigated by Uniformly Applicable Development Policies.** The project would connect into the existing drainage facilities adjacent to the project site and would create pervious surfaces as part of its drainage and water quality control features that would be required to conform to City standards as set forth in Condition of Approval 16 and 18 to reduce impacts related to stormwater quality and protecting structures from a 100 year flood event.
- d. **No Impact.** The project is not located in a flood hazard area and includes water quality control features.
- e. **Substantially Mitigated by Uniformly Applicable Development Policies.** The project would connect into the existing drainage facilities adjacent to the project site and would create pervious surfaces as part of its drainage and water quality control features that would be required to conform to City standards as set forth in Condition of Approval 16. SCGA is preparing a Groundwater Sustainability Plan for submittal to DWR by January 31, 2022.

4.10.3 Mitigation Measure

None required.

4.10.4 General Plan Consistency Analysis

Impacts related to hydrology and water quality have been adequately addressed in Chapter 4.9 of the General Plan EIR. The project is consistent with the site's General Plan land use designation and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006).

The project site consists of a paved parking lot in a developed business park, with trees located on and surrounding the site. The site is comprised of impervious paved surfaces and islands of pervious surfaces in the parking lot and around the border of the site. No natural waterways or drainage features occur on the site. The project would create pervious surfaces as part of its drainage and water quality control features and would comply with Rancho Cordova's Standard Construction Specifications for Erosion and Sediment Control and Municipal Code Chapters 15.12 (Stormwater Management and Discharge Control) and Chapter 16.44 (Land Grading and Erosion Control) to reduce erosion and runoff associated with construction activities. The project would not substantially decrease groundwater supplies or interfere substantially with groundwater recharge because the project would be consistent with the overall growth anticipated in the General Plan, associated water demands, and groundwater impacts addressed in the General Plan EIR. The project would create pervious surfaces as part of its drainage and water quality control feature and would not involve the creation of a well.

The project would not substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, increase the rate or amount of surface runoff in a manner which would result in flooding, create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff, or impede or redirect flood flows.

The project would not risk release of pollutants due to project inundation in flood hazard, tsunami, or seiche zones because the project is not located in a flood hazard area and includes water quality control features.

The project would not conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan because the project would connect into the existing drainage facilities adjacent to the project site and would create pervious surfaces as part of its drainage and water quality control features. Additionally, the project will comply with all local hydrological design standards and regulations. Specifically, the project would adhere with the General Plan Action ISF.2.4.1, which requires all projects to secure an assured, legally entitled water supply and delivery system with existing infrastructure. The project would connect into the existing drainage facilities adjacent to the project site and obtain public water service from Golden State Water Company. Golden State Water Company uses both surface and groundwater to meet water demand. Project service would not involve the construction of a new well.

There are no significant effects related to hydrology and water quality peculiar to the proposed project or project site; additionally, there are no significant hydrological and water quality impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic.

4.10.5 References

City of Rancho Cordova. 2006. (March) *General Plan Draft EIR*. State Clearinghouse No. 2005022137. Prepared by the City of Rancho Cordova.

4.11 LAND USE AND PLANNING

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XI. Land Use and Planning.					
Would the project:					
a) Physically divide an established community?	☐	☐	☒	☐	☐
b) Cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☒	☐	☐

4.11.1 Environmental Setting

The project site is located within a developed commercial business park within the city of Rancho Cordova. The site is currently a paved parking lot used for parking by the adjacent California Northstate University College of Health Services. The site is zoned OPMU under the city's general plan and is consistent with the surrounding zoning in the business park. OPMU zones permit a floor area ratio of 0.25 to 2.0. The project's floor area ratio is within the allowed ratio.

4.11.2 Discussion

a, b. No Impact. The project site is located within a developed commercial business park, and would be consistent with the current surrounding uses, General Plan, and zoning. The project does not include the addition of any roadways that would divide existing or proposed communities. Therefore, the project would have **no impact**.

4.11.3 Mitigation Measure

None required.

4.11.4 General Plan Consistency Analysis

Impacts related to land use and planning have been adequately addressed in Chapter 4.1 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. Therefore, it will not conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect. Additionally, the project would not divide existing or proposed communities. Therefore, the project would have no impact. Pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic.

4.12 MINERAL RESOURCES

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XII. Mineral Resources.					
Would the project:					
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☒	☐	☐
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?	☐	☐	☒	☐	☐

4.12.1 Environmental Setting

The project is located within a developed commercial business park within the City. There are no mineral resource excavation activities in the project area.

4.12.2 Discussion

a, b. No Impact. The project site consists of a paved parking lot, located within a developed commercial business park. There are no mineral resource excavation activities in the project area. The project site and surrounding area are not located within a mineral resource overlay zone (City of Rancho Cordova 2006). Therefore, the project would have no impact on the availability of known mineral resources. No further analysis is required.

4.12.3 Mitigation Measure

None required.

4.12.4 General Plan Consistency Analysis

Impacts related to mineral resources have been adequately addressed in Chapter 4.8 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006). There are no mineral resource excavation activities in the project area. The project site and surrounding area are not located within a mineral resource overlay zone (City of Rancho Cordova 2006). Therefore, the project would have no impact on the availability of known mineral resources. Pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic.

4.12.5 References

City of Rancho Cordova. 2006. (March) *General Plan Draft EIR*. State Clearinghouse No. 2005022137. Prepared by the City of Rancho Cordova.

4.13 NOISE

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XIII.Noise.					
Would the project result in:					
a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or in other applicable local, state, or federal standards?	☐	☐	☐	☒	☒
b) Generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☒	☐	☐
c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☒	☐	☐

4.13.1 Environmental Setting

The project site is located in an urban area of the City of Rancho Cordova. The dominant noise sources in the project area are major roadways, including US 50 and Prospect Park Drive. Other noise sources include aircraft operations associated with Mather Airport, formerly Mather Air Force Base.

The nearest noise sensitive receptors (e.g., residences) to the project site are located approximately 2,000 feet from the northern boundary of the project site, across US 50.

4.13.2 Discussion

a. **Analyzed in Prior EIR, Substantially Mitigated by Uniformly Applicable Development Policies.** Noise levels could increase with implementation of the project, due to increases in on-site activities associated with construction and operation of the proposed dormitory facilities.

CONSTRUCTION

During the construction phases of the proposed project, noise from on-site construction activities, including construction, grading, and parking lot paving, would add to the noise environment in the project vicinity. Activities involved in construction would typically generate maximum noise levels ranging from 85 to 90 dB at a distance of 50 feet. Noise would also be generated during the construction phase by increased truck traffic on area roadways.

However, project construction activities would occur between the hours of 6 a.m. and 8 p.m. during weekdays, and between the hours of 7 a.m. and 8 p.m. on weekends, in order to be considered exempt from the provisions of the Rancho Cordova Noise Ordinance (Municipal Code Section 6.68.090(E)). Construction noise would be temporary,

estimated to occur during 2020 to 2021. Construction noise would be reduced due to the modular design of the project. As noted above, the nearest residential uses are approximately 2,000 feet north of the project site. Through implementation of Municipal Code requirements limiting the hours of construction noise, the project would avoid generating noise during the most sensitive night and early morning hours, thus minimizing potential disturbance of sensitive receptors in the vicinity.

OPERATION

The project would also generate noise during operational activities, primarily associated with increased vehicle activity along local roadways. However, the General Plan EIR estimated roadway noise levels based on the proposed land use designations and allowable densities at the project site. As stated above under Section 3.8, "Greenhouse Gas Emissions" and below under Section 3.17, "Transportation," the project would generate fewer vehicle trips than the allowable land use designations identified in the General Plan and evaluated in the General Plan EIR. As a result, the potential roadway noise levels associated with implementation of the project are considered to be already included as part of the roadway noise levels associated with General Plan implementation. Refer to Table 4.7-8 (pages 4.7-23 through 4.7-25) of the General Plan EIR for further clarification (City of Rancho Cordova 2006). No new or more significant impacts beyond what was previously identified in the General Plan EIR would occur. No further environmental review is required.

b. No Impact. Implementation of the project would not involve the daily operation of on-site uses that are normally associated with perceivable groundborne vibration or groundborne noise. Such uses are normally limited to heavy commercial or industrial operations, including mining. However, during construction activities, the use of heavy equipment at the project site could generate some localized vibration levels. On-site equipment would largely consist of rubber-tired loaders and other equipment that would not generate substantial vibration beyond 25 feet of distance between source and receptor. Further, project construction activities would be restricted by the City's noise ordinance, thereby limiting construction activities to between the hours of 6 a.m. and 8 p.m. during weekdays, and between the hours of 7 a.m. and 8 p.m. on weekends, in order to be considered exempt from the provisions of the Rancho Cordova Noise Ordinance (Municipal Code Section 6.68.090(E)). As noted above, the nearest residential uses are approximately 2,000 feet of the project site. Therefore, based on the distance between potential receptors and the project site and compliance with the City's Municipal Code, on-site activities would not generate substantial vibration or groundborne noise. No impact would occur.

c. No Impact. The project site is not located within the 60 dBA CNEL contour for Mather Airport (Sacramento County 2020), and as such, on-site residences would not be exposed to airport-related noise in excess of City standards. No impact would occur.

4.13.3 Mitigation Measure

None required.

4.13.4 General Plan Consistency Analysis

Impacts related to noise have been adequately addressed in Chapter 4.7 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006).

Construction noise would be temporary and would comply with the City's Rancho noise ordinance. Operational noise levels would not exceed those anticipated by the General Plan EIR, and the project would generate fewer vehicle trips than the allowable land use designations identified in the General Plan and evaluated in the General Plan EIR. The project would have no impacts related to groundborne vibration or noise or related to exposure to excessive airport-related noise. There are no significant effects related to noise impacts peculiar to the proposed project or project site;

additionally, there are no significant impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.13.5 References

City of Rancho Cordova. 2006. (March) *General Plan Draft EIR*. State Clearinghouse No. 2005022137. Prepared by the City of Rancho Cordova.

Sacramento County. 2020. Land Use Compatibility Planning Noise Contours. Available:
https://sacramento.aero/scas/environment/noise/mather_airport_mhr/noise_contours2. Accessed June 22, 2020.

4.14 POPULATION AND HOUSING

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XIV. Population and Housing. Would the project:					
a) Induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒	☐
b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☒	☐	☐

4.14.1 Environmental Setting

The project is located within a developed commercial business park within the City of Rancho Cordova. The project site is zoned Office Professional Mixed-Use that allows for residential development. The project would build dorm facilities to house a portion of the existing student base, who currently live off-site and commute to the California Northstate University College of Health Sciences. The project would build 416 dorm rooms across three buildings. Building A would include 190 dorm rooms, Building B would include 210 dorm rooms, and Building C would include the cafeteria and 16 dorm rooms. The project is not anticipated to induce growth² of the existing student population of the university.

4.14.2 Discussion

a. Analyzed in Prior EIR. The project would build dorm facilities to house a portion of the existing student population of the California Northstate University College of Health Sciences. The project would create 416 dorm rooms for students currently commuting to the university to relocate to the university campus, and the effects of the student housing has been evaluated throughout this draft EIR. It would not support a substantial increase to the existing population. The project would not include the extension of roads or other infrastructure. Further it is consistent with the General Plan land use designations and planned growth under the General Plan. The General Plan EIR anticipated a growth in population of 74,289. The project would have no unplanned direct or indirect impact on the size of the student population or nearby communities. Because this impact was previously analyzed in the General Plan EIR, no further environmental review is required.

b. No Impact. The project site is currently a paved parking lot, located within a developed commercial business park. Neither the project nor the construction of the project would displace existing people or housing. Therefore, the project would have no impact.

² The University is anticipated to grow to 420 students independent of the project.

4.14.3 Mitigation Measure

None required.

4.14.4 General Plan Consistency Analysis

Impacts related to population and housing have been adequately addressed in Chapter 4.3 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006). The project would not displace any existing people or housing and does not exceed population growth anticipated by the General Plan EIR. There are no significant effects related to population and housing peculiar to the proposed project or project site; additionally, there are no significant impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.15 PUBLIC SERVICES

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XV. Public Services.					
Would the project:					
a) Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, or the need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:					
Fire protection?	☐	☐	☐	☒	☒
Police protection?	☐	☐	☐	☒	☒
Schools?	☐	☐	☒	☐	☐
Parks?	☐	☐	☒	☐	☐
Other public facilities?	☐	☐	☒	☐	☐

4.15.1 Environmental Setting

The Sacramento Metropolitan Fire District provides fire protection services, emergency transportation and medical services, and rescue services to the City of Rancho Cordova. The closest fire station is Station 66, at 3180 Kilgore Road, 0.6 miles from the project site. Station 61 is also nearby, located at 10595 Folsom Blvd, 0.9 miles from the project site (SMFD 2020).

The Rancho Cordova Police Department provides police protection services to the City of Rancho Cordova. The police station is located at 2897 Kilgore Road, approximately 0.5 miles from the project site (RCPD 2020).

The Cordova Recreation and Park District (CRPD) provides more than 40 parks and recreation facilities to the City of Rancho Cordova and the unincorporated areas of East College Greens, Rosemont, Mather, and Gold River (CRPD 2020).

The Folsom Cordova Unified School District (FCUSD) serves the cities of Rancho Cordova and Folsom. The FCUSD serves approximately 20,500 students, and includes 20 elementary schools, 4 middle schools, 3 high schools, and 5 alternative schools (FCUSD 2020).

4.15.2 Discussion

- a) **Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, or the need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:**

Fire protection/ Police protection?

Analyzed in a Prior EIR and Substantially Mitigated by Uniformly Applicable Development Policies. The project is consistent with the General Plan land use designation and planned growth under the General Plan, which was analyzed in the General Plan EIR. The project would not require the construction of new facilities for fire protection and law enforcement but would be subject to conditions of approval 22-28 regarding emergency fire access and hydrants and Conditional of Approval 31 for the support to annex into the Police Services CFD.

Schools?

No Impact. The project would be required to pay would be required to pay school impact fees. Government Code Section 65995(h) states that the payment or satisfaction of a fee, charge, or other requirement levied or imposed pursuant to Section 17620 of the Education Code is deemed to be full and complete mitigation of the impacts for the planning, use, development, or provision of adequate school facilities. Further, the project would not impact school populations because it will serve a transient student population in a dormitory setting, not families with school-aged children.

Parks/Other public facilities?

- a. **No Impact.** The project would consist of infill development that would not result in substantial population growth. Therefore, it would not trigger the need for new park facilities or other public facilities.

4.15.3 Mitigation Measure

None required.

4.15.4 General Plan Consistency Analysis

Impacts related to public services have been adequately addressed in Chapter 4.12 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006). As discussed above, the project would not necessitate construction related to new or altered public facilities or impact response times. There are no significant effects related to public services peculiar to the proposed project or project site; additionally, there are no significant impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic

4.15.5 References

Cordova Recreation and Park District. 2020. About. Available: <https://crpd.com/about/>. Accessed June 23, 2020.

CRPD. See Cordova Recreation and Park District.

FCUSD. See Folsom Cordova Unified School District

Folsom Cordova Unified School District. 2020. District Boundaries and Population. Available:
<https://www.fcusd.org/domain/739> Accessed June 23, 2020.

Rancho Cordova Police Department. 2020. About Us. Available: <https://www.ranhocordovapd.com/about-us>.
Accessed June 23, 2020.

RCPD. *See* Rancho Cordova Police Department.

Sacramento Metropolitan Fire Department. 2020. Metro Fire Stations. Available:
<https://www.metrofire.ca.gov/index.php/about-us/fire-station-locations>. Accessed June 23, 2020.

SMFD. *See* Sacramento Metropolitan Fire Department.

4.16 RECREATION

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XVI. Recreation. Would the project:					
a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒	☐
b) Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?	☐	☐	☐	☒	☐

4.16.1 Environmental Setting

CRPD provides more than 40 parks and recreation facilities to the City of Rancho Cordova and the unincorporated areas of East College Greens, Rosemont, Mather, and Gold River (CRPD 2020). The Prospect Green Open Space, located near the Pick-n-Pull office building at 10860 Gold Center Dr, is 0.20 miles southwest of the project site and is the closest grassy open space to the project. Renaissance Park at 3125 Mowbray Way and The Village Green at 3141 Bridgeway Dr are the closest park facilities, 0.6 and 0.65 miles southwest of the project site, respectively. The project plans to include a grassy open space in between the dorms for use by the students and faculty.

4.16.2 Discussion

- a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?
- b) Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?

Analyzed in Prior EIR. The proposed project is consistent with the land use designations of the City's General Plan and current zoning of the project site, and, as a result, increased demand on parks and recreational facilities from development of the project were anticipated in the General Plan and analyzed by the General Plan EIR. Therefore, the proposed project would not accelerate substantial deterioration of existing parks and recreational facilities, nor would the proposed project require the construction or expansion of recreational facilities beyond what was anticipated in the General Plan EIR. Because this impact was previously analyzed in the General Plan EIR, no further environmental review is required.

4.16.3 Mitigation Measure

None required.

4.16.4 General Plan Consistency Analysis

The proposed project is consistent with the General Plan land use designation for the project site, and impacts to recreation facilities associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to recreational facilities peculiar to the project or project site; additionally, there are no significant impacts to recreation facilities that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required.

4.16.5 References

Cordova Recreation and Park District. 2020. About. Available: <https://crpd.com/about/>. Accessed June 23, 2020.

CRPD. See Cordova Recreation and Park District.

4.17 TRANSPORTATION

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XVII. Transportation.					
Would the project:					
a) Conflict with a program, plan, ordinance or policy addressing the circulation system, including transit, roadway, bicycle, and pedestrian facilities?	☐	☐	☒	☐	☐
b) Conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?	☐	☐	☒	☐	☐
c) Substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☒	☐	☐
d) Result in inadequate emergency access?	☐	☐	☒	☐	☐

4.17.1 Environmental Setting

The project site is located in a developed area of the City of Rancho Cordova. Existing access to the site is provided along Prospect Park Drive, which connects the project site to Zinfandel Drive (via Gold Center Drive and White Rock Road) and to Sunrise Boulevard (via Sun Center Drive and White Road Road).

4.17.2 Discussion

a. No Impact. Project development would result in an intensification of development at the project site, but would not modify existing vehicle circulation in the area through roadway modifications. Further, the project would include the installation of on-site bicycle parking and pedestrian circulation measures, both to and from California Northstate University and between on-site uses (i.e., between the cafeteria, dorms, and parking). As a result, no conflicts with existing programs, plans, ordinances, or policies addressing the circulation system are anticipated, and no further review is required.

b. No Impact. As noted above, the project is anticipated to generate 486 new daily trips (KD Anderson & Associates 2020), 891,294 vehicle miles traveled (VMT) per year, and 7.8 VMT per capita per day, based on an on-site population of 400 students. Regional VMT averages for residential uses are 17.91 VMT per capita per day (SACOG 2020). The project's VMT per capita represents 43 percent of the current regional average (a 57 percent reduction), thereby exceeding the 15 percent target reduction recommended by the California Office of Planning and Research. Although the project increases on-site population, it locates students closer to their destination, thereby reducing VMT, consistent with regional efforts and the intent of residential infill development. Therefore, the project would not conflict or be inconsistent with CEQA Guidelines Section 15064.3(b) related to VMT. Because there will be no impact, no further review is required.

c, d. No Impact. Project development would result in an intensification of development at the project site, but would not modify existing vehicle circulation in the area through roadway modifications. Furthermore, internal roadways would be designed in accordance with City standards to allow for the safe passage of emergency vehicles

in the event of a call for service. Therefore, the project would not increase hazards due to a geometric design feature nor would it result in inadequate emergency access. Because there will be no impact, no further review is required.

4.17.3 Mitigation Measure

None required.

4.17.4 General Plan Consistency Analysis

Impacts related to transportation have been adequately addressed in Chapter 4.5 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006). As discussed above, the project would have not conflict with any program, plan, ordinance or policy addressing the circulation system or conflict with or be inconsistent with CEQA Guidelines section 15064.3(b). Further it would have no impacts related to increasing design feature hazards or resulting in adequate emergency access. There are no significant effects related to transportation peculiar to the proposed project or project site; additionally, there are no significant transportation impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic.

4.17.5 References

KD Anderson & Associates. 2020 (January 31). Trip Generation Estimate for the California Northstate University Dormitory Project, Rancho Cordova, CA.

SACOG. See Sacramento Area Council of Governments.

Sacramento Area Council of Governments. 2020. *Senate Bill 743*. Available: <http://sb743-sacog.opendata.arcgis.com/>. Accessed June 18, 2020.

4.18 TRIBAL CULTURAL RESOURCES

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XVIII. Tribal Cultural Resources.					
Would the project:					
a) Cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resources Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:					
i) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resources Code section 5020.1(k)?	☐	☐	☐	☐	☒
ii) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resource Code Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe?	☐	☐	☐	☐	☒

4.18.1 Environmental Setting

The project site is comprised of a paved parking lot in a developed business park with no existing buildings on site, and the surrounding area has been developed with office and commercial uses. Most of the prehistoric sites are located along the American River and creeks, and some of the sites are known to contain human remains (City of Rancho Cordova 2006). General Plan Draft EIR Figure 4.11-1 identifies that there are no archaeological or culturally sensitive areas in the project area (City of Rancho Cordova 2006). The General Plan EIR's analysis of impacts to cultural and paleontological resources included analysis of tribal cultural resources.

4.18.2 Discussion

a. **Substantially Mitigated by Uniformly Applicable Development Policies.** As noted above, the project area is not located within archaeological or culturally sensitive areas identified in the General Plan EIR. The project would be required to comply with Condition of Approval 10 that implements General Plan Action CHR 1.3.2 that protects cultural resources that would include tribal cultural resources and human remains accidentally discovered during construction. Because this impact would be substantially mitigated by uniformly applicable development policies, no further environmental review is required

4.18.3 Mitigation Measure

None required.

4.18.4 General Plan Consistency Analysis

Impacts related to tribal cultural resources have been adequately addressed in Chapter 4.11 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006). As shown above, the project area is not located within archaeological or culturally sensitive areas identified in the General Plan EIR. If tribal cultural resources or human remains were accidentally discovered during construction, the project would implement Action CHR 1.3.2. There are no significant effects related to tribal cultural resources peculiar to the proposed project or project site; additionally, there are no significant tribal cultural resources impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic.

4.18.5 References

City of Rancho Cordova. 2006. (March) *General Plan Draft EIR*. State Clearinghouse No. 2005022137. Prepared by the City of Rancho Cordova.

4.19 UTILITIES AND SERVICE SYSTEMS

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XIX. Utilities and Service Systems.					
Would the project:					
a) Require or result in the relocation or construction of construction of new or expanded water, wastewater treatment or stormwater drainage, electric power, natural gas, or telecommunication facilities, the construction or relocation of which could cause significant environmental effects?	☐	☐	☐	☒	☐
b) Have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?	☐	☐	☐	☒	☐
c) Result in a determination by the wastewater treatment provider that serves or may serve the project that it has adequate capacity to serve the project's projected demand, in addition to the provider's existing commitments?	☐	☐	☐	☒	☐
d) Generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?	☐	☐	☐	☒	☐
e) Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?	☐	☐	☐	☒	☐

4.19.1 Environmental Setting

The project site is located in a developed business park in Rancho Cordova. Water service to the project area is provided by Golden State Water Company. Sewer services are provided by the Sacramento Area Sewer District, and wastewater treatment services are provided by Regional San (City of Rancho Cordova, 2020a). Electrical and gas services are provided by SMUD (SMUD 2020). Solid waste disposal is operated by the City and permitted private haulers. All services are currently provided to buildings and lots adjacent to the project site.

4.19.2 Discussion

a-e. Analyzed in Prior EIR. The City of Rancho Cordova's General Plan analyzed the projected growth of the City and the ability of utility services to grow in response. The project is consistent with, and would not exceed, the anticipated growth analyzed in the City's General Plan and the General Plan EIR. City staff have reviewed the demands associated with the project and determined that existing facilities related to water, wastewater,

telecommunications, and electricity are adequate to accommodate the demands of the project without requiring additional infrastructure (City of Rancho Cordova 2020b). The General Plan EIR determined that there is adequate landfill capacity to accommodate projected population growth and subsequent solid waste generation anticipated under buildout of the General Plan. The project would comply with all statutes and regulations related to solid waste and would not impair the attainment of solid waste reduction goals. The project would comply with the California Integrated Waste Management Act of 1989 (AB 939), which diversion of a minimum of 50 percent of discarded materials away from disposal in landfills. The project would also comply with General Plan policies and actions and Municipal Code requirements in Chapters 6.20, 6.21, and 6.92 regarding waste management and recycling. No further environmental review is required.

4.19.3 Mitigation Measure

None required.

4.19.4 General Plan Consistency Analysis

Impacts related to utilities and service systems have been adequately addressed in Chapter 4.12 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006). As discussed above, City staff have reviewed the demands associated with the project and determined that existing facilities related to water, wastewater, telecommunications, and electricity are adequate to accommodate the demands of the project without requiring additional infrastructure. There is adequate landfill capacity for solid waste generated by the project, and project would comply with all statutes and regulations related to solid waste and would not impair the attainment of solid waste reduction goals. There are no significant effects related to utilities and service systems peculiar to the proposed project or project site; additionally, there are no significant impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required.

4.19.5 References

- City of Rancho Cordova. 2020a. Water, Sewer, and Drainage Services. Available: <https://www.cityofranhocordova.org/government/public-works/services-and-programs/water-sewer-and-drainage-services>. Accessed June 23, 2020.
- . 2020b. Staff Report – California Northstate University Dormitory Conditional Use Permit and Major Design Review Permit; Project No. DD9919.
- Sacramento Municipal Utility District. 2020. Our Service Area. Available: <https://www.smud.org/en/Corporate/About-us/SMUDs-Territory-Map>. Accessed June 23, 2020
- Sacramento Suburban Water District. 2016. *2015 Urban Water Management Plan*. Prepared by Brown and Caldwell. Available: <http://www.sswd.org/home/showdocument?id=7629>. Accessed June 23, 2020.

4.20 WILDFIRE

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XX. Wildfire.					
If located in or near state responsibility areas or lands classified as very high fire hazard severity zones, would the project.					
a) Substantially impair an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒	☐
b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?	☐	☐	☒	☐	☐
c) Require the installation of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?	☐	☐	☒	☐	☐
d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?	☐	☐	☒	☐	☐

4.20.1 Environmental Setting

According to the California Department of Forestry and Fire Protection (CAL FIRE) Fire and Resource Assessment Program, the project site is not located within a State Responsibility Area classified as either a Very High or High Fire Hazard Severity Zone (FHSZ) (CAL FIRE 2007). The project site is located within an urbanized area and does not interface with natural habitat or open grassy fields.

4.20.2 Discussion

a. Analyzed in Prior EIR. Development within the City of Ranch Cordova, including the project site, was evaluated as part of the General Plan EIR for its potential to impair implementation of or interfere with the Sacramento Multi-Hazard Disaster Plan. As the project would not modify the existing roadway and circulation network, it would not affect emergency vehicle access to or past the project site, nor would it impair evacuation routes. Further, the project would be designed in accordance with current requirements with respect to fire suppression and on-site emergency notification and evacuation procedures. As such, no new or more significant impact would occur beyond what was previously evaluated in the City's General Plan EIR. No further review is required.

b-c. No impact. The project site is currently developed with a paved parking lot, and as noted above, it does not interface with natural habitat or open grassy fields. Additionally, the project site is not located within a State Responsibility Area classified as either a Very High or High FHSZ. Further, the project site is largely flat and landscaping and intervening structures temper winds in the area that pass through the project site. As such, development of the project would not exacerbate potential wildfire risks. No impact would occur.

4.20.3 Mitigation Measure

None required.

4.20.4 General Plan Consistency Analysis

Impacts related to wildland fires have been adequately addressed in Chapter 4.12 of the General Plan EIR. The project is consistent with the site's General Plan land use designation, and the General Plan EIR anticipated buildout of the project site with Office Mixed Use. This designation encourages the integration of commercial and or residential use in conjunction with office use and allows for public/quasi-public uses (City of Rancho Cordova 2006). As discussed above, the project would not modify the existing roadway and circulation network, would not affect emergency vehicle access to or past the project site, nor would it impair evacuation routes. Further, the project would not exacerbate wildfire risks as the project site is relatively flat, developed with a paved parking lot, does not interface with natural habitat or open grassy fields, and is not located within a State Responsibility Area classified as either a Very High or High FHSZ. There are no significant effects related to wildfires peculiar to the proposed project or project site; additionally, there are no significant impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183, further CEQA review is not required for this topic.

4.20.5 References

CALFIRE. See California Department of Forestry and Fire Protection.

California Department of Forestry and Fire Protection. 2007. Fire Hazard Severity Zones in SRA – Sacramento County. Available: https://osfm.fire.ca.gov/media/6756/fhszs_map34.pdf. Accessed June 22, 2020.

4.21 MANDATORY FINDINGS OF SIGNIFICANCE

ISSUES (and supporting information sources)	Significant Impact	Less Than Significant or Less than Significant with Mitigation Incorporated	No Impact	Analyzed in Prior EIR	Substantially Mitigated by Uniformly Applicable Development Policies
XX. Mandatory Findings of Significance.					
a) Does the project have the potential to substantially degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, substantially reduce the number or restrict the range of an endangered, rare, or threatened species, or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☐	☒	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.)	☐	☐	☐	☒	☒
c) Does the project have environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒	☒

4.21.1 Environmental Setting

The environmental setting for this section is presented above in the environmental settings for each of the checklist issue areas. No additional environmental setting is necessary.

4.21.2 Discussion

a. Analyzed in Prior EIR. As discussed above and as supported by the analysis and conclusions in the General Plan EIR, the project would not degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, or reduce the number or restrict the range of a rare or endangered plant or animal. Further and with respect to cultural resources, the project, as evaluated in Section 3.5, "Cultural Resources" and 3.19, "Tribal Cultural Resources" above, would not eliminate important examples of the major periods of California history or prehistory. To ensure the project would not result in impacts beyond those anticipated by the General Plan EIR, the project would adhere to General Plan Action NR.1.1.4 and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance. Additionally, the project would implement General Plan

Action CHR 1.3.2 to reduce impacts related to the unanticipated and accidental discovery of cultural resources, tribal cultural resources, and human remains during construction. No further review is required.

b, c. Analyzed in Prior EIR, Substantially Mitigated by Uniformly Applicable Development Policies. Potential cumulative impacts of development, including infill projects such as the project were analyzed in the City's General Plan EIR. The General Plan EIR identified potentially significant and unavoidable cumulative impacts with respect to land use, agricultural resources, transportation, air quality, noise, mineral resources, biological resources, and utilities. However, several of the cumulative impact determinations of the General Plan EIR were related to greenfield development along the urban edge of the City and would not be associated with the development of the project site. For example, the project would not contribute to the cumulative condition for agricultural resources, mineral resources, and biological resources due to the lack of Important Farmland, known mineral resources that would be lost if the site is developed, and sensitive species or habitat at the project site. Further, the project's contribution to cumulative impacts identified in the City's General Plan EIR would not result in a new or more significant cumulative impact determination than was previously identified.

With respect to land use, transportation, air quality, noise, GHG emissions, and utilities, the project was evaluated for its potential impact and contribution to cumulative impacts. As noted above, the project was determined to be either within the scope of the City's General Plan EIR, having no impact, or substantially mitigated due to the implementation of uniformly applicable development policies. With respect to transportation, the use of level of service (LOS) as a metric for a physical environmental impact, as evaluated in the City's General Plan EIR, is no longer considered an appropriate measure for changes to the physical environment under CEQA. However, as noted above, the project would constitute an infill development consistent with regional transportation goals (i.e., inherently VMT reducing). Therefore, the project would not result in new or more significant cumulative impacts and the potential cumulative conditions and impact conclusions identified in the City's General Plan EIR are considered applicable to the project.

The proposed project would not cause substantial adverse effects to human beings insofar as air quality, GHG emissions, geology and soils, hazards and hazardous materials, and noise impacts are concerned. Therefore, no further environmental review is required.

4.21.3 Mitigation Measure

None required.

4.21.4 General Plan Consistency Analysis

The General Plan EIR addresses cumulative impacts related to buildout under the General Plan. Given the proposed project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the proposed project would generate cumulative impacts similar to those analyzed in the General Plan EIR.

To ensure the project would not result in biological impacts or impacts related to cultural resources or tribal cultural resources beyond those anticipated by the General Plan EIR, the project would adhere to General Plan Action NR.1.1.4 and would conduct a preconstruction nest surveys and would implement General Plan Action CHR 1.3.2. Therefore, the proposed project would not: 1) degrade the quality of the environment; 2) substantially reduce or impact the habitat of fish or wildlife species; 3) cause fish or wildlife populations to drop below self-sustaining levels; 4) threaten to eliminate a plant or animal community; 5) reduce the number or restrict the range of a rare or endangered plant or animal; or 6) eliminate important examples of the major periods of California history or prehistory. Thus, impacts associated with biological, cultural, and tribal resources have been adequately addressed and would not differ from those previously identified in the General Plan EIR. No further environmental review is required.

The proposed project was included in the General Plan EIR's future development assumptions, which acknowledged that cumulative impacts to land use, agricultural resources, transportation, air quality, noise, mineral resources,

biological resources, and utilities. However, as discussed above, the project would not contribute to cumulative impacts to agricultural resources, mineral resources, or biological resources. Additionally, all the cumulative impacts identified as significant and unavoidable were adequately addressed in the General Plan EIR. Given that the proposed project is consistent with the City's General Plan land use designation for the project site, cumulative impacts associated with buildout of the site have been anticipated by the City and were analyzed in the General Plan EIR. There are no cumulative effects peculiar to the project or project site. Additionally, there are no cumulative impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows are more severe than previously discussed. Therefore, no further environmental review is required.

The proposed project would not cause substantial adverse effects to human beings insofar as air quality, GHG emissions, geology and soils, hazards and hazardous materials, and noise impacts are concerned. Pursuant to CEQA Guidelines section 15183, no further environmental review is required.

SECTION V - ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED

The infill project could potentially result in one or more of the following environmental effects.

- | | | |
|--|---|---|
| ☐ Aesthetics | ☐ Agriculture and Forestry Resources | ☐ Air Quality |
| ☐ Biological Resources | ☐ Cultural Resources | ☐ Energy |
| ☐ Geology/Soils | ☐ Greenhouse Gas Emissions | ☐ Hazards & Hazardous Materials |
| ☐ Hydrology/Water Quality | ☐ Land Use/Planning | ☐ Mineral Resources |
| ☐ Noise | ☐ Population/Housing | ☐ Public Services |
| ☐ Recreation | ☐ Transportation | ☐ Tribal Cultural Resources |
| ☐ Utilities/Service Systems | ☐ Wildfire | ☐ Mandatory Findings of Significance |

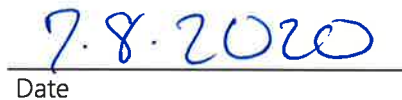
This page intentionally left blank.

SECTION VI - DETERMINATION

On the basis of this Infill Environmental Checklist:

- ☒ I find that the proposed infill project WOULD NOT have any significant effects on the environment that either have not already been analyzed in a prior EIR or that are more significant than previously analyzed, or that uniformly applicable development policies would not substantially mitigate. Pursuant to Public Resources Code Section 21094.5, CEQA does not apply to such effects. A Notice of Determination (Section 15094) will be filed.
- ☐ I find that the proposed infill project will have effects that either have not been analyzed in a prior EIR, or are more significant than described in the prior EIR, and that no uniformly applicable development policies would substantially mitigate such effects. With respect to those effects that are subject to CEQA, I find that such effects WOULD NOT be significant and a NEGATIVE DECLARATION, or if the project is a Transit Priority Project a SUSTAINABLE COMMUNITIES ENVIRONMENTAL ASSESSMENT, will be prepared.
- ☐ I find that the proposed infill project will have effects that either have not been analyzed in a prior EIR, or are more significant than described in the prior EIR, and that no uniformly applicable development policies would substantially mitigate such effects. I find that although those effects could be significant, there will not be a significant effect in this case because revisions in the infill project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION, or if the project is a Transit Priority Project a SUSTAINABLE COMMUNITIES ENVIRONMENTAL ASSESSMENT, will be prepared.
- ☐ I find that the proposed infill project would have effects that either have not been analyzed in a prior EIR, or are more significant than described in the prior EIR, and that no uniformly applicable development policies would substantially mitigate such effects. I find that those effects WOULD be significant, and an infill ENVIRONMENTAL IMPACT REPORT is required to analyze those effects that are subject to CEQA.


Signature


Date

Signature

Date

This page intentionally left blank.

Memo



455 Capitol Mall, Suite 300
Sacramento, CA 95814
916.444.7301

Date: June 24, 2020

To: CA Northstate University
2910 Prospect Park Drive
Rancho Cordova, CA 95670

From: Brenda Hom and Honey Walters, Ascent Environmental

Subject: California Northstate University College of Health Sciences ("CNU") Dormitory Project ("Project") Greenhouse Gas and Energy Analysis

1 INTRODUCTION

This memorandum assesses the potential greenhouse gas (GHG) and energy impacts associated with the California Northstate University College of Health Sciences ("CNU") Dormitory Project ("Project") in response to comments received from Soluri Meserve on behalf of Goldenberg & Associates Real Estate Investments.

The Project would result in the construction and operation of 416 dormitory rooms, totaling 107,822 square feet (sq. ft.) that includes a 9,237 sq. ft. cafeteria, a 147-space parking lot, and 35,086 sq. ft. of landscaped area. It was assumed that construction would begin in fall 2020.

2 GREENHOUSE GAS EMISSION ANALYSIS

Construction-Generated Greenhouse Gas Emissions

GHG emissions were modeled using the California Emissions Estimator Model (CalEEMod) (Version 2016.3.2) software, as recommended by the Sacramento Metropolitan Air Quality Management District (SMAQMD) (SCAQMD 2017, SMAQMD 2020a:3-5). In CalEEMod, mid-rise apartment, high-turnover restaurant, city park, and parking lot land uses were used to represent the proposed uses on the Project site. Based on CalEEMod estimates of the Project land uses, construction would last 14 months. As a conservative approach, it was assumed that the existing parking lot on site would be removed as part of the demolition phase of the Project. The Project is proposed to be constructed using modular construction which would likely result in fewer construction haul trips and worker trips than traditional construction. However, CalEEMod default values for construction inputs typical of traditional construction were used in order to ensure a conservative approach. Because the analysis does not account for the trip reductions associated with modular construction, the Project would likely result GHG emissions lower than what was modeled and presented in the memorandum.

Based on the modeling conducted, approximately 740 metric tons of carbon dioxide equivalent (MT CO₂e) would be generated by construction activity during the 14-month construction period (2020-2021). A maximum of 651 MT CO₂e/year would be emitted in 2021 (Table 1).

Table 1 Construction-Generated Greenhouse Gas Emissions

Year	Total MT CO ₂ e
2020	89.1
2021	651
Total Construction GHG Emissions	740
Maximum Annual GHG Emissions (MT CO ₂ e/year)	651
SMAQMD Construction Threshold (MT CO ₂ e/year)	1,100
Threshold Exceeded?	No

Notes: Total may not equal sum of individual components due to rounding.

MT CO₂e = metric tons of carbon dioxide equivalent; GHG = greenhouse gas; SMAQMD = Sacramento Metropolitan Air Quality Management District.

See Attachment A for detailed input parameters and modeling results.

Sources: SMAQMD 2020a; CalEEMod Version 2016.3.2.; Modeled by Ascent Environmental in 2020

Based on the maximum annual emissions of 651 MT CO₂e/year calculated for construction in 2021, GHG emissions generated would not exceed SMAQMD's threshold of 1,100 MT CO₂e/year for GHG construction emissions (SMAQMD 2020a). Given that emissions of GHGs during construction are short-term, temporary, and below SMAQMD thresholds, construction of the Project would not generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.

Operational Greenhouse Gas Emissions

Long-term operational emissions of GHGs were calculated using CalEEMod, as recommended by SMAQMD. Based on CalEEMod estimates of the Project construction duration, operations would begin in 2022.

With respect to GHG emissions generated by the Project's on-site energy use, Sacramento Municipal Utility District (SMUD) GHG emissions factors for 2022 were calculated and applied based on SMUD's latest 2018 Power Content Label and natural gas power plant emission factors from the Emissions & Generation Resource Integrated Database (eGRID 2018) (SMUD 2019, EPA 2020). 2022 SMUD emission factors were interpolated based on SMUD's 2018 power mix and the anticipated achievement of the State's carbon neutrality target by 2045 under Senate Bill 100.

CalEEMod's default energy intensity factors for the proposed land uses were adjusted to account for the 2019 Building Energy Efficiency Standards (California Code of Regulations Title 24, Part 6). Under these standards, applicable residential and commercial energy use would be 33 and 5 percent more efficient, respectively, than the 2013 standards, which are used in the current version of CalEEMod (CEC 2015, 2018). Compliance with all 2019 energy standards requirements, as required by law, was assumed when adjusting parameters in the CalEEMod model.

KD Anderson & Associates completed a trip generation study for the purpose of analyzing level of service (LOS) impacts to study area transportation facilities associated with implementation of the Project. However, this study did not address vehicle miles traveled (VMT). Due to the fundamental differences in the LOS and VMT transportation analysis metrics, the KD Anderson & Associates study did not address how the Project would affect existing travel patterns for the college as it relates to VMT. The Project would serve the current student body and existing capacity for additional student enrollment. Therefore, the Project may induce enrollment of new students and result in new trips, but it would also reduce existing student trips. By locating student housing in close proximity to the existing classroom facilities, it is likely that the number of existing student trips would decrease, and trips and associated

length of travel generated by both existing and new students would be shorter than if the Project were not to occur. Additionally, the Project would be located along Regional Transit's Rancho Cordova Route 177 and is within one-half mile of an existing major transit stop (i.e., Regional Transit Cordova Town Center Light-rail Station). In addition, the Project is located in an area identified by the Sacramento Area Council of Governments (SACOG) in the 2020 Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS) as a High Frequency Transit Area (HFTA) for Sacramento County. These are areas located within one-half mile of a major transit stop (including an existing or planned light rail, streetcar, or train station) or an existing or planned high-quality transit corridor. Therefore, the Project would likely be more VMT efficient based on its proximity to transit.

In the interest of providing a conservative analysis, vehicle trip data obtained from the KD Anderson & Associates trip generation study was used to determine operational mobile source emissions (KD Anderson & Associates 2020). Therefore, the operational mobile source emissions of the Project would likely be lower than presented here due to the conservative approach of the modeling detailed above. The KD Anderson study indicated that, when the dormitories are fully occupied, the Project could result in a net increase of 644 daily trips. Because classes are in session at CNU only 275 days per year (CNU 2020), average annual daily trips were estimated as 486 trips/day or 1.17 trips/day per student.

Annual operational GHG emissions were evaluated against SMAQMD-recommended threshold of significance for land use development projects, as discussed above. Because dormitories function differently from apartments in terms of trip generation (i.e., dormitory residents live on or near campus and do not commute to school), vehicle trip rates were applied from the KD Anderson trip generation study results, while other vehicle trip parameters (e.g., trip length, vehicle mix) in CalEEMod were based on the university land use category, which is appropriate for students and allows for more accurate emissions estimates. Additionally, because CalEEMod uses the 2014 version of California Air Resources Board's (CARB) Emission Factor model (EMFAC2014) as the default source of mobile source emissions factors, these values were updated based on CARB's more recent EMFAC2017 (Version 1.0.2) model to provide additional improvement in accuracy of emissions estimates (CARB 2020).

Table 2 Operational Greenhouse Gas Emissions

Emissions Sector	Annual MT CO ₂ e
Area	7.2
Energy	474
Mobile	378
Solid Waste	151
Water and Wastewater	41
Total Operational GHG Emissions	1,051
SMAQMD Operational Screening Threshold (MT CO₂e/year)¹	1,100
Threshold Exceeded?	No

Notes: Total may not equal sum of individual components due to rounding.

MT CO₂e = metric tons of carbon dioxide equivalent.

¹ Projects that exceed 1,100 metric tons/year must implement SMAQMD-prescribed best management practices. (SMAQMD 2020a)

See Attachment A for detailed input parameters and modeling results.

Sources: SMAQMD 2020a; CalEEMod Version 2016.3.2.; Modeled by Ascent Environmental in 2020

In SMAQMD's threshold justification report, projects that fall under the screening level of 1,100 MT CO₂e/year are anticipated to only account for less than two percent of annual emissions in the county. Projects exceeding this threshold would be required to apply best management practices prescribed by SMAQMD, which have been demonstrated to reduce the County's emissions in line with of California Air Resources Board's (CARB) Climate Change Scoping Plan (SMAQMD 2020a). Based on modeling conducted, the Project would emit 1,051 MT CO₂e/year during operations, which does not exceed SMAQMD's operational screening threshold of 1,100 MT CO₂e (SMAQMD 2020b). Because Project emissions are below the SMAQMD threshold, operation of the Project would not generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.

Conclusion

SMAQMD considers a project to have a significant impact if its GHG emissions exceed its annual mass emissions threshold of significance for construction or operations. As discussed above, Project-generated construction and operational GHG emissions would not exceed SMAQMD's construction and operational GHG thresholds. Thus, the Project would not generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment and would be less than significant.

3 ENERGY

Construction Energy Use

During construction, it is assumed that diesel fuel would be used in construction equipment and both diesel and gasoline fuels would be used in on-road vehicles for hauling trips and worker commute trips. The GHG emissions estimates and hauling and worker vehicle trip generation rates in CalEEMod were used to calculate construction-related fuel use. Diesel fuel use from off-road construction equipment was estimated based on total off-road GHG emissions estimates and a factor of 10.21 kilogram of carbon dioxide (kg CO₂) per gallon of diesel (The Climate Registry 2019). Diesel and gasoline fuel use from on-road construction haul trucks and worker commute trips were estimated using VMT calculated from model default trip rates and lengths and fuel efficiency factors (in miles per gallon) for light duty vehicles and heavy-duty trucks in Sacramento County in 2022 from EMFAC2017.

Total construction-related energy use during the entire construction period is shown in Table 3.

Table 3 Construction-Related Energy Use

Project Component	Total Gallons
Gasoline Consumption by Worker Commute Trips	155
Diesel Consumption by Haul Truck Trips	2,185
Diesel Consumption by Off-Road Construction Equipment	28,280
Total Gasoline Consumption	155
Total Diesel Consumption	30,465

See Attachment A for detailed input parameters and modeling results.

Sources: CalEEMod Version 2016.3.2.; Modeled by Ascent Environmental in 2020

The City of Rancho Cordova Municipal Code Section 16.92.040 requires construction and demolition waste generators to complete and submit a waste management plan to the City and to divert recyclable waste materials to an appropriate facility (City of Rancho Cordova 2011). This requirement is in compliance with State law, which requires that a minimum of 50 percent of the waste generated from certain construction and demolition projects is recycled. Meeting these requirements would result in additional energy conservation from avoided landfilling and material recycling through reduced solid waste collection activities and virgin material manufacture and transport.

Standard construction practices discourage unnecessary idling and operation of poorly maintained equipment. There are no unusual Project characteristics that would necessitate the use of construction equipment that would be less energy efficient than those used at comparable construction sites in other parts of the region and the State. The energy used for Project construction would not require significant additional capacity or significantly increase peak or base period demands for electricity and other forms of energy. Construction-related impacts would be less than significant.

Operational Energy Use

During Project operation, energy would be consumed by building operations and through fuel used in vehicle trips. Annual energy use during Project operations was calculated using CalEEMod Version 2016.3.2 software and calculated off-model from CalEEMod outputs. Model inputs are described in Section 2, "Greenhouse Gas Emissions."

With respect to building energy, the Project would result in the use of electricity and natural gas on-site as part of normal operations for space and water heating, indoor and outdoor lighting, and powering appliances. In CalEEMod, the energy intensities of mid-rise apartments, high-turnover restaurants, and parking lots were used to represent the proposed uses on the Project site. The use of mid-rise apartments for the purposes of modeling the operation energy use of the proposed dorms is a conservative approach because the dorm rooms would not have kitchens; and thus, associated appliances (e.g., full size refrigerators, ovens, dishwashers) would not be used in during operation of the Project.

As discussed under Greenhouse Gas Emissions, the Project is assumed to meet 2019 California Building Energy Efficiency Standards. Although the existing Project site currently operates parking lot outdoor lighting, it is conservatively assumed that the existing lights are not in operation, and so the proposed lights would result in a net increase in energy use.

Table 4 shows the adjusted building energy intensities for this Project, as modeled in CalEEMod.

Table 4 Operational Building Energy Intensity Modeling Inputs

Project Component	Size Metric	Title 24 Elec. Energy Intensity (kWh/size/yr) ¹	Nontitle 24 Elec. Energy Intensity (kWh/size/yr)	Lighting Energy Intensity (kWh/size/yr)	Title 24 Nat Gas Energy Intensity (kBtu/size/yr)	Nontitle 24 Nat Gas Energy Intensity (kBtu/size/yr)
Dormitories (Apartments, Mid-Rise)	sq. ft.	309	3,054	741	4,728	2,687
Cafeteria (High Turnover Restaurant)	sq. ft.	8.4	27	6.2	57	118
Parking Lot	acre	0	0	0.35	0	0
Total Consumption		317	3,081	748	4,785	2,805

Notes: kWh=kilowatt-hour; yr=year; kBtu=one thousand British thermal units.

¹ Results were adjusted based on 2019 Title 24 standards. Title 24 of the California Code of Regulations contains energy conservation standards applicable to residential and non-residential buildings. For electricity, Title 24 uses include space heating, space cooling, water heating, and ventilation. Non-Title 24 uses include all other end uses, such as appliances, electronics, and other miscellaneous plug-in uses. For natural gas, Title 24 uses including building heating and hot water end uses. Non-Title 24 natural gas uses include cooking and appliances (including pool/spa heaters).

See Attachment A for detailed input parameters and modeling results.

Sources: CalEEMod Version 2016.3.2.; Modeled by Ascent Environmental in 2020

Operation of the proposed Project would increase energy use from existing conditions. However, structures built as part of the Project would be subject to Titles 20 and 24 of the California Code of Regulations, which serve to reduce

demand for electrical energy by implementing energy-efficient standards for residential and non-residential buildings. In addition, the City's General Plan includes Policies LU.2.7, H.4.1, NR.7.1, NR.7.2, NR.7.3, and NR.7.4 to encourage the development of more energy efficient structures, increase overall energy conservation citywide, and reduce the consumption spread of energy-efficient technology by offering rebates and other incentives to commercial and residential developers. Compliance with these standards, which are intended to promote energy efficiency, would ensure that the increase would not be "wasteful, inefficient, or unnecessary." Finally, SACOG's 2020 MTP/SCS concluded that per capita energy consumption will decrease as a result of implementation of the plan. As discussed above, the proposed Project is consistent with the MTP/SCS in that it locates housing in an area designated as a High Frequency Transit Area for Sacramento County.

Electricity

The proposed Project would increase electricity consumption and require new utility connections. The proposed Project would result in a projected electricity consumption totaling approximately 2.1 gigawatt-hours per year. Existing utilities, operated by SMUD, already serve the Project site. The Project is consistent with applicable land use plans, which SMUD incorporates into their assessment of infrastructure needs, there would be adequate service available to meet the demand generated by the Project.

As of 2018, 45 percent of electricity provided by SMUD is sourced from renewable sources (SMUD 2019).

Natural Gas

Based on the Project's operation at the full buildout, the proposed Project would increase natural gas consumption annually totaling approximately 4,685 million British Thermal Units (MMBTU) per year and will require new on-site utility connections. However, the Project site is located within an area that is already served by Pacific Gas and Electric (PG&E) natural gas utilities. The Project is consistent with applicable land use plans, which PG&E incorporates into their assessment of infrastructure needs, there would be adequate service available to meet the demand generated by the Project. Thus, it is anticipated that PG&E natural gas supplies would be sufficient to support the Project's demand for natural gas. The Project is not expected to result in an increase in demand for natural gas that exceeds available supply or distribution infrastructure capabilities that could result in the construction of new energy facilities or expansion of existing facilities.

Transportation Energy

As described above under "Operational Greenhouse Gas Emissions," implementation of the Project could result in a reduction of student VMT as compared to current college operations. However, in the interest of providing a conservative analysis, vehicle trip data obtained from the KD Anderson & Associates traffic study (KD Anderson & Associates 2020) was used to determine vehicle energy consumption.

With respect to vehicle fuel use, the Project could result in an annual increase of up to 486 new daily trips or 891,294 VMT per year. It was assumed that these trips would primarily use gasoline-powered passenger vehicles. As with construction estimates, gasoline fuel use was estimated using fuel efficiency factors (in miles per gallon) for light duty vehicles in Sacramento County in 2022 as queried from EMFAC2017. Based on these estimates, gasoline consumption is estimated to be 30,238 gallons per year.

Table 5 shows the total annual energy consumption for this Project, as modeled in CalEEMod.

Table 5 Annual Energy Consumption during Project Operation

Project Component	Electricity (MWh/yr)	Natural Gas (MMBtu/yr)	Gasoline (gal/yr)
Dormitories (Apartments, Mid-Rise)	1,707	3,085	—
Cafeteria (High Turnover Restaurant)	378	1,600	—

Project Component	Electricity (MWh/yr)	Natural Gas (MMBtu/yr)	Gasoline (gal/yr)
Parking Lot	15	—	—
Vehicle Trips	—	—	30,238
Total Consumption	2,100	4,685	30,238
Notes: MWh=megawatt-hour; yr=year; MMBtu=one million British thermal units; gal=gallons. See Attachment A for detailed input parameters and modeling results. Sources: CalEEMod Version 2016.3.2.; Modeled by Ascent Environmental in 2020			

Fuel consumption associated with vehicle trips generated from the Project would not be considered inefficient, wasteful, or unnecessary in comparison to other similar developments in the region. The Project is an infill development that would provide on-site student housing that is anticipated to reduce total student generated VMT and associated fuel use as compared to current operations of the college. Enabling more students to live on campus, the Project would reduce reliance on the automobile, thus VMT per service entire campus population would be lower than current conditions. As identified above, the Project would be located along Regional Transit's Rancho Cordova Route 177 and is within one-half mile of an existing major transit stop (i.e., Regional Transit Cordova Town Center Light-rail Station). This would likely result in the Project being more VMT efficient based on its proximity to transit. Thus, fuel consumption associated with vehicle trips generated by the Project would not be considered inefficient, wasteful, or unnecessary and, in fact, would become more efficient as a result of the project.

Conclusion

Implementation of the Project is anticipated to increase the consumption of electricity, natural gas, and fossil fuels during construction and operation. However, the Project is an infill development and would reduce mobile fuel on a regional basis by reducing total student generated VMT. The Project would also be subject to the 2019 Building Energy Efficiency Standards and at least 45 percent of the electricity provided by SMUD would be from renewable sources. Thus, energy consumption would not be wasteful, inefficient, or unnecessary, and the Project would not result in a substantial increase in energy consumption that would require new energy supply infrastructure or capacity enhancing improvements to existing facilities. Therefore, the Project construction and operation-related impacts would be less than significant.

4 REFERENCES

- California Air Resources Board. 2020. EMFAC2017 computer program, Version 1.0.2 (web-based). Sacramento, CA. Available: <https://arb.ca.gov/emfac/>. Accessed May 29, 2020.
- California Energy Commission. 2015. 2016 Building Energy Efficiency Standards. Adoption Hearing. June 10, 2015. Available: http://www.energy.ca.gov/title24/2016standards/rulemaking/documents/2015-06-10_hearing/2015-06-10_Adoption_Hearing_Presentation.pdf. Accessed June 2, 2019.
- . 2018 (March). 2019 Building Energy Efficiency Standards. Frequently Asked Questions. Available: https://www.energy.ca.gov/sites/default/files/2020-03/Title_24_2019_Building_Standards_FAQ_ada.pdf. Accessed June 1, 2020.
- CARB. See California Air Resources Board.

- California Northstate University, College of Health Sciences. 2020. *CHS Academic Calendar 2020-2021*. Available: https://healthsciences.cnsu.edu/shareddocs/CHS_Academic_Calendar_2020-2021_Final.pdf. Accessed June 1, 2020.
- CEC. See California Energy Commission.
- City of Rancho Cordova. 2011. *Construction & Demolition Debris Reduction, Reuse, Recycling Ordinance*. Available: <https://www.cityofranhocordova.org/home/showdocument?id=11455>. Accessed June 3, 2020.
- The Climate Registry. 2019 (May). 2019 Default emission factors. Available: <https://www.theclimateregistry.org/wp-content/uploads/2019/05/The-Climate-Registry-2019-Default-Emission-Factor-Document.pdf>. Accessed June 2, 2020.
- CNU. See California Northstate University, College of Health Sciences.
- EPA. See U.S. Environmental Protection Agency.
- KD Anderson & Associates. 2020 (January 31). Trip Generation Estimate for the California Northstate University Dormitory Project, Rancho Cordova, CA.
- Sacramento Metropolitan Air Quality Management District. 2020a (April). *Guide to Air Quality Assessment in Sacramento County*. Available: <http://www.airquality.org/Residents/CEQA-Land-Use-Planning/CEQA-Guidance-Tools>. Accessed May 29, 2020.
- . 2020b (March). *Greenhouse Gas Thresholds for Sacramento County*. Prepared by Ramboll U. S. Corporation for SMAQMD. Available: <http://www.airquality.org/LandUseTransportation/Documents/SMAQMDGHGThresholds2020-03-04v2.pdf>. Accessed June 2, 2020.
- Sacramento Municipal Utility District. 2019 (July). *2018 Power Content Label*. Available: <https://www.smud.org/-/media/Documents/Corporate/Environmental-Leadership/PowerContentLabel.ashx>. Accessed June 2, 2020.
- SCAQMD. See South Coast Air Quality Management District.
- SMAQMD. See Sacramento Metropolitan Air Quality Management District.
- SMUD. See Sacramento Municipal Utility District.
- South Coast Air Quality Management District. 2017. California Emissions Estimator Model (CalEEMod) Version 2016.3.2. Available: <http://www.caleemod.com/>. Accessed June 1, 2020.
- U.S. Environmental Protection Agency. 2020. *Emissions & Generation Resource Integrated Database (eGRID) 2018*. Available: <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>. Accessed June 2, 2020.

Energy Consumption Summary for the CNU Dormitory Project**Construction-Related Energy Consumption**

	<u>value</u>	<u>units</u>	<u>source</u>
Gasoline Consumption by Worker Commute Trips	155	gal	wksht: Construction Fuel Use
Diesel Consumption by Truck Trips	65,741	gal	wksht: Construction Fuel Use

Operational Energy Consumption

	<u>value</u>	<u>units</u>	<u>source</u>
Gasoline Consumption by Worker Commute Trips	30,238	gal/year	wksht: Operational Automotive Fuel Use
Natural Gas Consumption	4,685	MMBtu/yr	wksht: Operational Building Energy Use
Electricity Consumption	2,100	MWh/yr	wksht: Operational Building Energy Use

Energy Consumption Associated with Building Operations

Natural Gas Consumption

<u>Activity</u>	<u>value</u>	<u>units</u>	<u>Source</u>
Apartments Mid Rise	3,085	MMBtu/yr	1
High Turnover (Sit Down Restaurant)	1,600	MMBtu/yr	1
Total Annual Natural Gas Consumption	4,685	MMBtu/yr	summation

Electricity Consumption

<u>Activity</u>	<u>MWh/yr</u>		<u>Source</u>
Apartments Mid Rise	1707.33	MWh/yr	1
High Turnover (Sit Down Restaurant)	378	MWh/yr	1
Parking Lot	15	MWh/yr	1
Total Annual Electricity Consumption	2,100	MWh/yr	summation

Sources

- 1 CalEEMod Output

Operational Consumption of Automotive Fuels

	<u>value</u>	<u>units</u>	<u>source</u>
CalEEMod Calculated Annual VMT	891,294.00	miles	CalEEMod
Composite fuel efficiency of all passenger vehicles	29.48	miles/gal	wksht: Veh Fuel Efficiency Rts
Total gasoline used by passenger vehicles	30,238	gal/year	calculation

Construction-Related Fuel Consumption

Off-Road Construction Fuel Use

	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	MT/yr					
2020	0.0000	88.7233	88.7233	0.0140	0.0000	89.0723
2021	0.0000	648.9034	648.9034	0.0650	0.0000	650.5294
Total	0.0000	648.9034	648.9034	0.0650	0.0000	650.5294

Source: CalEEMod Output

	<u>value</u>	<u>units</u>	<u>source</u>
Diesel Emissions Factor	10.21	kg CO2/gal	2019 Climate Registry Default Emission Factors
Total CO2 Emissions from Off-Road Construction Activity	648,903	kg CO2	calculation
Total Diesel Gallons Used from Off-Road Construction Activity	63,556	gal	calculation

On-Road Construction Fuel Use**Trips and VMT**

Phase Name	Worker Trip Number	Vendor Trip Number	Hauling Trip Number	Worker Trip Length	Vendor Trip Length	Hauling Trip Length	Total Worker Travel (VMT)	Total Vendor Travel (VMT)	Total Haul Trip Length (VMT)
Demolition	13.00	0.00	569.00	10.00	6.50	20.00	130	-	11,380
Site Preparation	8.00	0.00	0.00	10.00	6.50	20.00	80	-	-
Grading	10.00	0.00	0.00	10.00	6.50	20.00	100	-	-
Building Construction	343.00	64.00	0.00	10.00	6.50	20.00	3,430	416	-
Paving	15.00	0.00	0.00	10.00	6.50	20.00	150	-	-
Architectural Coating	69.00	0.00	0.00	10.00	6.50	20.00	690	-	-
Total							4,580	416	11,380

Source: CalEEMod Output

	value	units	source
Composite fuel efficiency of all passenger vehicles	29.48	miles/gal	wksht: Veh Fuel Efficiency Rts
Fuel Efficiency of Haul Trucks	5.40	miles/gal	wksht: Veh Fuel Efficiency Rts
Total Passenger Vehicle VMT	4,580	miles	
Total Heavy Duty Vehicle VMT	11,796	miles	
Total gasoline used by passenger vehicles	155	gal	calculation. Assume worker trips are made by gas LDVs.
Total diesel used by trucks	2,185	gal	calculation. Assume vendor and hauling trips are made by diesel HDVs.

Total Construction Fuel Use

	value	units	source
Total Diesel Use	65,741	gal	calculation
Total Gasoline Use	155	gal	calculation

Title 24 Adjustments

Land Use Type	Factor	2013	2016	2019
Residential (Apts)	T24 Electricity Use in kWh/size	460.92	331.86	308.63
Residential (Apts)	T24 NG Use in therms/size	7,061.10	5,083.99	4,728.11
Commercial (Cafeteria)	T24 Electricity Use in kWh/size	8.80	8.36	8.36
Commercial (Cafeteria)	T24 NG Use in therms/size	59.66	56.68	56.68

Land Use Type	Factor	2013	2016	2019
Residential	Percent Improvement over previous standard	n/a	28%	7%
Commercial	Percent Improvement over previous standard	n/a	5%	0%

Title 24 References: (CEC 2015) "2016 Building Energy Efficiency Standards"
 (CEC 2018) "2019 Building Energy Efficiency Standards"

https://www.calbo.org/sites/main/files/file-attachments/2015-06-10_adoption_hearing_presentation.pdf
https://www.energy.ca.gov/sites/default/files/2020-03/Title_24_2019_Building_Standards_FAQ_ada.pdf

California Northstate University College of Health Sciences - Days in Academic Calendar

Semester	Date Start	Date End	Days
Summer 2020	6/10/2020	7/31/2020	51
Fall 2020	8/24/2020	12/11/2020	109
Spring 2021	1/19/2021	5/14/2021	115
Total Days:			275

Reference: https://healthsciences.cnsu.edu/shareddocs/CHS_Academic_Calendar_2020-2021_Final.pdf

Assumptions and Emission Factors

GWP Factors		Value	Comment				
CO2		1	IPCC Fourth Assessment Report (consistent with California GHG Inventory)				
CH4		25					
N2O		298					
Average California Electricity Emissions Factors							
Year	State annual CO2 combustion output emission rate (lb/MWh)	State annual CH4 combustion output emission rate (lb/GWh)	State annual N2O combustion output emission rate (lb/GWh)	Zero Carbon Sources*	GHG-Emitting Generation Sources**	Notes/Source	
2009	906.9	50.6	7.3			eGrid 2009	
2010	874.9	52.5	7.6	45%	55%	eGrid 2010	
2011	874.9	52.5	7.6	45%	55%	2010 values	
2012	881.5	50.9	6.9	38%	62%	eGrid 2012	
2013	881.5	50.9	6.9	38%	62%	2012 values	
2014	844.8	51.7	6.3	38%	62%	eGrid 2014	
2015	844.8	51.7	6.3	38%	62%	2014 values	
2016	452.5	26.0	3.0	50%	50%	eGrid 2016	
2017	452.5	26.0	3.0	50%	50%	2016 values	
2018	496.5	34.0	4.0	50%	50%	eGrid 2018	
* Zero-Carbon Sources include all GHG neutral sources of electricity generation including nuclear, hydropower, biomass, wind, solar and geothermal							
** >90% of GHG-emitting sources are natural gas sources.							
eGrid Source: https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid							
Electricity emission factors - by utility							
Utility	Year	GHG-free mix*	lb CO2/MWh	lb CH4/MWh	lb N2O/MWh	lb CO2e/MWh	Notes/Source
SMUD	2018	45%	273.1	0.037	0.004	275.3	https://www.smud.org/-/media/Documents/Corporate/Environmental-Leadership/PowerContentLabel.ashx . All GHG-emitting sources are from natural gas.
SMUD	2019	47%	263.0	0.022	0.003	264.3	Interpolated between
SMUD	2020	49%	252.8	0.020	0.002	254.0	Interpolated between
SMUD	2021	51%	242.7	0.018	0.002	243.8	Interpolated between
SMUD	2022	53%	232.6	0.016	0.002	233.6	Interpolated between
SMUD	2045	100%	0.0	0.000	0.000	0.0	Assumed based on SB 100 targets
*This is the percentage of power provided by large hydro, renewables, and nuclear, and other resources that emit either no GHGs or a negligible amount of GHGs. Percentage based on published power mix from CEC's Power Content Label for each utility.							

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 1 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

California Northstate University Dorms
Sacramento County, Annual

1.0 Project Characteristics**1.1 Land Usage**

Land Uses	Size	Metric	Lot Acreage	Floor Surface Area	Population
Other Non-Asphalt Surfaces	0.37	Acre	0.37	16,117.20	0
Parking Lot	0.97	Acre	0.97	42,253.20	0
City Park	0.81	Acre	0.81	35,283.60	0
High Turnover (Sit Down Restaurant)	9.16	1000sqft	0.21	9,160.00	0
Apartments Mid Rise	416.00	Dwelling Unit	0.51	109,217.00	416

1.2 Other Project Characteristics

Urbanization	Urban	Wind Speed (m/s)	3.5	Precipitation Freq (Days)	58
Climate Zone	6			Operational Year	2022
Utility Company	Sacramento Municipal Utility District				
CO2 Intensity (lb/MW hr)	232.6	CH4 Intensity (lb/MW hr)	0.016	N2O Intensity (lb/MW hr)	0.002

1.3 User Entered Comments & Non-Default Data

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 2 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

Project Characteristics - Default emissions factors (CO₂, CH₄, N₂O) replaced with SMUD 2022 EFs (from "General Assumptions and EFs (SMUD 2022).xlsx" in Attachment A)

Land Use - Assume high turnover restaurant best represents cafeteria. Mobile trips available from traffic study.

Demolition - Assume entire existing pavement will be removed.

Grading - Site already graded as it is currently a parking lot.

Vehicle Trips - Per academic calendar, classes in session 275 d/yr. KD Anderson traffic study est. net increase of 644 daily trips => 485 avg daily trips/year OR 1.166 daily trips per occupant (416 occupants). Assume trip distr and lengths similar to university.

Energy Use - Updated based on 2019 T24 standards (res: 28% reduction by 2016 & 7% further reduction by 2019; non-res: 5% reduction by 2016)

Table Name	Column Name	Default Value	New Value
tblArchitecturalCoating	ConstArea_Nonresidential_Exterior	4,580.00	13,770.00
tblArchitecturalCoating	ConstArea_Nonresidential_Interior	13,740.00	41,310.00
tblAreaCoating	Area_Nonresidential_Exterior	4580	13770
tblAreaCoating	Area_Nonresidential_Interior	13740	41310
tblEnergyUse	T24E	460.92	308.63
tblEnergyUse	T24E	8.80	8.36
tblEnergyUse	T24NG	7,061.10	4,728.11
tblEnergyUse	T24NG	59.66	56.68
tblGrading	AcresOfGrading	3.00	0.00
tblLandUse	LandUseSquareFeet	416,000.00	109,217.00
tblLandUse	LotAcreage	10.95	0.51
tblLandUse	Population	1,111.00	416.00
tblProjectCharacteristics	CH4IntensityFactor	0.029	0.016
tblProjectCharacteristics	CO2IntensityFactor	590.31	232.6
tblProjectCharacteristics	N2OIntensityFactor	0.006	0.002
tblTripsAndVMT	VendorTripNumber	61.00	64.00
tblVehicleEF	HHD	0.60	0.18
tblVehicleEF	HHD	0.07	0.06

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 3 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

tblVehicleEF	HHD	0.11	0.00
tblVehicleEF	HHD	4,159.31	9,153.87
tblVehicleEF	HHD	1,651.06	1,538.11
tblVehicleEF	HHD	9.15	0.02
tblVehicleEF	LDA	4.2860e-003	2.5680e-003
tblVehicleEF	LDA	5.8650e-003	0.06
tblVehicleEF	LDA	252.52	260.95
tblVehicleEF	LDA	57.68	54.60
tblVehicleEF	LDT1	0.01	5.4680e-003
tblVehicleEF	LDT1	0.02	0.08
tblVehicleEF	LDT1	313.76	308.81
tblVehicleEF	LDT1	71.71	65.79
tblVehicleEF	LDT2	6.1470e-003	3.8830e-003
tblVehicleEF	LDT2	8.5390e-003	0.08
tblVehicleEF	LDT2	354.77	334.69
tblVehicleEF	LDT2	81.19	72.01
tblVehicleEF	LHD1	5.3360e-003	0.07
tblVehicleEF	LHD1	0.02	0.01
tblVehicleEF	LHD1	0.02	0.01
tblVehicleEF	LHD1	9.21	129.43
tblVehicleEF	LHD1	701.67	805.85
tblVehicleEF	LHD1	31.04	10.23
tblVehicleEF	LHD2	3.6020e-003	0.04
tblVehicleEF	LHD2	9.9840e-003	8.6010e-003
tblVehicleEF	LHD2	8.8820e-003	8.3040e-003
tblVehicleEF	LHD2	14.25	194.40
tblVehicleEF	LHD2	720.74	795.82

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 4 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

tblVehicleEF	LHD2	24.40	6.82
tblVehicleEF	MCY	0.44	0.34
tblVehicleEF	MCY	0.17	0.26
tblVehicleEF	MCY	168.00	210.86
tblVehicleEF	MCY	47.74	63.07
tblVehicleEF	MDV	0.01	5.0650e-003
tblVehicleEF	MDV	0.02	0.09
tblVehicleEF	MDV	479.92	410.48
tblVehicleEF	MDV	108.64	87.89
tblVehicleEF	MH	0.04	0.01
tblVehicleEF	MH	0.03	0.02
tblVehicleEF	MH	1,233.39	1,603.42
tblVehicleEF	MH	60.21	19.41
tblVehicleEF	MHD	0.02	0.04
tblVehicleEF	MHD	7.5850e-003	6.6210e-003
tblVehicleEF	MHD	0.06	5.3430e-003
tblVehicleEF	MHD	147.37	1,425.11
tblVehicleEF	MHD	1,210.28	1,161.69
tblVehicleEF	MHD	57.55	5.26
tblVehicleEF	OBUS	0.01	0.10
tblVehicleEF	OBUS	0.01	0.01
tblVehicleEF	OBUS	0.03	0.01
tblVehicleEF	OBUS	128.59	1,671.65
tblVehicleEF	OBUS	1,355.95	1,492.53
tblVehicleEF	OBUS	68.41	11.11
tblVehicleEF	SBUS	0.84	0.38
tblVehicleEF	SBUS	0.01	6.3810e-003

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 5 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

tblVehicleEF	SBUS	0.07	8.4610e-003
tblVehicleEF	SBUS	1,201.53	3,573.20
tblVehicleEF	SBUS	1,096.07	1,113.09
tblVehicleEF	SBUS	44.67	7.18
tblVehicleEF	UBUS	2.06	4.73
tblVehicleEF	UBUS	0.08	0.03
tblVehicleEF	UBUS	1,890.52	2,058.02
tblVehicleEF	UBUS	137.34	25.45
tblVehicleTrips	CC_TL	0.00	5.00
tblVehicleTrips	CC_TTP	0.00	88.60
tblVehicleTrips	CNW_TL	0.00	6.50
tblVehicleTrips	CNW_TTP	0.00	5.00
tblVehicleTrips	CW_TL	0.00	10.00
tblVehicleTrips	CW_TTP	0.00	6.40
tblVehicleTrips	DV_TP	11.00	9.00
tblVehicleTrips	HO_TL	6.50	0.00
tblVehicleTrips	HO_TTP	41.00	0.00
tblVehicleTrips	HS_TL	5.00	0.00
tblVehicleTrips	HS_TTP	12.50	0.00
tblVehicleTrips	HW_TL	10.00	0.00
tblVehicleTrips	HW_TTP	46.50	0.00
tblVehicleTrips	PB_TP	3.00	0.00
tblVehicleTrips	PR_TP	86.00	91.00
tblVehicleTrips	ST_TR	6.39	1.17
tblVehicleTrips	ST_TR	22.75	0.00
tblVehicleTrips	ST_TR	158.37	0.00
tblVehicleTrips	SU_TR	5.86	1.17

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 6 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

tblVehicleTrips	SU_TR	16.74	0.00
tblVehicleTrips	SU_TR	131.84	0.00
tblVehicleTrips	WD_TR	6.65	1.17
tblVehicleTrips	WD_TR	1.89	0.00
tblVehicleTrips	WD_TR	127.15	0.00

2.0 Emissions Summary

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 7 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2020	0.0569	0.5670	0.3834	9.8000e-004	0.1143	0.0233	0.1376	0.0294	0.0218	0.0511	0.0000	88.7233	88.7233	0.0140	0.0000	89.0723
2021	1.8670	2.6682	2.8783	7.3000e-003	0.3224	0.0995	0.4219	0.0867	0.0951	0.1818	0.0000	648.9034	648.9034	0.0650	0.0000	650.5294
Maximum	1.8670	2.6682	2.8783	7.3000e-003	0.3224	0.0995	0.4219	0.0867	0.0951	0.1818	0.0000	648.9034	648.9034	0.0650	0.0000	650.5294

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2020	0.0569	0.5670	0.3834	9.8000e-004	0.1143	0.0233	0.1376	0.0294	0.0218	0.0511	0.0000	88.7233	88.7233	0.0140	0.0000	89.0722
2021	1.8670	2.6682	2.8783	7.3000e-003	0.3224	0.0995	0.4219	0.0867	0.0951	0.1818	0.0000	648.9032	648.9032	0.0650	0.0000	650.5291
Maximum	1.8670	2.6682	2.8783	7.3000e-003	0.3224	0.0995	0.4219	0.0867	0.0951	0.1818	0.0000	648.9032	648.9032	0.0650	0.0000	650.5291

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Percent Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 8 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

Quarter	Start Date	End Date	Maximum Unmitigated ROG + NOX (tons/quarter)	Maximum Mitigated ROG + NOX (tons/quarter)
1	11-2-2020	2-1-2021	0.9134	0.9134
2	2-2-2021	5-1-2021	0.8547	0.8547
3	5-2-2021	8-1-2021	0.8798	0.8798
4	8-2-2021	9-30-2021	0.5738	0.5738
		Highest	0.9134	0.9134

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	0.6781	0.0495	4.2948	2.3000e-004		0.0237	0.0237		0.0237	0.0237	0.0000	7.0080	7.0080	6.7600e-003	0.0000	7.1771
Energy	0.0253	0.2206	0.1264	1.3800e-003		0.0175	0.0175		0.0175	0.0175	0.0000	471.5941	471.5941	0.0200	6.4900e-003	474.0287
Mobile	0.1278	0.5208	1.3078	3.9100e-003	0.3324	3.5300e-003	0.3359	0.0891	3.3000e-003	0.0924	0.0000	377.4088	377.4088	0.0272	0.0000	378.0879
Waste						0.0000	0.0000		0.0000	0.0000	60.9846	0.0000	60.9846	3.6041	0.0000	151.0867
Water						0.0000	0.0000		0.0000	0.0000	10.5732	22.4418	33.0149	0.0379	0.0232	40.8728
Total	0.8311	0.7909	5.7290	5.5200e-003	0.3324	0.0447	0.3771	0.0891	0.0445	0.1336	71.5577	878.4528	950.0105	3.6960	0.0297	1,051.2531

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 9 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

2.2 Overall Operational**Mitigated Operational**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	0.6781	0.0495	4.2948	2.3000e-004		0.0237	0.0237		0.0237	0.0237	0.0000	7.0080	7.0080	6.7600e-003	0.0000	7.1771
Energy	0.0253	0.2206	0.1264	1.3800e-003		0.0175	0.0175		0.0175	0.0175	0.0000	471.5941	471.5941	0.0200	6.4900e-003	474.0287
Mobile	0.1278	0.5208	1.3078	3.9100e-003	0.3324	3.5300e-003	0.3359	0.0891	3.3000e-003	0.0924	0.0000	377.4088	377.4088	0.0272	0.0000	378.0879
Waste						0.0000	0.0000		0.0000	0.0000	60.9846	0.0000	60.9846	3.6041	0.0000	151.0867
Water						0.0000	0.0000		0.0000	0.0000	10.5732	22.4418	33.0149	0.0379	0.0232	40.8728
Total	0.8311	0.7909	5.7290	5.5200e-003	0.3324	0.0447	0.3771	0.0891	0.0445	0.1336	71.5577	878.4528	950.0105	3.6960	0.0297	1,051.2531

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Percent Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.0 Construction Detail**Construction Phase**

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 10 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

Phase Number	Phase Name	Phase Type	Start Date	End Date	Num Days Week	Num Days	Phase Description
1	Demolition	Demolition	11/2/2020	11/27/2020	5	20	
2	Site Preparation	Site Preparation	11/28/2020	12/4/2020	5	3	
3	Grading	Grading	12/5/2020	12/16/2020	5	6	
4	Building Construction	Building Construction	12/17/2020	11/3/2021	5	220	
5	Paving	Paving	11/4/2021	11/29/2021	5	10	
6	Architectural Coating	Architectural Coating	11/30/2021	12/23/2021	5	10	

Acres of Grading (Site Preparation Phase): 4.5**Acres of Grading (Grading Phase): 0****Acres of Paving: 1.34**

Residential Indoor: 221,164; Residential Outdoor: 73,721; Non-Residential Indoor: 41,310; Non-Residential Outdoor: 13,770; Striped Parking Area: 3,502 (Architectural Coating – sqft)

OffRoad Equipment

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 11 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

Phase Name	Offroad Equipment Type	Amount	Usage Hours	Horse Power	Load Factor
Demolition	Concrete/Industrial Saws	1	8.00	81	0.73
Demolition	Rubber Tired Dozers	1	8.00	247	0.40
Demolition	Tractors/Loaders/Backhoes	3	8.00	97	0.37
Site Preparation	Graders	1	8.00	187	0.41
Site Preparation	Scrapers	1	8.00	367	0.48
Site Preparation	Tractors/Loaders/Backhoes	1	7.00	97	0.37
Grading	Graders	1	8.00	187	0.41
Grading	Rubber Tired Dozers	1	8.00	247	0.40
Grading	Tractors/Loaders/Backhoes	2	7.00	97	0.37
Building Construction	Cranes	1	8.00	231	0.29
Building Construction	Forklifts	2	7.00	89	0.20
Building Construction	Generator Sets	1	8.00	84	0.74
Building Construction	Tractors/Loaders/Backhoes	1	6.00	97	0.37
Building Construction	Welders	3	8.00	46	0.45
Paving	Cement and Mortar Mixers	1	8.00	9	0.56
Paving	Pavers	1	8.00	130	0.42
Paving	Paving Equipment	1	8.00	132	0.36
Paving	Rollers	2	8.00	80	0.38
Paving	Tractors/Loaders/Backhoes	1	8.00	97	0.37
Architectural Coating	Air Compressors	1	6.00	78	0.48

Trips and VMT

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 12 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorns - Sacramento County, Annual

Phase Name	Offroad Equipment Count	Worker Trip Number	Vendor Trip Number	Hauling Trip Number	Worker Trip Length	Vendor Trip Length	Hauling Trip Length	Worker Vehicle Class	Vendor Vehicle Class	Hauling Vehicle Class
Demolition	5	13.00	0.00	569.00	10.00	6.50	20.00	LD_Mix	HDT_Mix	HHDT
Site Preparation	3	8.00	0.00	0.00	10.00	6.50	20.00	LD_Mix	HDT_Mix	HHDT
Grading	4	10.00	0.00	0.00	10.00	6.50	20.00	LD_Mix	HDT_Mix	HHDT
Building Construction	8	343.00	64.00	0.00	10.00	6.50	20.00	LD_Mix	HDT_Mix	HHDT
Paving	6	15.00	0.00	0.00	10.00	6.50	20.00	LD_Mix	HDT_Mix	HHDT
Architectural Coating	1	69.00	0.00	0.00	10.00	6.50	20.00	LD_Mix	HDT_Mix	HHDT

3.1 Mitigation Measures Construction

3.2 Demolition - 2020

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0642	0.0000	0.0642	9.7100e-003	0.0000	9.7100e-003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0213	0.2095	0.1466	2.4000e-004		0.0115	0.0115		0.0108	0.0108	0.0000	21.0677	21.0677	5.4200e-003	0.0000	21.2031
Total	0.0213	0.2095	0.1466	2.4000e-004	0.0642	0.0115	0.0757	9.7100e-003	0.0108	0.0205	0.0000	21.0677	21.0677	5.4200e-003	0.0000	21.2031

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 13 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.2 Demolition - 2020**Unmitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	2.1900e-003	0.0817	0.0185	2.2000e-004	4.8000e-003	2.9000e-004	5.0900e-003	1.3200e-003	2.8000e-004	1.6000e-003	0.0000	21.7678	21.7678	1.2700e-003	0.0000	21.7994
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	4.8000e-004	3.3000e-004	3.6000e-003	1.0000e-005	9.5000e-004	1.0000e-005	9.6000e-004	2.5000e-004	1.0000e-005	2.6000e-004	0.0000	0.8460	0.8460	2.0000e-005	0.0000	0.8466
Total	2.6700e-003	0.0821	0.0221	2.3000e-004	5.7500e-003	3.0000e-004	6.0500e-003	1.5700e-003	2.9000e-004	1.8600e-003	0.0000	22.6138	22.6138	1.2900e-003	0.0000	22.6460

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0642	0.0000	0.0642	9.7100e-003	0.0000	9.7100e-003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0213	0.2095	0.1466	2.4000e-004		0.0115	0.0115		0.0108	0.0108	0.0000	21.0676	21.0676	5.4200e-003	0.0000	21.2030
Total	0.0213	0.2095	0.1466	2.4000e-004	0.0642	0.0115	0.0757	9.7100e-003	0.0108	0.0205	0.0000	21.0676	21.0676	5.4200e-003	0.0000	21.2030

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 14 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.2 Demolition - 2020**Mitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	2.1900e-003	0.0817	0.0185	2.2000e-004	4.8000e-003	2.9000e-004	5.0900e-003	1.3200e-003	2.8000e-004	1.6000e-003	0.0000	21.7678	21.7678	1.2700e-003	0.0000	21.7994
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	4.8000e-004	3.3000e-004	3.6000e-003	1.0000e-005	9.5000e-004	1.0000e-005	9.6000e-004	2.5000e-004	1.0000e-005	2.6000e-004	0.0000	0.8460	0.8460	2.0000e-005	0.0000	0.8466
Total	2.6700e-003	0.0821	0.0221	2.3000e-004	5.7500e-003	3.0000e-004	6.0500e-003	1.5700e-003	2.9000e-004	1.8600e-003	0.0000	22.6138	22.6138	1.2900e-003	0.0000	22.6460

3.3 Site Preparation - 2020**Unmitigated Construction On-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					3.9800e-003	0.0000	3.9800e-003	4.3000e-004	0.0000	4.3000e-004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	4.1300e-003	0.0498	0.0282	6.0000e-005		1.9400e-003	1.9400e-003		1.7900e-003	1.7900e-003	0.0000	5.3817	5.3817	1.7400e-003	0.0000	5.4252
Total	4.1300e-003	0.0498	0.0282	6.0000e-005	3.9800e-003	1.9400e-003	5.9200e-003	4.3000e-004	1.7900e-003	2.2200e-003	0.0000	5.3817	5.3817	1.7400e-003	0.0000	5.4252

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 15 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.3 Site Preparation - 2020

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	7.0000e-005	5.0000e-005	5.5000e-004	0.0000	1.5000e-004	0.0000	1.5000e-004	4.0000e-005	0.0000	4.0000e-005	0.0000	0.1302	0.1302	0.0000	0.0000	0.1302
Total	7.0000e-005	5.0000e-005	5.5000e-004	0.0000	1.5000e-004	0.0000	1.5000e-004	4.0000e-005	0.0000	4.0000e-005	0.0000	0.1302	0.1302	0.0000	0.0000	0.1302

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					3.9800e-003	0.0000	3.9800e-003	4.3000e-004	0.0000	4.3000e-004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	4.1300e-003	0.0498	0.0282	6.0000e-005		1.9400e-003	1.9400e-003		1.7900e-003	1.7900e-003	0.0000	5.3817	5.3817	1.7400e-003	0.0000	5.4252
Total	4.1300e-003	0.0498	0.0282	6.0000e-005	3.9800e-003	1.9400e-003	5.9200e-003	4.3000e-004	1.7900e-003	2.2200e-003	0.0000	5.3817	5.3817	1.7400e-003	0.0000	5.4252

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 16 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.3 Site Preparation - 2020**Mitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	7.0000e-005	5.0000e-005	5.5000e-004	0.0000	1.5000e-004	0.0000	1.5000e-004	4.0000e-005	0.0000	4.0000e-005	0.0000	0.1302	0.1302	0.0000	0.0000	0.1302
Total	7.0000e-005	5.0000e-005	5.5000e-004	0.0000	1.5000e-004	0.0000	1.5000e-004	4.0000e-005	0.0000	4.0000e-005	0.0000	0.1302	0.1302	0.0000	0.0000	0.1302

3.4 Grading - 2020**Unmitigated Construction On-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0241	0.0000	0.0241	0.0132	0.0000	0.0132	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	7.6900e-003	0.0854	0.0397	8.0000e-005		3.9600e-003	3.9600e-003		3.6400e-003	3.6400e-003	0.0000	7.2444	7.2444	2.3400e-003	0.0000	7.3030
Total	7.6900e-003	0.0854	0.0397	8.0000e-005	0.0241	3.9600e-003	0.0281	0.0132	3.6400e-003	0.0169	0.0000	7.2444	7.2444	2.3400e-003	0.0000	7.3030

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 17 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.4 Grading - 2020**Unmitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	1.5000e-004	1.0000e-004	1.1100e-003	0.0000	2.9000e-004	0.0000	3.0000e-004	8.0000e-005	0.0000	8.0000e-005	0.0000	0.2603	0.2603	1.0000e-005	0.0000	0.2605
Total	1.5000e-004	1.0000e-004	1.1100e-003	0.0000	2.9000e-004	0.0000	3.0000e-004	8.0000e-005	0.0000	8.0000e-005	0.0000	0.2603	0.2603	1.0000e-005	0.0000	0.2605

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0241	0.0000	0.0241	0.0132	0.0000	0.0132	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	7.6900e-003	0.0854	0.0397	8.0000e-005		3.9600e-003	3.9600e-003		3.6400e-003	3.6400e-003	0.0000	7.2444	7.2444	2.3400e-003	0.0000	7.3030
Total	7.6900e-003	0.0854	0.0397	8.0000e-005	0.0241	3.9600e-003	0.0281	0.0132	3.6400e-003	0.0169	0.0000	7.2444	7.2444	2.3400e-003	0.0000	7.3030

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 18 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.4 Grading - 2020

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	1.5000e-004	1.0000e-004	1.1100e-003	0.0000	2.9000e-004	0.0000	3.0000e-004	8.0000e-005	0.0000	8.0000e-005	0.0000	0.2603	0.2603	1.0000e-005	0.0000	0.2605
Total	1.5000e-004	1.0000e-004	1.1100e-003	0.0000	2.9000e-004	0.0000	3.0000e-004	8.0000e-005	0.0000	8.0000e-005	0.0000	0.2603	0.2603	1.0000e-005	0.0000	0.2605

3.5 Building Construction - 2020

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.0126	0.0959	0.0819	1.4000e-004		5.2200e-003	5.2200e-003		5.0000e-003	5.0000e-003	0.0000	11.4204	11.4204	2.3200e-003	0.0000	11.4784
Total	0.0126	0.0959	0.0819	1.4000e-004		5.2200e-003	5.2200e-003		5.0000e-003	5.0000e-003	0.0000	11.4204	11.4204	2.3200e-003	0.0000	11.4784

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 19 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.5 Building Construction - 2020

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	1.3500e-003	0.0395	0.0110	9.0000e-005	2.0600e-003	2.0000e-004	2.2600e-003	5.9000e-004	2.0000e-004	7.9000e-004	0.0000	8.3288	8.3288	4.9000e-004	0.0000	8.3411
Worker	7.0200e-003	4.7600e-003	0.0522	1.4000e-004	0.0139	1.0000e-004	0.0140	3.6900e-003	9.0000e-005	3.7800e-003	0.0000	12.2761	12.2761	3.5000e-004	0.0000	12.2848
Total	8.3700e-003	0.0442	0.0632	2.3000e-004	0.0159	3.0000e-004	0.0162	4.2800e-003	2.9000e-004	4.5700e-003	0.0000	20.6049	20.6049	8.4000e-004	0.0000	20.6259

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.0126	0.0959	0.0819	1.4000e-004		5.2200e-003	5.2200e-003		5.0000e-003	5.0000e-003	0.0000	11.4204	11.4204	2.3200e-003	0.0000	11.4784
Total	0.0126	0.0959	0.0819	1.4000e-004		5.2200e-003	5.2200e-003		5.0000e-003	5.0000e-003	0.0000	11.4204	11.4204	2.3200e-003	0.0000	11.4784

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 20 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.5 Building Construction - 2020**Mitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	1.3500e-003	0.0395	0.0110	9.0000e-005	2.0600e-003	2.0000e-004	2.2600e-003	5.9000e-004	2.0000e-004	7.9000e-004	0.0000	8.3288	8.3288	4.9000e-004	0.0000	8.3411
Worker	7.0200e-003	4.7600e-003	0.0522	1.4000e-004	0.0139	1.0000e-004	0.0140	3.6900e-003	9.0000e-005	3.7800e-003	0.0000	12.2761	12.2761	3.5000e-004	0.0000	12.2848
Total	8.3700e-003	0.0442	0.0632	2.3000e-004	0.0159	3.0000e-004	0.0162	4.2800e-003	2.9000e-004	4.5700e-003	0.0000	20.6049	20.6049	8.4000e-004	0.0000	20.6259

3.5 Building Construction - 2021**Unmitigated Construction On-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.2239	1.7550	1.5946	2.7400e-003		0.0895	0.0895		0.0858	0.0858	0.0000	227.3754	227.3754	0.0447	0.0000	228.4937
Total	0.2239	1.7550	1.5946	2.7400e-003		0.0895	0.0895		0.0858	0.0858	0.0000	227.3754	227.3754	0.0447	0.0000	228.4937

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 21 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.5 Building Construction - 2021**Unmitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0220	0.7169	0.1916	1.7100e-003	0.0410	1.9800e-003	0.0430	0.0118	1.8900e-003	0.0137	0.0000	164.4389	164.4389	9.4000e-003	0.0000	164.6740
Worker	0.1301	0.0850	0.9506	2.6100e-003	0.2758	1.9300e-003	0.2778	0.0734	1.7800e-003	0.0751	0.0000	236.0848	236.0848	6.2000e-003	0.0000	236.2398
Total	0.1521	0.8019	1.1422	4.3200e-003	0.3168	3.9100e-003	0.3207	0.0852	3.6700e-003	0.0889	0.0000	400.5238	400.5238	0.0156	0.0000	400.9138

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.2239	1.7550	1.5946	2.7400e-003		0.0895	0.0895		0.0858	0.0858	0.0000	227.3751	227.3751	0.0447	0.0000	228.4934
Total	0.2239	1.7550	1.5946	2.7400e-003		0.0895	0.0895		0.0858	0.0858	0.0000	227.3751	227.3751	0.0447	0.0000	228.4934

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 22 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.5 Building Construction - 2021**Mitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0220	0.7169	0.1916	1.7100e-003	0.0410	1.9800e-003	0.0430	0.0118	1.8900e-003	0.0137	0.0000	164.4389	164.4389	9.4000e-003	0.0000	164.6740
Worker	0.1301	0.0850	0.9506	2.6100e-003	0.2758	1.9300e-003	0.2778	0.0734	1.7800e-003	0.0751	0.0000	236.0848	236.0848	6.2000e-003	0.0000	236.2398
Total	0.1521	0.8019	1.1422	4.3200e-003	0.3168	3.9100e-003	0.3207	0.0852	3.6700e-003	0.0889	0.0000	400.5238	400.5238	0.0156	0.0000	400.9138

3.6 Paving - 2021**Unmitigated Construction On-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	9.5700e-003	0.0958	0.1060	1.6000e-004		5.2400e-003	5.2400e-003		4.8300e-003	4.8300e-003	0.0000	13.9543	13.9543	4.4200e-003	0.0000	14.0649
Paving	2.2900e-003					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0119	0.0958	0.1060	1.6000e-004		5.2400e-003	5.2400e-003		4.8300e-003	4.8300e-003	0.0000	13.9543	13.9543	4.4200e-003	0.0000	14.0649

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 23 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.6 Paving - 2021

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	4.7000e-004	3.1000e-004	3.4200e-003	1.0000e-005	9.9000e-004	1.0000e-005	1.0000e-003	2.6000e-004	1.0000e-005	2.7000e-004	0.0000	0.8486	0.8486	2.0000e-005	0.0000	0.8491
Total	4.7000e-004	3.1000e-004	3.4200e-003	1.0000e-005	9.9000e-004	1.0000e-005	1.0000e-003	2.6000e-004	1.0000e-005	2.7000e-004	0.0000	0.8486	0.8486	2.0000e-005	0.0000	0.8491

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	9.5700e-003	0.0958	0.1060	1.6000e-004		5.2400e-003	5.2400e-003		4.8300e-003	4.8300e-003	0.0000	13.9543	13.9543	4.4200e-003	0.0000	14.0649
Paving	2.2900e-003					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0119	0.0958	0.1060	1.6000e-004		5.2400e-003	5.2400e-003		4.8300e-003	4.8300e-003	0.0000	13.9543	13.9543	4.4200e-003	0.0000	14.0649

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 24 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.6 Paving - 2021**Mitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	4.7000e-004	3.1000e-004	3.4200e-003	1.0000e-005	9.9000e-004	1.0000e-005	1.0000e-003	2.6000e-004	1.0000e-005	2.7000e-004	0.0000	0.8486	0.8486	2.0000e-005	0.0000	0.8491
Total	4.7000e-004	3.1000e-004	3.4200e-003	1.0000e-005	9.9000e-004	1.0000e-005	1.0000e-003	2.6000e-004	1.0000e-005	2.7000e-004	0.0000	0.8486	0.8486	2.0000e-005	0.0000	0.8491

3.7 Architectural Coating - 2021**Unmitigated Construction On-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Archit. Coating	1.4745					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	1.9700e-003	0.0137	0.0164	3.0000e-005		8.5000e-004	8.5000e-004		8.5000e-004	8.5000e-004	0.0000	2.2979	2.2979	1.6000e-004	0.0000	2.3019
Total	1.4765	0.0137	0.0164	3.0000e-005		8.5000e-004	8.5000e-004		8.5000e-004	8.5000e-004	0.0000	2.2979	2.2979	1.6000e-004	0.0000	2.3019

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 25 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.7 Architectural Coating - 2021

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	2.1500e-003	1.4100e-003	0.0157	4.0000e-005	4.5600e-003	3.0000e-005	4.5900e-003	1.2100e-003	3.0000e-005	1.2400e-003	0.0000	3.9035	3.9035	1.0000e-004	0.0000	3.9060
Total	2.1500e-003	1.4100e-003	0.0157	4.0000e-005	4.5600e-003	3.0000e-005	4.5900e-003	1.2100e-003	3.0000e-005	1.2400e-003	0.0000	3.9035	3.9035	1.0000e-004	0.0000	3.9060

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Archit. Coating	1.4745					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	1.9700e-003	0.0137	0.0164	3.0000e-005		8.5000e-004	8.5000e-004		8.5000e-004	8.5000e-004	0.0000	2.2979	2.2979	1.6000e-004	0.0000	2.3019
Total	1.4765	0.0137	0.0164	3.0000e-005		8.5000e-004	8.5000e-004		8.5000e-004	8.5000e-004	0.0000	2.2979	2.2979	1.6000e-004	0.0000	2.3019

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 26 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

3.7 Architectural Coating - 2021**Mitigated Construction Off-Site**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	2.1500e-003	1.4100e-003	0.0157	4.0000e-005	4.5600e-003	3.0000e-005	4.5900e-003	1.2100e-003	3.0000e-005	1.2400e-003	0.0000	3.9035	3.9035	1.0000e-004	0.0000	3.9060
Total	2.1500e-003	1.4100e-003	0.0157	4.0000e-005	4.5600e-003	3.0000e-005	4.5900e-003	1.2100e-003	3.0000e-005	1.2400e-003	0.0000	3.9035	3.9035	1.0000e-004	0.0000	3.9060

4.0 Operational Detail - Mobile**4.1 Mitigation Measures Mobile**

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 27 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	0.1278	0.5208	1.3078	3.9100e-003	0.3324	3.5300e-003	0.3359	0.0891	3.3000e-003	0.0924	0.0000	377.4088	377.4088	0.0272	0.0000	378.0879
Unmitigated	0.1278	0.5208	1.3078	3.9100e-003	0.3324	3.5300e-003	0.3359	0.0891	3.3000e-003	0.0924	0.0000	377.4088	377.4088	0.0272	0.0000	378.0879

4.2 Trip Summary Information

Land Use	Average Daily Trip Rate			Unmitigated	Mitigated
	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Apartments Mid Rise	486.72	486.72	486.72	891,294	891,294
City Park	0.00	0.00	0.00		
High Turnover (Sit Down Restaurant)	0.00	0.00	0.00		
Other Non-Asphalt Surfaces	0.00	0.00	0.00		
Parking Lot	0.00	0.00	0.00		
Total	486.72	486.72	486.72	891,294	891,294

4.3 Trip Type Information

Land Use	Miles			Trip %			Trip Purpose %		
	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW	Primary	Diverted	Pass-by
Apartments Mid Rise	0.00	0.00	0.00	0.00	0.00	0.00	91	9	0
City Park	10.00	5.00	6.50	33.00	48.00	19.00	66	28	6
High Turnover (Sit Down)	10.00	5.00	6.50	8.50	72.50	19.00	37	20	43
Other Non-Asphalt Surfaces	10.00	5.00	6.50	0.00	0.00	0.00	0	0	0
Parking Lot	10.00	5.00	6.50	0.00	0.00	0.00	0	0	0

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 28 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

4.4 Fleet Mix

Land Use	LDA	LDT1	LDT2	MDV	LHD1	LHD2	MHD	HHD	OBUS	UBUS	MCY	SBUS	MH
Apartments Mid Rise	0.559527	0.038733	0.206173	0.118029	0.019040	0.005245	0.018552	0.023249	0.002031	0.002054	0.005884	0.000619	0.000865
City Park	0.559527	0.038733	0.206173	0.118029	0.019040	0.005245	0.018552	0.023249	0.002031	0.002054	0.005884	0.000619	0.000865
High Turnover (Sit Down Restaurant)	0.559527	0.038733	0.206173	0.118029	0.019040	0.005245	0.018552	0.023249	0.002031	0.002054	0.005884	0.000619	0.000865
Other Non-Asphalt Surfaces	0.559527	0.038733	0.206173	0.118029	0.019040	0.005245	0.018552	0.023249	0.002031	0.002054	0.005884	0.000619	0.000865
Parking Lot	0.559527	0.038733	0.206173	0.118029	0.019040	0.005245	0.018552	0.023249	0.002031	0.002054	0.005884	0.000619	0.000865

5.0 Energy Detail

Historical Energy Use: N

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.0000	0.0000		0.0000	0.0000	0.0000	221.5782	221.5782	0.0152	1.9100e-003	222.5271
Electricity Unmitigated						0.0000	0.0000		0.0000	0.0000	0.0000	221.5782	221.5782	0.0152	1.9100e-003	222.5271
NaturalGas Mitigated	0.0253	0.2206	0.1264	1.3800e-003		0.0175	0.0175		0.0175	0.0175	0.0000	250.0159	250.0159	4.7900e-003	4.5800e-003	251.5016
NaturalGas Unmitigated	0.0253	0.2206	0.1264	1.3800e-003		0.0175	0.0175		0.0175	0.0175	0.0000	250.0159	250.0159	4.7900e-003	4.5800e-003	251.5016

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 29 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	tons/yr										MT/yr					
Apartments Mid Rise	3.08469e+006	0.0166	0.1421	0.0605	9.1000e-004		0.0115	0.0115		0.0115	0.0115	0.0000	164.6106	164.6106	3.1600e-003	3.0200e-003	165.5888
City Park	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
High Turnover (Sit Down Restaurant)	1.60044e+006	8.6300e-003	0.0785	0.0659	4.7000e-004		5.9600e-003	5.9600e-003		5.9600e-003	5.9600e-003	0.0000	85.4053	85.4053	1.6400e-003	1.5700e-003	85.9128
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Parking Lot	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total		0.0253	0.2206	0.1264	1.3800e-003		0.0175	0.0175		0.0175	0.0175	0.0000	250.0159	250.0159	4.8000e-003	4.5900e-003	251.5016

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 30 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

5.2 Energy by Land Use - NaturalGas

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	tons/yr										MT/yr					
Apartments Mid Rise	3.08469e+006	0.0166	0.1421	0.0605	9.1000e-004		0.0115	0.0115		0.0115	0.0115	0.0000	164.6106	164.6106	3.1600e-003	3.0200e-003	165.5888
City Park	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
High Turnover (Sit Down Restaurant)	1.60044e+006	8.6300e-003	0.0785	0.0659	4.7000e-004		5.9600e-003	5.9600e-003		5.9600e-003	5.9600e-003	0.0000	85.4053	85.4053	1.6400e-003	1.5700e-003	85.9128
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Parking Lot	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total		0.0253	0.2206	0.1264	1.3800e-003		0.0175	0.0175		0.0175	0.0175	0.0000	250.0159	250.0159	4.8000e-003	4.5900e-003	251.5016

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 31 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

5.3 Energy by Land Use - Electricity**Unmitigated**

	Electricity Use	Total CO2	CH4	N2O	CO2e
Land Use	kWh/yr	MT/yr			
Apartments Mid Rise	1.70733e+006	180.1334	0.0124	1.5500e-003	180.9047
City Park	0	0.0000	0.0000	0.0000	0.0000
High Turnover (Sit Down Restaurant)	378033	39.8846	2.7400e-003	3.4000e-004	40.0554
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000
Parking Lot	14788.6	1.5603	1.1000e-004	1.0000e-005	1.5670
Total		221.5782	0.0152	1.9000e-003	222.5271

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 32 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

5.3 Energy by Land Use - Electricity**Mitigated**

	Electricity Use	Total CO2	CH4	N2O	CO2e
Land Use	kWh/yr	MT/yr			
Apartments Mid Rise	1.70733e+006	180.1334	0.0124	1.5500e-003	180.9047
City Park	0	0.0000	0.0000	0.0000	0.0000
High Turnover (Sit Down Restaurant)	378033	39.8846	2.7400e-003	3.4000e-004	40.0554
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000
Parking Lot	14788.6	1.5603	1.1000e-004	1.0000e-005	1.5670
Total		221.5782	0.0152	1.9000e-003	222.5271

6.0 Area Detail**6.1 Mitigation Measures Area**

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 33 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	0.6781	0.0495	4.2948	2.3000e-004		0.0237	0.0237		0.0237	0.0237	0.0000	7.0080	7.0080	6.7600e-003	0.0000	7.1771
Unmitigated	0.6781	0.0495	4.2948	2.3000e-004		0.0237	0.0237		0.0237	0.0237	0.0000	7.0080	7.0080	6.7600e-003	0.0000	7.1771

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.0819					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Consumer Products	0.4664					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hearth	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Landscaping	0.1297	0.0495	4.2948	2.3000e-004		0.0237	0.0237		0.0237	0.0237	0.0000	7.0080	7.0080	6.7600e-003	0.0000	7.1771
Total	0.6781	0.0495	4.2948	2.3000e-004		0.0237	0.0237		0.0237	0.0237	0.0000	7.0080	7.0080	6.7600e-003	0.0000	7.1771

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 34 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

6.2 Area by SubCategory**Mitigated**

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.0819					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Consumer Products	0.4664					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hearth	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Landscaping	0.1297	0.0495	4.2948	2.3000e-004		0.0237	0.0237		0.0237	0.0237	0.0000	7.0080	7.0080	6.7600e-003	0.0000	7.1771
Total	0.6781	0.0495	4.2948	2.3000e-004		0.0237	0.0237		0.0237	0.0237	0.0000	7.0080	7.0080	6.7600e-003	0.0000	7.1771

7.0 Water Detail**7.1 Mitigation Measures Water**

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 35 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

	Total CO2	CH4	N2O	CO2e
Category	MT/yr			
Mitigated	33.0149	0.0379	0.0232	40.8728
Unmitigated	33.0149	0.0379	0.0232	40.8728

7.2 Water by Land Use**Unmitigated**

	Indoor/Outdoor Use	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	MT/yr			
Apartments Mid Rise	27.1041 / 17.0874	30.1477	0.0344	0.0210	37.2754
City Park	0 / 0.9651	0.3564	2.0000e-005	0.0000	0.3579
High Turnover (Sit Down Restaurant)	2.78037 / 0.17747	2.5109	3.4900e-003	2.1500e-003	3.2395
Other Non-Asphalt Surfaces	0 / 0	0.0000	0.0000	0.0000	0.0000
Parking Lot	0 / 0	0.0000	0.0000	0.0000	0.0000
Total		33.0149	0.0379	0.0232	40.8728

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 36 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

7.2 Water by Land Use**Mitigated**

	Indoor/Outdoor Use	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	MT/yr			
Apartments Mid Rise	27.1041 / 17.0874	30.1477	0.0344	0.0210	37.2754
City Park	0 / 0.9651	0.3564	2.0000e-005	0.0000	0.3579
High Turnover (Sit Down Restaurant)	2.78037 / 0.17747	2.5109	3.4900e-003	2.1500e-003	3.2395
Other Non-Asphalt Surfaces	0 / 0	0.0000	0.0000	0.0000	0.0000
Parking Lot	0 / 0	0.0000	0.0000	0.0000	0.0000
Total		33.0149	0.0379	0.0232	40.8728

8.0 Waste Detail**8.1 Mitigation Measures Waste**

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 37 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

Category/Year

	Total CO2	CH4	N2O	CO2e
	MT/yr			
Mitigated	60.9846	3.6041	0.0000	151.0867
Unmitigated	60.9846	3.6041	0.0000	151.0867

8.2 Waste by Land Use**Unmitigated**

	Waste Disposed	Total CO2	CH4	N2O	CO2e
Land Use	tons	MT/yr			
Apartments Mid Rise	191.36	38.8444	2.2956	0.0000	96.2352
City Park	0.07	0.0142	8.4000e-004	0.0000	0.0352
High Turnover (Sit Down Restaurant)	109	22.1260	1.3076	0.0000	54.8163
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000
Parking Lot	0	0.0000	0.0000	0.0000	0.0000
Total		60.9846	3.6041	0.0000	151.0867

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 38 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

8.2 Waste by Land Use**Mitigated**

	Waste Disposed	Total CO2	CH4	N2O	CO2e
Land Use	tons	MT/yr			
Apartments Mid Rise	191.36	38.8444	2.2956	0.0000	96.2352
City Park	0.07	0.0142	8.4000e-004	0.0000	0.0352
High Turnover (Sit Down Restaurant)	109	22.1260	1.3076	0.0000	54.8163
Other Non-Asphalt Surfaces	0	0.0000	0.0000	0.0000	0.0000
Parking Lot	0	0.0000	0.0000	0.0000	0.0000
Total		60.9846	3.6041	0.0000	151.0867

9.0 Operational Offroad

Equipment Type	Number	Hours/Day	Days/Year	Horse Power	Load Factor	Fuel Type
----------------	--------	-----------	-----------	-------------	-------------	-----------

10.0 Stationary Equipment**Fire Pumps and Emergency Generators**

Equipment Type	Number	Hours/Day	Hours/Year	Horse Power	Load Factor	Fuel Type
----------------	--------	-----------	------------	-------------	-------------	-----------

Boilers

Equipment Type	Number	Heat Input/Day	Heat Input/Year	Boiler Rating	Fuel Type
----------------	--------	----------------	-----------------	---------------	-----------

ITEM 11.1.

CalEEMod Version: CalEEMod.2016.3.2

Page 39 of 39

ATTACHMENT 2

Date: 6/3/2020 10:40 AM

California Northstate University Dorms - Sacramento County, Annual

User Defined Equipment

Equipment Type	Number
----------------	--------

11.0 Vegetation

**CITY OF RANCHO CORDOVA
CITY COUNCIL RESOLUTION NO. XX-2020**

**A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA,
STATE OF CALIFORNIA, APPROVING A CONDITIONAL USE PERMIT AND MAJOR
DESIGN REVIEW FOR THE CALIFORNIA NORTHSTATE UNIVERSITY DORMITORY
PROJECT NO. DD9919**

WHEREAS, Cindy Zheng (hereinafter referred to as Applicant) filed an application with the City of Rancho Cordova for a Conditional Use Permit and Major Design Review approval for the California Northstate University Dormitory project; and

WHEREAS, the City Council is the appropriate authority to hear and take action on this project; and

WHEREAS, the project site is located along Prospect Park Drive at the intersection of Prospect Park Drive and Sun Center Drive APN 072-0600-002-0000; and

WHEREAS, the project would not result in any significant effects to the environment, and therefore was determined to be Exempt per California Environmental Quality Act Section 15183; Consistent with Community Plan, General Plan, and Zoning Code and 15183.3 Streamlining Infill Project; and

WHEREAS, the City Council of the City of Rancho Cordova has conducted a properly noticed public hearing pursuant to Government Code section 65090 and has duly considered all written and verbal testimony presented during the July 20, 2020 hearing.

**NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA
HEREBY RESOLVES AS FOLLOWS:**

1. The proposed project is exempt from CEQA under Guidelines Section 15183, Projects Consistent with a Community Plan, General Plan, and Zoning Code. The following evidence supports the CEQA exemption.
 - A. **Finding:** The project has been analyzed and is exempt per California Environmental Quality Act Guidelines Section 15183 "Consistent with Community Plan, General Plan, and Zoning and Section 15183.3 Streamlining Infill Projects."

Evidence: On June 26, 2006, the City certified the EIR for the City of Rancho Cordova General Plan (General Plan EIR). The General Plan EIR is a program EIR, prepared pursuant to CEQA Guidelines section 15168.

The project is consistent with the type and intensity of development anticipated by the General Plan EIR. The project site is designated as Office Mixed Use by the City's General Plan, and the General Plan EIR anticipated buildout of the project site with Office Mixed Uses. This designation encourages the integration of commercial and/or residential use in conjunction with office use and allows for public/quasi-public uses. The project will integrate student housing into an existing office park and will support the existing California Northstate University. The project site is zoned Office Professional Mixed-Use (OPMU), which allows a minimum floor area ratio of 0.25 and a maximum floor area ratio of 2.0 (Municipal Code § 23.313.040). The project's floor area ratio is

0.63, which is less than half of the floor area allowed in the General Plan. The foregoing demonstrates that the project is consistent with the type and intensity of development anticipated by the General Plan EIR.

The City previously complied with CEQA by analyzing impacts related to buildout under the General Plan in the General Plan EIR. As outlined in Exhibit A to this Resolution, CEQA Findings of Fact Related to CEQA Guideline Section 15183 Exemption, the new discretionary actions are consistent with those considered in the General Plan EIR and there are no project-specific significant effects which are peculiar to the project or its site, the City may rely upon the analysis in the certified General Plan EIR to the extent it remains adequate.

As outlined in Exhibit B to this Resolution, CEQA Findings of Fact Related to CEQA Guidelines Section 15183.3 Exemption, the City has determined that the project is eligible for infill streamlining pursuant to Public Resources section 21094.5.

Public Resources Code section 21094.5 exempts from further environmental review projects whose potential environmental effects were either analyzed in a prior environmental impact report (EIR) for a planning level decision, or are mitigated by uniformly applicable development policies or standards. Planning level decisions are enactments or amendments of general plans or any general plan elements, community plan, specific plan, or zoning code. (CEQA Guidelines, § 15183.3, subd. (f).) In this case, the General Plan EIR constitutes the EIR for the planning level decision. Uniformly applicable development policies or standards are “policies or standards adopted or enacted by a city or county, or by a lead agency, that reduce one or more adverse environmental effects.”

2. Approve the **Conditional Use Permit** subject to the Conditions of Approval attached hereto as Exhibit D, and subject to the findings as defined by Zoning Code section 23.134.030 and evidence as follows:
 - A. **Finding:** The site size, dimensions, location, topography, and access are adequate for the needs of the proposed use, considering the proposed building mass, parking, traffic, noise, vibration, exhaust/ emissions, light, glare, erosion, odor, dust, visibility, safety, and aesthetic considerations.

Evidence: The 2.87ac. parcel is of a sufficient size to accommodate the proposed use. The two buildings, at a height ranging from 54 feet to 61 feet fit within the maximum height of 65 feet for the OPMU zone. While these buildings will be taller than many of the surroundings buildings, they are in keeping with other buildings in the immediate vicinity. Adequate parking for the dorms is provided through onsite parking and shared parking with the university on the parcel to the west. The building materials will not create any glare and the new lighting meets the standards of the code and does not create off site impacts. During construction, there will be temporary construction impacts such as dust and noise. However, these are short term in nature and will adhere to existing local standards for construction emissions and noise. The site has adequate access from Prospect Park Drive and does not create any unsafe travel movements.
 - B. **Finding:** The negative impacts of the proposed use on adjacent properties and on the public can be mitigated through application of other code standards or other reasonable conditions of approval.

Evidence: The project has been conditioned by all applicable departments and agencies to minimize any potential impacts to include lighting standards and required environmental surveys prior to grading the site. The project would not have any negative impacts on adjacent properties or the public.

- C. **Finding:** All required public facilities have adequate capacity to serve the proposal.

Evidence: The project has been reviewed and conditioned by all applicable departments and agencies to supply adequate facilities. All facilities to include electricity, water, and sewer are existing and in place. Therefore, all required public facilities are adequate to serve the proposed student dormitory project.

- D. **Finding:** The project meets the requirements of the zoning code including design standards, design guidelines, and special use provisions.

Evidence: The project complies with all applicable standards and guidelines included in the Rancho Cordova Municipal Code, including Title 23 Zoning. Required setbacks, height, parking, lighting, etc. for the OPMU zone and use have been adhered to through project design and layout.

- E. **Finding:** If structures and site plans are considered nonconforming, the elements of a project that are nonconforming have been brought into compliance with the zoning code, where feasible.

Evidence: The proposed project has been reviewed in accordance with applicable sections of the Rancho Cordova Municipal Code, including Title 23 Zoning. The project is new construction and will be built in compliance with all code standards and would not be considered nonconforming.

3. Approve the Design Review, subject to the Major Design Review Package (Exhibit C) and the Conditions of Approval (Exhibit D) as modified; supported by the following Findings and Evidence, as required by Zoning Code Section 23.140.070:

- A. **Finding:** The proposed project is consistent with the objectives of the General Plan, complies with applicable zoning regulations, Specific Plan provisions, and special planning area provisions, and is consistent with the applicable Rancho Cordova design guidelines.

Evidence: The proposed project is consistent with the purpose and intent of adopted policies and regulations, including the General Plan, Zoning Code, and Design Guidelines with the approved Conditional Use Permit. The proposed buildings are consistent in height, setbacks, and the architecture is consistent with the surrounding area. The proposed project provides a housing opportunity for students currently attending and future students of California Northstate University.

- B. **Finding:** The proposed architecture, site design, and landscape are suitable for the purposes of the building and the site and will enhance the character of the neighborhood and community.

Evidence: The site design, building architecture, and landscape plan are consistent with the Zoning Code and City Design Guidelines. The proposed buildings are located in the most suitable location on the site that provides adequate emergency safety access to the buildings. The proposed project material and colors are consistent with the surrounding area and design guidelines and incorporate additional architectural character into the area.

- C. **Finding:** The architecture, including the character, scale, and quality of the design, relationship with the site and other buildings, building materials, screening of exterior appurtenances, exterior lighting and signing, and similar elements, establishes a clear design concept and is compatible with the character of existing or anticipated buildings on adjoining and nearby properties.

Evidence: The proposed project design is consistent with the surrounding buildings in the area. The design, color, and materials have been designed to integrate and compliment the surrounding buildings and area, but also provide additional architectural character to the area. Lighting plans have been provided showing minimum light spill out to the property line.

- D. **Finding:** The proposed project will not create conflicts with vehicular, bicycle, or pedestrian transportation modes of circulation.

Evidence: The proposed project will not substantially affect current traffic flows or existing modes of transportation circulation. One of the three driveways is existing. The new driveways have been placed in a location to not conflict with existing driveways in the area and meet the minimum distance separation requirements. Bike racks have been included in the site plan.

PASSED AND ADOPTED by the City Council of the City of Rancho Cordova on the 20th day of July 2020 by the following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

David M. Sander, Mayor

ATTEST:

ITEM 11.1.

ATTACHMENT 3

Stacy Leitner, CMC
City Clerk

ITEM 11.1.

**ATTACHMENT 4
Exhibit A to the Resolution**

**CEQA FINDINGS OF FACT RELATED TO
CEQA GUIDELINES SECTION 15183 EXEMPTION**

For the California Northstate University Dormitory Project

Prepared by the City Rancho Cordova

July 2020

PROJECT SUMMARY

California Northstate University (project applicant) proposes to develop a new dormitory (project) for an existing college campus. The proposed development would include 400 dorms located within two standalone structures, an on-site cafeteria building with an additional 16 dorms, and a courtyard with open space, landscaping, and a patio area on an existing parking lot for the University.

PROJECT DESCRIPTION

The project would include two dormitory buildings, Buildings A and B, and a cafeteria building. Building A would be approximately 50,700 square feet (sf) in size and provide 190 dorm rooms, and Building B would be approximately 53,900 sf in size and provide 210 dorm rooms. Both structures would be approximately 55-60 feet (5 stories) in height and would provide laundry facilities, lounge space, and a recreation room. The cafeteria building would offer dining options for students attending the university and/or residing in the dorms and would provide 16 additional dorm rooms. The proposed dorms would be modular construction (i.e., manufactured off-site and assembled together on the project site). The exterior of each building would then be constructed on the outside of the modular units once they are assembled on site. This type of construction will be unique in Rancho Cordova, but has been used frequently in other jurisdictions for various housing types, including student housing.

PROJECT LOCATION

The project site is located at 2910 Prospect Park Drive in the central portion of the City of Rancho Cordova. The project site includes Assessor's Parcel Number (APN) 072-0600-002-0000. The site is bounded by Prospect Park Drive to the north/northeast, California Northstate University to the west, and commercial office space to the south/southeast. Adjacent uses to the project site are entirely office uses, with some office space occupied by educational uses. US 50 is located approximately 400 feet to the northwest of the project site.

The project site is designated as Office Mixed Use by the City's General Plan and is zoned Office Professional Mixed Use (OPMU).

PRIOR ENVIRONMENTAL REVIEW

On June 26, 2006, the City certified the EIR for the City of Rancho Cordova General Plan (General Plan EIR). The General Plan EIR is a program EIR, prepared pursuant to CEQA Guidelines section 15168.

The project is consistent with the type and intensity of development anticipated by the General Plan EIR. The project site is designated as Office Mixed Use by the City's General Plan, and the General Plan EIR anticipated buildout of the project site with Office Mixed Uses. This designation encourages the integration of commercial and/or residential use in conjunction with office use and allows for public/quasi-public uses. The project will integrate student housing into an existing office park and will support the existing California Northstate University. The project site is zoned

Office Professional Mixed-Use (OPMU), which allows a minimum floor area ratio of 0.25 and a maximum floor area ratio of 2.0 (Municipal Code § 23.313.040). The project's floor area ratio is 0.63, which is less than half of the floor area allowed in the General Plan. The foregoing demonstrates that the project is consistent with the type and intensity of development anticipated by the General Plan EIR.

The City previously complied with CEQA by analyzing impacts related to buildout under the General Plan in the General Plan EIR. Because the new discretionary actions are consistent with those considered in the General Plan EIR and there are no project-specific significant effects which are peculiar to the project or its site, the City may rely upon the analysis in the certified General Plan EIR to the extent it remains adequate.

Pursuant to CEQA Guidelines section 15183, where a project is consistent with the use and density established for a property under an existing general plan or zoning ordinance for which a city has already certified an EIR, additional environmental review is not required "except as might be necessary to examine whether there are project-specific significant effects which are peculiar to the project or its site." (CEQA Guidelines, § 15183, subd. (a); see also Pub. Resources Code, § 21083.3, subd. (b).) If such requirements are met, the examination of environmental effects is limited to those which the agency determines:

1. Are peculiar to the project or the parcel on which the project would be located;
2. Were not analyzed as significant effects in a prior EIR on the zoning action, general plan or community plan with which the project is consistent;
3. Are potentially significant off-site impacts and cumulative impacts which were not discussed in the prior EIR prepared for the general plan, community plan or zoning action; or
4. Are previously identified significant effects which, as a result of substantial new information which was not known at the time the EIR was certified, are determined to have a more severe adverse impact than discussed in the prior EIR.

(CEQA Guidelines, § 15183, subd. (b).)

Regarding "peculiar" impacts, CEQA Guidelines section 15183, subdivision (f), states the following:

An effect of a project on the environment shall not be considered peculiar to the project or the parcel for the purposes of this section if uniformly applied development policies or standards have been previously adopted by the city or county with a finding that the development policies or standards will substantially mitigate that environmental effect when applied to future projects, unless substantial new information shows that the policies or standards will not substantially mitigate the environmental effect. The finding shall be based on substantial evidence which need not include an EIR.

The 2020 Appendix N Checklist for the California Northstate University Dormitory Project (Appendix N Checklist) identifies General Plan policies and/or actions that would apply to the development of the project and have been determined in the General Plan EIR to substantially

mitigate environmental effects. The Appendix N Checklist identifies additional uniformly applicable development policies that the City finds would apply to the project and would substantially mitigate environmental effects. Therefore, impacts mitigated by the applicable policies and/or actions are not considered peculiar, pursuant to CEQA Guidelines section 15183, subdivision (f).

Consistent with the requirements of CEQA Guidelines section 15183, the Appendix N Checklist determined that the project would not result in impacts peculiar to the project or project site or impacts that were not analyzed or discussed in the General Plan EIR. Additionally, the project would not result in any potentially significant off-site or cumulative impacts that were not anticipated by the General Plan EIR. Also, there are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Thus, the City may rely upon the analysis in the certified General Plan EIR, and no further CEQA review is required.

RECORD OF PROCEEDINGS

For the purposes of CEQA, and the findings set forth herein, the administrative record for the City's decision on the project consists of the following documents, at a minimum, which are incorporated by reference and made part of the record supporting these findings:

- 2006 City of Rancho Cordova General Plan
- 2006 City of Rancho Cordova General Plan Draft EIR
- 2006 City of Rancho Cordova General Plan Final EIR

In addition to the above items, the record includes, but is not limited to, the following documents related to the second stage entitlements:

- 2020 Appendix N Checklist for the California Northstate University Dormitory Project;
- All resolutions adopted by the City regarding the project and all documents cited or referred to therein as well as all staff reports, analyses, and summaries related to the adoption of those resolutions;
- All reports, studies, memoranda, maps, staff reports, or other planning documents relating to the project prepared by the City, consultants to the City, or responsible or trustee agencies with respect to the City's compliance with the requirements of CEQA and with respect to the City's action on the project;
- All documents submitted to the City by other public agencies or members of the public in connection with the project;
- Any minutes and/or verbatim transcripts of all information sessions, public meetings, and public hearings held by the City in connection with the project;
- Any documentary or other evidence submitted to the City at such information sessions, public meetings and public hearings;

- Matters of common knowledge to the City, including, but not limited to federal, State, and local laws and regulations;
- The City's Zoning Code;
- Any documents expressly cited in these findings, in addition to those cited above; and
- Any other materials required for the record of proceedings by Public Resources Code section 21167.6, subdivision (e).

Without exception, any documents set forth above not found in the project files fall into one of two categories. Many of them reflect prior planning or legislative decisions of the City. (See *City of Santa Cruz v. Local Agency Formation Commission* (1978) 76 Cal.App.3d 381, 391-392; *Dominey v. Department of Personnel Administration* (1988) 205 Cal.App.3d 729, 738, fn. 6.) Other documents influenced the expert advice provided to City Staff or consultants. For that reason, such documents form part of the underlying factual basis for the City's decisions relating to approval of the project. (See Pub. Resources Code, § 21167.6, subd. (e)(10); *Browning-Ferris Industries v. City Council of City of San Jose* (1986) 181 Cal.App.3d 852, 866; *Stanislaus Audubon Society, Inc. v. County of Stanislaus* (1995) 33 Cal.App.4th 144, 153, 155.)

FINDINGS REQUIRED UNDER CEQA

Public Resources Code section 21002 provides that “public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects.” The same statute provides that the procedures required by CEQA “are intended to assist public agencies in systematically identifying both the significant effects of projects and the feasible alternatives or feasible mitigation measures which will avoid or substantially lessen such significant effects.” Public Resources Code section 21002 goes on to provide that “in the event [that] specific economic, social, or other conditions make infeasible such project alternatives or such mitigation measures, individual projects may be approved in spite of one or more significant effects thereof.”

The mandate and principles announced in Public Resources Code section 21002 are implemented, in part, through the requirement that agencies must adopt findings before approving projects for which EIRs are required. For each significant environmental effect identified in an EIR for a project, the approving agency must issue a written finding reaching one or more of three permissible conclusions. The first such finding is that changes or alterations have been required in, or incorporated into, the project which avoid or substantially lessen the significant environmental effect as identified in the Final EIR. The second permissible finding is that such changes or alterations are within the responsibility and jurisdiction of another public agency and not the agency making the finding, and such changes have been adopted by such other agency or can and should be adopted by such other agency. The third potential conclusion is that specific economic, legal, social, technological, or other considerations, including provision of employment opportunities for highly trained workers, make infeasible the mitigation measures or project alternatives identified in the Final EIR. (CEQA Guidelines, § 15091.) Public Resources Code section 21061.1 defines “feasible” to mean “capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, legal, and technological factors.” CEQA Guidelines section 15364 adds another factor: “legal”

considerations. (See also *Citizens of Goleta Valley v. Bd. of Supervisors* (1990) 52 Cal.3d 553, 565.) The CEQA findings required by Public Resources Code section 21002 were made when the General Plan EIR was certified by the City in 2006 and are incorporated by reference herein.

These findings supplement the Public Resources Code section 21002 findings and provide a roadmap to the analysis contained in the Appendix N Checklist, which explained that impacts related to buildout under the General Plan were adequately addressed in the General Plan EIR and determined that the project would not result in impacts peculiar to the project or project site or impacts that were not analyzed or discussed in the General Plan EIR. Project alternatives were previously considered as part of the General Plan EIR and discussed by the City Council prior to its certification. The Appendix N Checklist determined that significant environmental impacts identified in the General Plan EIR were not found to have a more severe adverse impact than anticipated by the General Plan EIR due to substantial new information. Thus, the Appendix N Checklist determined no further CEQA review was required for the project.

In support of its approval of the project, the City makes the following findings pursuant to Public Resources Code sections 21080 and 21083.3 as well as CEQA Guidelines sections 15091 and 15183:

I. Aesthetics

Chapter 4.13 of the General Plan EIR addresses aesthetic impacts related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate aesthetic impacts similar to those analyzed in the General Plan EIR.

The project would not have a substantial adverse effect on a scenic vista. The project site is located within a fully developed business park, with well-established trees along all major roads in the vicinity and bordering each parcel. The project would not damage a designated scenic highway because US 50 is not a designated scenic highway. Additionally, due to the relatively flat topography of the area and the presence of numerous landscape trees on the project site and adjacent parcels, no scenic resources or vistas are visible from the project site, nor are there any nearby scenic resources or vistas that have views of the project site.

The project would comply with the City's development standards and design guidelines, including the Rancho Cordova Design Guidelines, to ensure compatibility with the visual character of the surrounding area (see Rancho Cordova Design Guidelines, pp. 2:88-2:90). While the project would replace the existing paved parking lot with several buildings, on-site structures would be consistent in massing, scale, and architectural style with existing structures in the area. The design, color, and materials have been designed to integrate and compliment the surrounding buildings and area.

The project would comply with the Municipal Code, including Chapter 23.725, regarding lighting and glare, to ensure the project would not result in significant impacts. Requirements in Chapter 23.725 ensure that light trespass and glare have negligible impact on surrounding property (especially residential) and roadways. Further, since the project site is surrounded by office uses,

there would be no impact from nighttime spillover lighting interrupting sleeping patterns or otherwise causing a nuisance to neighboring residents.

Finding: The project is consistent with the General Plan land use designation for the project site, and aesthetic impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to aesthetics peculiar to the project or project site; additionally, there are no significant aesthetic impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) The standards in the Appendix N Checklist address impacts that are not peculiar to the project and that are addressed in the General Plan EIR; therefore, CEQA Guidelines section 15183, subdivision (f), findings are not required. Nevertheless, the City finds that application of uniformly applicable development policies and standards, including the General Plan policies, Zoning Code (including Chapter 23.725), and Design Guidelines, would substantially mitigate any potentially significant impacts related to scenic quality, light, and glare. Therefore, further environmental review is not required.

II. Agriculture and Forest Resources

Chapter 4.2 of the General Plan EIR addresses impacts to agriculture and forestry resources related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate agriculture and forestry impacts similar to those analyzed in the General Plan EIR.

The project would not convert California Department of Conservation Farmland Mapping and Monitoring Program-designated Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use. The project site is a paved parking lot located in a developed business park. There are no agricultural lands, timberlands, forest lands, or non-disturbed environments on or adjacent to the project site.

The project would not conflict with existing zoning for agricultural use or a Williamson Act contract because the project site is not under a Williamson Act contract and is zoned Office Mixed Use.

The project area is designated as Urban and Built-Up Land in the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP). As a result, development of the project does not conflict with the zoning for, or cause rezoning of, forest land, timberland, or timberland zoned Timberland Production. Therefore, it would not result in the loss of forest land or conversion of forest land to non-forest use.

Finding: The project is consistent with the General Plan land use designation for the project site, and agriculture and forestry impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to agriculture and forestry resources peculiar to the project or project site; additionally, there are no significant agriculture and forestry resources impacts that were not analyzed or discussed in the General Plan EIR or that

substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

III. Air Quality

Chapter 4.6 of the General Plan EIR addresses impacts to air quality related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate air quality impacts similar to those analyzed in the General Plan EIR.

The project would not conflict with or obstruct implementation of any applicable air quality plan. As stated, its land use was evaluated in the General Plan EIR. As an infill site, it would produce 32 to 57 percent less air pollutant emission per capita, according to the EPA. It is also projected to result in a 57 percent reduction in per capita VMT, which would reduce vehicle emissions.

The project would not result in cumulatively considerable net increase in any criteria pollutant beyond those previously analyzed in the General Plan EIR. Sacramento County is currently designated nonattainment with respect to ozone and PM₁₀; thus, buildout consistent with the General Plan EIR was determined to be a significant and unavoidable impact. The project would reduce cumulatively considerable increases in ozone and PM₁₀, as well as PM_{2.5}, to below SMAQMD's significance thresholds through compliance with the SMAQMD rules and regulations, including application of best available control technologies (BACT) and best management practices (BMPs).

The project would not expose sensitive receptors to substantial pollutant concentrations. The project's floor area ratio is 0.63, which is less than half of the floor area allowed in the General Plan. Because the project is consistent with the development density established in the General Plan, the operational effects of development of the site would have been considered in the EIR, including vehicle trips on US 50 and the emissions associated with those trips. Further, there are no sensitive receptors within 1,500 feet of the project site; the nearest residential uses are approximately 2,000 feet north of the project site. Additionally, the types of uses proposed as part of the project are not considered to be associated with the generation of substantial TAC emissions.

The project is not anticipated to result in objectionable odors or substantial operational dust emissions. Additionally, it would implement SMAQMD rules and regulations that ensure construction would not result in substantial dust emissions.

Finding: The project is consistent with the General Plan land use designation for the project site, and air quality impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to air quality emissions peculiar to the project or project site; additionally, there are no significant air quality impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) The standards in the Appendix N Checklist address impacts that

are not peculiar to the project and that are addressed in the General Plan EIR; therefore, CEQA Guidelines section 15183, subdivision (f), findings are not required. Nevertheless, the City finds that application of uniformly applicable development policies and standards, including SMAQMD rules and regulations, including application of BACT and BMPs, would substantially mitigate any potentially significant impacts related to cumulative air quality impacts associated with cumulative increases in PM_{10} and ozone. Therefore, further environmental review is not required.

IV. Biological Resources

Chapter 4.10 of the General Plan EIR addresses biological resource impacts related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate biological resource impacts similar to those analyzed in the General Plan EIR.

The project would not have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or the U.S. Fish and Wildlife Service. The project site is currently a paved parking lot within a developed business park, with trees located on and surrounding the site. During nesting season, there is the potential for protected birds to be temporarily present on the project site due to migratory and nesting habits. The project would adhere to General Plan Action NR.1.1.4 and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance. If nesting activity is observed, consultation with the Planning Department shall be conducted in order to determine the appropriate mitigation, if any, required to minimize impacts to nesting birds.

The project would not have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations or by the California Department of Fish and Wildlife or the U.S. Fish and Wildlife Service because the project site is a paved parking lot.

The project would not have a substantial adverse effect on state or federally protected wetlands through direct removal, filling, hydrological interruption, or other means because it does not contain any wetlands, waterways, riparian habitats, or other sensitive communities.

The project would not substantially interfere with the movement of any wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites. While there is the potential for protected birds to be temporarily present on the project site due to migratory and nesting habits during nesting season, the project would adhere to Action NR.1.1.4 in the General Plan and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance. If nesting activity is observed, consultation with the Planning Department shall be conducted in order to determine the appropriate mitigation, if any, required to minimize impacts to nesting birds.

The project would not conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance. While the project would remove some mature trees in parking lot green islands, the project would comply with the City's requirements regarding protected trees (Chapter 19:12 of the Municipal Code). Specifically, the project would comply with the City's Tree Ordinance, which requires that the removal of trees with a diameter at standard height 12" or more be replaced at a minimum ratio of 1:1 or otherwise compensated through payment into the City's tree program fund.

The project would not conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan because there are no nearby or onsite conservation areas which would be impacted by construction and operational activities.

Finding: The project is consistent with the General Plan land use designation for the project site, and biological resource impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to biological resources peculiar to the project or project site; additionally, there are no significant biological resource impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) The standards in the Appendix N Checklist address impacts that are not peculiar to the project and that are addressed in the General Plan EIR; therefore, CEQA Guidelines section 15183, subdivision (f), findings are not required. Nevertheless, the City finds that application of uniformly applicable development policies and standards, including General Plan Action NR.1.1.4 and Chapter 19:12 of the Municipal Code, would substantially mitigate any potentially significant impacts related to protected species, movement of native resident wildlife species or wildlife nursery sites, and compliance with local tree preservation ordinances. Therefore, further environmental review is not required.

V. Cultural Resources

Chapter 4.11 of the General Plan EIR addresses impacts to cultural resources related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate cultural impacts similar to those analyzed in the General Plan EIR.

The project would not cause a substantial adverse change in the significance of a historical resource pursuant to CEQA Guidelines section 15064.5 because no historic buildings or resources are on the project site.

The project would not cause a substantial adverse change in the significance of an archaeological resource pursuant to section 15064.5 because the project site is not located within archaeologically or culturally sensitive areas identified by the General Plan EIR, and, through compliance with General Plan Action CHR 1.3.2, cultural resources inadvertently discovered during construction would be protected.

The project would comply with the General Plan EIR's policies related to potential disturbances of interred human remains, including those outside dedicated cemeteries. By complying with California Health and Safety Code Sections 7050.5 and 7052, California Public Resources Code Section 5097, and General Plan Action CHR 1.3.2, the project would identify, preserve, and protect archaeological deposits and remains within the project site, if discovered during development.

Finding: The project is consistent with the General Plan land use designation for the project site, and cultural resource impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to cultural resources peculiar to the project or project site; additionally, there are no significant cultural resource impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) The standards in the Appendix N Checklist address impacts that are not peculiar to the project and that are addressed in the General Plan EIR; therefore, CEQA Guidelines section 15183, subdivision (f), findings are not required. Nevertheless, the City finds that application of application of uniformly applicable development policies and standards, including California Health and Safety Code sections 7050.5 and 7052, California Public Resources Code section 5097, and General Plan Action CHR 1.3.2, would substantially mitigate any potentially significant direct and indirect impacts to archeological resources and the disturbance of human remains. Therefore, further environmental review is not required.

VI. Energy

Though the General Plan EIR did not examine this issue, the project would not result in potentially significant impacts due to wasteful, inefficient, or unnecessary consumption of energy resources during construction or operation. The dormitories would be composed of modular units. Compared to typical construction assumed in the General Plan EIR, modular units are more energy efficient to construct, require less construction equipment on the project site, and result in less waste during construction. Less waste results in less energy demand for raw materials. Thus, the project would not result in potentially significant impacts due to wasteful, inefficient, or unnecessary consumption of energy resources during construction.

Operational energy use would be reduced compared to typical projects assumed in the General Plan EIR. The Project is an infill development and would reduce diesel and gasoline fuel consumption on a regional basis by reducing total student generated VMT. Housing students on the campus would result in a 57 percent reduction in VMT compared to the current regional average. Additionally, SACOG's 2020 Metropolitan Transportation Policy/Sustainable Communities Strategy (MTP/SCS) concluded that per capita energy consumption will decrease as a result of implementation of the MTP/SCS. The proposed Project is consistent with the MTP/SCS in that it locates housing in an area designated as a High Frequency Transit Area for Sacramento County.

Additionally, the new buildings would be required to comply with the Building Energy Efficiency Standards (California Code of Regulations, Title 24, Parts 6 and 11, adopted by Municipal Code sections 16.26.030 and 16.38.030), which provide minimum efficiency standards related to various building features, including appliances, water and space heating and cooling equipment, building insulation and roofing, and lighting. Implementation of these standards would significantly reduce energy usage from the project. Further, the dormitories would likely be more energy-efficient than housing options available to students off campus, resulting in less energy demand per capita. By providing sustainable, energy efficient development, which incorporates energy-efficient technology, the project adheres to General Plan Policies LU.2.7, H.4.1, NR.7.1, NR.7.2 and NR.7.3. Moreover, at least 45 percent of the electricity provided by SMUD would be from renewable sources. Therefore, the project would not result in potentially significant operational impacts due to wasteful, inefficient, or unnecessary consumption of energy resources.

The project would not conflict with or obstruct a local plan for renewable energy or energy efficiency. As noted above, the project would comply with Municipal Code sections 16.26.030 and 16.38.030 and would adhere to General Plan Policies LU.2.7, H.4.1, NR.7.1, NR.7.2 and NR.7.3. Additionally, it is consistent with SACOG's MTP/SCS and would result in significant VMT reductions, compared to the current regional average, which exceeds the California Office of Planning and Research's (OPR's) recommended VMT reduction target.

Finding: The project would not result in potentially significant energy impacts. Further, the project would comply with uniformly applicable development policies and standards, including Municipal Code sections 16.26.030 and 16.38.030 and General Plan Policies LU.2.7, H.4.1, NR.7.1, NR.7.2 and NR.7.3, which significantly reduce energy consumption. The City specifically finds that the these uniformly applicable development policies and standards would substantially mitigate potential energy impacts, reducing them to less than significant by reducing construction and operational energy consumption. Therefore, there are no significant energy impacts peculiar to the proposed project or project site, and further environmental review is not required.

VII. Geology and Soils

Chapter 4.8 of the General Plan EIR addresses geological and soil resources. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate geological and soil impacts similar to those analyzed in the General Plan EIR.

The project would not directly or indirectly cause potential substantial adverse effects (including the risk of loss, injury, or death) involving rupture of a known earthquake fault or strong seismic ground shaking. The California Geological Survey does not include Rancho Cordova on its list of cities affected by Alquist-Priolo Fault Zones, and there are no geologic or soil vulnerabilities associated with project development unanticipated by the City in its General Plan EIR. The project would adhere to the 2019 California Code of Regulations, Part 2, Title 24 (California Building Standards Code, adopted by Municipal Code section 16.04.030) (CBSC), as well as local, state, and federal construction and earthquake design standards and regulations. Construction and

operation would involve limited excavation and would not create new seismic events or exacerbate existing seismic hazards.

Substantial adverse effects related to liquefaction are not anticipated because the General Plan EIR planning area is considered at minimal risk for liquefaction, and all projects are required to comply with the local building design standards and regulations.

The project site does not contain historically-mapped landslides or steep or unstable slopes. Therefore, the project would not directly or indirectly cause potential substantial adverse effects involving landslides.

The project would not result in substantial soil erosion or the loss of topsoil because while grading and site preparation activities would disturb soils, the project would comply with General Plan policies and actions mitigating soil erosion and the City's Improvement Standards and Land Grading and Erosion Control Ordinance.

As discussed, the project site is not located on an unstable geologic unit or soil that would become unstable as a result of the project, or that which could potentially result in landslide, subsidence, liquefaction, or collapse. Additionally, the project would comply with the CBSC, which would reduce the risk of lateral spreading.

Compliance with the CBSC's policies and engineering practices would minimize any risks associated with project development related to expansive soil.

The project would not result in impacts related to septic tanks or other alternative wastewater disposal systems because it would connect to existing County sewer services.

The project would not directly or indirectly destroy a unique paleontological resource or other unique geologic features through compliance with General Plan Action CHR 1.3.2, which protects paleontological resources inadvertently discovered during construction activities.

Finding: The project is consistent with the General Plan land use designation for the project site, and geology and soil impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to geology and soil resources peculiar to the project or project site; additionally, there are no significant geology and soil impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) The standards in the Appendix N Checklist address impacts that are not peculiar to the project and that are addressed in the General Plan EIR; therefore, CEQA Guidelines section 15183, subdivision (f), findings are not required. Nevertheless, the City finds that application of uniformly applicable development policies and standards, including the City's Improvement Standards and Land Grading and Erosion Control Ordinance, as well as Municipal Code section 16.04.030, would substantially mitigate any potentially significant impacts related to soil erosion, loss of topsoil, potential soil instability, and expansive soils. Therefore, further environmental review is not required.

VIII. Greenhouse Gas Emissions

The General Plan EIR did not examine impacts from greenhouse gas (GHG) emissions. Nevertheless, the project would not result in significant impacts related to GHG emissions. SMAQMD's screening thresholds were used to evaluate whether the project would result in GHG emissions that may have a significant impact on the environment. For both construction and operational emissions, the project would not exceed SMAQMD's GHG emission screening thresholds.

The project would not conflict with any plan, policy, or regulation for the purpose of reducing GHG emissions. As stated above, the project would not exceed SMAQMD's thresholds of significance for GHGs. Additionally, the project would result in a 57 percent reduction in per capita VMT compared to current regional average, which exceeds OPR's recommended 15 percent reduction target. The modular construction is anticipated to require less energy and reduced vehicle trips during construction, which would reduce construction-related GHG emissions. The project would comply with energy efficiency requirements mandated in Municipal Code sections 16.26.030 and 16.38.030, which would reduce operational GHG emissions by requiring increased energy efficiency.

Finding: The project would not result in potentially significant GHG emission impacts. The project would implement and comply with SMAQMD's screening thresholds for evaluating whether the project would result in GHG emissions that may have a significant impact on the environment. Additionally, it would comply with Municipal Code sections 16.26.030 and 16.38.030. The City specifically finds that these uniformly applicable development policies and standards would substantially mitigate potential energy impacts, reducing them to less than significant by reducing construction and operational GHG emissions. Therefore, there are no GHG emission impacts peculiar to the proposed project or project site, and further environmental review is not required.

IX. Hazards and Hazardous Materials

Chapter 4.4 of the General Plan EIR addresses impacts to hazards and hazardous materials related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate hazards and hazardous material impacts similar to those analyzed in the General Plan EIR.

The project would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials because the construction and operation of a student housing project does not necessitate the transport, use, or disposal of hazardous materials.

While the project could include hazardous materials standard to construction activities such as fuels, lubricants, paint, and solvents, the project would adhere to the applicable local, state, and federal regulations on the use, storage, and transport of these materials. The project would not create a significant hazard to the public or the environment through reasonably foreseeable upset or accident conditions involving the release of hazardous materials into the environment through

compliance with local, state, and federal regulations and General Plan policies relating to the proper handling of potentially hazardous materials.

The project is not within 0.25 of an existing or planned public school site. Construction activities would comply with all local, state, and federal regulations and policies regarding the safe handling and storage of hazardous materials; no risks would arise from project operation.

The project is not located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5.

The project is located approximately two miles northeast of the Mather Airport. The project would not result in a safety hazard or excessive noise for people residing or working in the project area because the project site is not located within the 60 dBA Community Noise Equivalent Level (CNEL) contour for Mather Airport (Sacramento County 2020), and as such, on-site residences would not be exposed to airport-related noise in excess of City standards. Additionally, the site is not located with the Mather Airport safety zone.

The project would not impair the implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan because the project does not include alterations to any major roadway or travel routes for evacuations and emergency response.

The project would not expose people or structures, either directly or indirectly, to a significant risk of loss, injury, or death involving wildland fires because the project site is within an urbanized area and is not adjacent to or intermixed with wildlands.

Finding: The project is consistent with the General Plan land use designation for the project site, and hazards and hazardous materials impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to hazards and hazardous materials peculiar to the project or project site; additionally, there are no significant hazards and hazardous materials impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) The standards in the Appendix N Checklist address impacts that are not peculiar to the project and that are addressed in the General Plan EIR; therefore, CEQA Guidelines section 15183, subdivision (f), findings are not required. Nevertheless, the City finds that compliance with local, state, and federal regulations and the General Plan would substantially mitigate any potentially significant impacts related to accidental hazardous materials releases. Therefore, further environmental review is not required.

X. Hydrology and Water Quality

Chapter 4.9 of the General Plan EIR addresses impacts to hydrology and water quality related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate hydrology and water quality impacts similar to those analyzed in the General Plan EIR.

ITEM 11.1.

ATTACHMENT 4 Exhibit A to the Resolution

The project would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality as it would comply with Rancho Cordova's Standard Construction Specifications for Erosion and Sediment Control and Municipal Code Chapters 15.12 (Stormwater Management and Discharge Control) and Chapter 16.44 (Land Grading and Erosion Control) to reduce erosion and runoff associated with construction activities. Additionally, the project would increase the permeable surface area, so it would not substantially alter or negatively impact the drainage patterns or runoff rates or volumes to the city stormwater system.

The project would not substantially decrease groundwater supplies or interfere substantially with groundwater recharge because the project would be consistent with the overall growth anticipated in the General Plan, associated water demands, and groundwater impacts addressed in the General Plan EIR. The project would create pervious surfaces as part of its drainage and water quality control feature and would not involve the creation of a well.

The project would not substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, increase the rate or amount of surface runoff in a manner which would result in flooding, create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff, or impede or redirect flood flows.

The project would not risk release of pollutants due to project inundation in flood hazard, tsunami, or seiche zones because the project is not located in a flood hazard area and includes water quality control features.

The project would not conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan because the project would connect into the existing drainage facilities adjacent to the project site and would create pervious surfaces as part of its drainage and water quality control features. Additionally, the project would comply with all local hydrological design standards and regulations. Specifically, the project would adhere with the General Plan Action ISF.2.4.1, which requires all projects to secure an assured, legally entitled water supply and delivery system with existing infrastructure. The project will obtain water service from Golden State Water Company.

Finding: The project is consistent with the General Plan land use designation for the project site, and hydrology and water quality impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to hydrology and water quality impacts peculiar to the project or project site; additionally, there are no significant hydrology and water quality impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) The standards in the Appendix N Checklist address impacts that are not peculiar to the project and that are addressed in the General Plan EIR; therefore, CEQA Guidelines section 15183, subdivision (f), findings are not required. Nevertheless, the City finds that compliance with

uniformly applicable development policies and standards, including General Plan Action ISF.2.4.1, and Rancho Cordova's Standard Construction Specifications for Erosion and Sediment Control, Municipal Code Chapters 15.12 and 16.44, would substantially mitigate any potentially significant impacts to water quality. Therefore, further environmental review is not required.

XI. Land Use and Planning

Chapter 4.1 of the General Plan EIR addresses impacts to land use and planning related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate land use and planning impacts similar to those analyzed in the General Plan EIR.

The project would not physically divide an established community because the project site is currently developed as a paved parking lot. Additionally, the project would not isolate any existing land uses, is consistent with the scale and intensity of existing adjacent land uses, and is sited within a planned industrial park.

The project site is currently zoned and designated Office Mixed Use. Further, the project does not conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect.

Finding: The project is consistent with the General Plan land use designation for the project site, and land use and planning impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to land use and planning peculiar to the project or project site; additionally, there are no significant land use and planning impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

XII. Mineral Resources

Chapter 4.8 of the General Plan EIR addresses impacts to mineral resources related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would result in impacts to mineral resources similar to those analyzed in the General Plan EIR.

The project would not result in the loss of a known mineral resource because there are no mineral resource excavation activities in the project area and the project site and surrounding area are not located within a mineral resource overlay zone.

Finding: The project is consistent with the General Plan land use designation for the project site, and mineral resource impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to mineral resources peculiar to the project or project site; additionally, there are no significant mineral resource impacts that were not

analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

XIII. Noise

Chapter 4.7 of the General Plan EIR addresses noise impacts related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate noise impacts similar to those analyzed in the General Plan EIR.

The project would not generate a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or in other applicable local, state, or federal standards. Project construction would generate maximum noise levels ranging from 85 to 90 dB at a distance of 50 feet, and construction activities would occur between the hours of 6 a.m. and 8 p.m. during weekdays, and between the hours of 7 a.m. and 8 p.m. on weekends, exempting the project from the provisions of the Rancho Cordova Noise Ordinance (Municipal Code Section 6.68.090(E)). Construction noise would be temporary, estimated to occur during 2020 to 2021. The nearest residential uses are approximately 2,000 feet north of the project site. Through implementation of Municipal Code requirements limiting the hours of construction noise, the project would avoid generating noise during the most sensitive night and early morning hours, minimizing potential disturbance of sensitive receptors in the vicinity. During operation, the project would generate fewer vehicle trips than the allowable land use designations identified in the General Plan and evaluated in the General Plan EIR, such that the potential roadway noise levels would not exceed noise levels anticipated by the General Plan EIR (General Plan EIR Table 4.7-8 at 4.7-23 – 4.7-25).

The project would not generate excessive groundborne vibration or groundborne noise levels. While the use of heavy equipment at the project site could generate some localized vibration levels, on-site equipment would largely consist of rubber-tired loaders and other equipment that would not generate substantial vibration beyond 25 feet of distance between source and receptor. As discussed, project construction activities would comply with the Rancho Cordova Noise Ordinance (Municipal Code Section 6.68.090(E)). The nearest residential uses are approximately 2,000 feet north of the project site, so based on the distance between potential receptors and the project site and compliance with the Municipal Code, on-site activities would not generate substantial vibration or groundborne noise.

While the project is located within two miles of Mather Airport, it is not within the 60 dBA CNEL contour and would not expose people residing or working in the project area to excessive levels of airport-related noise.

Finding: The project is consistent with the General Plan land use designation for the project site, and noise impacts associated with buildout were anticipated by and addressed in the General Plan

EIR. There are no significant effects related to noise impacts peculiar to the project or project site; additionally, there are no significant noise impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) The standards in the Appendix N Checklist address impacts that are not peculiar to the project and that are addressed in the General Plan EIR; therefore, CEQA Guidelines section 15183, subdivision (f), findings are not required. Nevertheless, the City finds that application of uniformly applicable development policies and standards, including the Rancho Cordova Noise Ordinance (Municipal Code Section 6.68.090(E)), would substantially mitigate any potentially significant impacts related to a substantial increase in ambient noise levels. Therefore, further environmental review is not required.

XIV. Population and Housing

Chapter 4.3 of the General Plan EIR addresses impacts to population and housing related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate population and housing impacts similar to those analyzed in the General Plan EIR.

The General Plan EIR determined buildout would result in significant and unavoidable population and housing impacts. The General Plan EIR anticipated a growth in population of 74,289. The project would have no unplanned direct or indirect impact on the size of the student population or nearby communities. Because the project is consistent with the City's General Plan land use designation for the project site, population impacts associated with buildout of the site were analyzed in the General Plan EIR. Therefore, population and housing impacts would not exceed those analyzed in the General Plan EIR. Further, there is no substantial new information that shows that the project would result in a more severe adverse impact than discussed in the General Plan EIR.

The project does not displace existing housing or persons and would not necessitate the construction of replacement housing because the project site is currently a paved parking lot, located within a developed commercial business park.

Finding: The project is consistent with the General Plan land use designation for the project site, and population and housing impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to population and housing peculiar to the project or project site; additionally, there are no significant population and housing impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

XV. Public Services

Chapter 4.12 of the General Plan EIR addresses impacts to public services related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate public service impacts similar to those analyzed in the General Plan EIR.

The project would not require the construction of new facilities for fire protection and law enforcement. The project would pay its fair share costs of annexation into the Police Services CFD.

The project would be required to pay school impact fees, which constitute full and complete mitigation of the impacts for the planning, use, development, or provision of adequate school facilities (Gov. Code, § 65995, subd. (h)). Further, the project would not impact school populations because it would serve a transient student population in a dormitory setting, not families with school-aged children.

The project would consist of infill development that would not result in substantial population growth. Therefore, it would not trigger the need for new park facilities or other public facilities.

Finding: The project is consistent with the General Plan land use designation for the project site, and public services impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to public services peculiar to the project or project site; additionally, there are no significant impacts related to public services that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

XVI. Recreation

Chapter 4.12 of the General Plan EIR addresses impacts to recreational facilities related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would not accelerate substantial deterioration of existing parks and recreational facilities or require the construction or expansion of recreational facilities beyond what was anticipated in the General Plan EIR.

Finding: The project is consistent with the General Plan land use designation for the project site, and impacts to recreation facilities associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to recreational facilities peculiar to the project or project site; additionally, there are no significant impacts to recreation facilities that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

XVII. Transportation

Chapter 4.5 of the General Plan EIR addresses impacts to transportation related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate transportation impacts similar to those analyzed in the General Plan EIR.

The project would not conflict with existing programs, plans, ordinances, or policies addressing the circulation system. Project development would result in an intensification of development at the project site, but would not modify existing vehicle circulation in the area through roadway modifications. Further, the project would include the installation of on-site bicycle parking and pedestrian circulation measures, both to and from California Northstate University and between on-site uses.

The project would not conflict with or be inconsistent with CEQA Guidelines section 15064.3(b). Locating students closer to their destination reduces VMT and is consistent with regional efforts and the intent of residential infill development. The project's VMT per capita represents 43 percent of the current regional average (a 57 percent reduction), which exceeds the 15 percent target reduction recommended by OPR.

The project would have no impacts related to increasing design feature hazards or resulting in adequate emergency access. As stated, the project would not modify existing vehicle circulation in the area through roadway modifications. Further, internal roadways would be designed in accordance with City standards to allow for the safe passage of emergency vehicles in the event of a call for service.

Finding: The project is consistent with the General Plan land use designation for the project site, and transportation impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to transportation peculiar to the project or project site; additionally, there are no significant transportation impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

XVIII. Tribal Cultural Resources

Chapter 4.11 of the General Plan EIR addresses impacts to cultural resources, including tribal cultural resources, related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate tribal cultural resource impacts similar to those analyzed in the General Plan EIR.

The project would not cause a substantial adverse change in the significance of a tribal cultural resource. The project area is not located within archaeological or culturally sensitive areas identified in the General Plan EIR. Further, if tribal cultural resources or human remains were accidentally discovered during construction, the project would implement General Plan Action

CHR 1.3.2, which protects cultural resources, including tribal cultural resources, and human remains accidentally discovered during construction. Action CHR 1.3.2 specifically requires the Planning Department be notified if cultural resources are uncovered during construction and that construction in the vicinity stop until an expert is retained to evaluate the finds and recommends appropriate action. Additionally, it requires the Planning Department and County Coroner be notified if any human remains are uncovered, and that if the remains are determined to be Native American, the procedures outlined in CEQA Guidelines section 15064.5, subdivisions (d) and (e), shall be followed.

Finding: The project is consistent with the General Plan land use designation for the project site, and tribal cultural resource impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to tribal cultural resources peculiar to the project or project site; additionally, there are no significant tribal cultural resource impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Nevertheless, the City finds that Action CHR 1.3.2 further reduces the project's less than significant impacts related to tribal cultural resources. Therefore, further environmental review is not required.

XIX. Utilities and Service Systems

Chapter 4.12 of the General Plan EIR addresses impacts to utilities and service systems related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would result in impacts related to utility and service systems similar to those analyzed in the General Plan EIR.

The General Plan EIR determined the General Plan would result in significant and unavoidable impacts related to new or expanded water and wastewater infrastructure. The General Plan EIR determined buildout of the General Plan would not result in significant impacts related to electric power, natural gas, or telecommunication facilities. Because the project is consistent with the City's General Plan land use designation for the project site, impacts associated with buildout of the site were analyzed in the General Plan EIR. Therefore, impacts related to the construction of new or expanded facilities would not exceed those analyzed in the General Plan EIR. Further, there is no substantial new information that shows that the significant effect would have a more severe adverse impact than anticipated by the General Plan EIR. Further, City staff have reviewed the demands associated with the project and determined that existing facilities related to water, wastewater, telecommunications, and electricity are adequate to accommodate the demands of the project without requiring additional infrastructure (City of Rancho Cordova 2020b).

The General Plan EIR determined that an adequate water supply likely existed to serve buildout of the City within its current corporate limits, but it was unknown whether the City's surplus supplies would be adequate to serve buildout beyond the corporate limits. The project would be located within the City, not a Planning Area; therefore, it would have an adequate water supply. Further, pursuant to General Plan Action ISF.2.4.1, the project has confirmed it has an assured

water supply and delivery system available. For the reasons discussed above, the project would not have a more severe adverse impact than anticipated by the General Plan EIR.

There is adequate landfill capacity for solid waste generated by the project, and the project would comply with all statutes and regulations related to solid waste and would not impair the attainment of solid waste reduction goals. Specifically, the project would comply with the California Integrated Waste Management Act of 1989 (AB 939), which requires diversion of a minimum of 50 percent of discarded materials away from disposal in landfills. The project would also comply with General Plan policies and actions and Municipal Code requirements in Chapters 6.20, 6.21, and 6.92 regarding waste management and recycling.

Finding: The project is consistent with the General Plan land use designation for the project site, and impacts related to utilities and service systems associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to utilities and service systems peculiar to the project or project site; additionally, there are no significant impacts related to utility and service systems that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

XX. Wildfire

Chapter 4.12 of the General Plan EIR addresses wildfire impacts related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate wildfire impacts similar to those analyzed in the General Plan EIR.

The project would not impair an adopted emergency response plan or emergency evacuation plan as it would not modify the existing roadway and circulation network, would not affect emergency vehicle access to or past the project site, or impair evacuation routes.

Further, the project would not exacerbate wildfire risks as the project site is relatively flat, developed with a paved parking lot, does not interface with natural habitat or open grassy fields, and is not located within a State Responsibility Area classified as either a Very High or High Fire Hazard Severity Zone. Accordingly, the project also would not expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes.

Finding: The project is consistent with the General Plan land use designation for the project site, and wildfire impacts associated with buildout were anticipated by and addressed in the General Plan EIR. There are no significant effects related to wildfires peculiar to the project or project site; additionally, there are no significant wildfire impacts that were not analyzed or discussed in the General Plan EIR or that substantial new information shows would be more severe than discussed in the General Plan EIR. (See Pub. Resources Code, § 21083.3, subd. (b); CEQA Guidelines, § 15183, subd. (b).) Therefore, further environmental review is not required.

XXI. Mandatory Findings of Significance

- a. During nesting season, there is potential for protected birds to be temporarily present on-site. The project would adhere to General Plan Action NR.1.1.4 and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance. If nesting activity is observed, consultation with the Planning Department shall be conducted in order to determine the appropriate mitigation, if any, required to minimize impacts to nesting birds. While the project would remove some mature trees, the project would comply with the City's Tree Ordinance, which in part requires that the removal of certain trees be replaced at a minimum ratio of 1:1 or otherwise compensated through payment into the City's tree program fund.

The site is currently developed as a parking lot and is surrounded by development. There are no historic buildings or resources on the project site, and the project site is not located within archaeologically or culturally sensitive areas identified by the General Plan EIR. If archeological, tribal cultural, or human remains were accidentally discovered during construction, the project would comply with General Plan Action CHR 1.3.2, California Health and Safety Code sections 7050.5 and 7052, and California Public Resources Code section 5097 to ensure there would be no significant impacts.

Due to the above, the project would not: 1) degrade the quality of the environment; 2) substantially reduce or impact the habitat of fish or wildlife species; 3) cause fish or wildlife populations to drop below self-sustaining levels; 4) threaten to eliminate a plant or animal community; 5) reduce the number or restrict the range of a rare or endangered plant or animal; or 6) eliminate important examples of the major periods of California history or prehistory. Therefore, impacts associated with biological, cultural, and tribal resources have been adequately addressed and would not differ from those previously identified in the General Plan EIR. No further environmental review is required.

- b. The project was included in the General Plan EIR's future development assumptions, which identified potentially significant and unavoidable cumulative impacts with respect to land use, agricultural resources, transportation, air quality, noise, mineral resources, biological resources, and utilities. However, as an infill development, the project would not contribute to cumulative impacts arising from greenfield development such as agricultural resources, mineral resources, or biological resources due to the loss of habitat. Further, the project's contribution to cumulative impacts identified in the City's General Plan EIR would not result in a new or more significant cumulative impact determination than was previously identified. As discussed above, cumulative impacts with respect to land use, transportation, air quality, noise, GHG emissions, and utilities, were determined to be either within the scope of the City's General Plan EIR, result in no impact, or be substantially mitigated due to the implementation of uniformly applicable development policies. As detailed throughout these findings, the project would implement and comply with uniformly applicable development policies and standards that would substantially mitigate any impacts that were not addressed in the General

ITEM 11.1.**ATTACHMENT 4
Exhibit A to the Resolution**

Plan EIR or that would be substantially more severe than anticipated by the General Plan EIR. Therefore, no further environmental review is required.

- c. The project would not cause substantial adverse effects to human beings insofar as air quality, GHG emissions, geology and soils, hazards and hazardous materials, and noise impacts are concerned. No further environmental review is required.

LEGAL EFFECT OF FINDINGS

These findings constitute the City's best efforts to set forth the evidentiary and policy bases for its decision to approve the Appendix N Checklist prepared pursuant to Public Resources Code section 21083.3 and CEQA Guidelines section 15183 in a manner consistent with the requirements of CEQA. To the extent that these findings conclude that various mitigation measures outlined in the 2006 General Plan EIR are feasible and have not been modified, superseded or withdrawn, the City hereby binds itself to implement these measures. Upon City-adoption of the ordinances approving the Appendix N Checklist, these findings will constitute a binding set of obligations.

ITEM 11.1.

**ATTACHMENT 5
Exhibit B to the Resolution**

**CEQA FINDINGS OF FACT RELATED TO
CEQA GUIDELINES SECTION 15183.3 EXEMPTION**

For the California Northstate University Dormitory Project

Prepared by the City Rancho Cordova

July 2020

PROJECT SUMMARY

California Northstate University (project applicant) proposes to develop a new dormitory (project) for an existing college campus. The proposed development would include 400 dorms located within two standalone structures, an on-site cafeteria building with an additional 16 dorms, and a courtyard with open space, landscaping, and a patio area on an existing parking lot for the University.

PROJECT DESCRIPTION

The project would include two dormitory buildings, Buildings A and B, and a cafeteria building. Building A would be approximately 50,700 square feet (sf) in size and provide 190 dorm rooms, and Building B would be approximately 53,900 sf in size and provide 210 dorm rooms. Both structures would be approximately 55-60 feet (5 stories) in height and would provide laundry facilities, lounge space, and a recreation room. The cafeteria building would offer dining options for students attending the university and/or residing in the dorms and would provide 16 additional dorm rooms. The proposed dorms would be modular construction (i.e., manufactured off-site and assembled together on the project site). The exterior of each building would then be constructed on the outside of the modular units once they are assembled on site. This type of construction will be unique in Rancho Cordova but has been used frequently in other jurisdictions for various housing types, including student housing.

PROJECT LOCATION

The project site is located at 2910 Prospect Park Drive in the central portion of the City of Rancho Cordova. The project site includes Assessor's Parcel Number (APN) 072-0600-002-0000. The site is bounded by Prospect Park Drive to the north/northeast, California Northstate University to the west, and commercial office space to the south/southeast. Adjacent uses to the project site are entirely office uses, with some office space occupied by educational uses. US 50 is located approximately 400 feet to the northwest of the project site.

The project site is designated as Office Mixed Use by the City's General Plan and is zoned Office Professional Mixed Use (OPMU).

PRIOR ENVIRONMENTAL REVIEW

On June 26, 2006 the City certified the EIR for the City of Rancho Cordova General Plan (General Plan EIR). The General Plan EIR is a program EIR, prepared pursuant to CEQA Guidelines section 15168.

The project is consistent with the type and intensity of development anticipated by the General Plan EIR. The project site is designated as Office Mixed Use by the City's General Plan, and the General Plan EIR anticipated buildout of the project site with Office Mixed Uses. This designation encourages the integration of commercial and/or residential use in conjunction with office use and allows for public/quasi-public uses. The project will integrate student housing into an existing office park and will support the existing California Northstate University. The project site is zoned

ITEM 11.1.

ATTACHMENT 5 Exhibit B to the Resolution

Office Professional Mixed-Use (OPMU), which allows a minimum floor area ratio of 0.25 and a maximum floor area ratio of 2.0 (Municipal Code § 23.313.040). The project's floor area ratio is 0.63, which is less than half of the floor area allowed in the General Plan. The foregoing demonstrates that the project is consistent with the type and intensity of development anticipated by the General Plan EIR.

The City previously complied with CEQA by analyzing impacts related to buildout under the General Plan in the General Plan EIR. As outlined below, the City has determined that the project is eligible for infill streamlining pursuant to Public Resources section 21094.5.

Public Resources Code section 21094.5 exempts from further environmental review projects whose potential environmental effects were either analyzed in a prior environmental impact report (EIR) for a planning level decision, or are mitigated by uniformly applicable development policies or standards. Planning level decisions are enactments or amendments of general plans or any general plan elements, community plan, specific plan, or zoning code. (CEQA Guidelines, § 15183.3, subd. (f).) In this case, the General Plan EIR constitutes the EIR for the planning level decision. Uniformly applicable development policies or standards are “policies or standards adopted or enacted by a city or county, or by a lead agency, that reduce one or more adverse environmental effects.” Examples of uniformly applicable development policies or standards include, but are not limited to:

- A. Regulations governing construction activities, including noise regulations, dust control, provisions for discovery of archeological and paleontological resources, stormwater runoff treatment and containment, protection against the release of hazardous materials, recycling of construction and demolition waste, temporary street closure and traffic rerouting, and similar regulations.
- B. Requirements in locally adopted building, grading and stormwater codes.
- C. Design guidelines.
- D. Requirements for protecting residents from sources of air pollution including high volume roadways and stationary sources.
- E. Impact fee programs to provide public improvements, police, fire, parks and other open space, libraries and other public services and infrastructure, including transit, bicycle and pedestrian infrastructure and traffic calming devices.
- F. Traffic impact fees.
- G. Requirements for reducing greenhouse gas emissions, as set forth in adopted land use plans, policies, or regulations.
- H. Ordinances addressing protection of urban trees and historic resources.

(CEQA Guidelines, 15183.3, subd. (f)(7).)

The project is exempt from further environmental review pursuant to Public Resources Code section 21094.5 and CEQA Guidelines section 15183.3. All of the project's potentially significant environmental effects fall into one of four categories:

1. No Impact.

ITEM 11.1.

ATTACHMENT 5 Exhibit B to the Resolution

2. Analyzed in the General Plan EIR and not more significant than analyzed in the General Plan EIR.
3. More significant than analyzed in the General Plan EIR, but substantially mitigated by uniformly applicable development policies or standards.
4. Not analyzed in the General Plan EIR, but substantially mitigated by uniformly applicable development policies or standards.

The 2020 Appendix N Checklist for the California Northstate University Dormitory Project (Appendix N Checklist) identifies General Plan policies and/or actions that would apply to the development of the project and have been determined in the General Plan EIR to substantially mitigate environmental effects. It also identifies uniformly applicable development policies or standards that would substantially mitigate environmental impacts that were either not analyzed in the General Plan EIR or that are more significant, i.e., substantially more severe, than previously analyzed.

Consistent with the requirements of CEQA Guidelines section 15183.3, the Appendix N Checklist determined that the project would not result in any significant impacts that are substantially more severe than anticipated in the General Plan EIR that cannot be substantially mitigated by uniformly applicable development policies or standards. The Appendix N Checklist also determined that, for impacts not analyzed in the General Plan EIR, the project would result in no impact or no impact that cannot be substantially mitigated by uniformly applicable development policies or standards. There are no significant effects that substantial new information shows would be substantially more severe than anticipated by the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

RECORD OF PROCEEDINGS

For the purposes of CEQA, and the findings set forth herein, the administrative record for the City's decision on the project consists of the following documents, at a minimum, which are incorporated by reference and made part of the record supporting these findings:

- 2006 City of Rancho Cordova General Plan
- 2006 City of Rancho Cordova General Plan Draft EIR
- 2006 City of Rancho Cordova General Plan Final EIR

In addition to the above items, the record includes, but is not limited to, the following documents related to the second stage entitlements:

- 2020 Appendix N Checklist for the California Northstate University Dormitory Project;
- All resolutions adopted by the City regarding the project and all documents cited or referred to therein as well as all staff reports, analyses, and summaries related to the adoption of those resolutions;
- All reports, studies, memoranda, maps, staff reports, or other planning documents relating to the project prepared by the City, consultants to the City, or responsible or

trustee agencies with respect to the City's compliance with the requirements of CEQA and with respect to the City's action on the project;

- All documents submitted to the City by other public agencies or members of the public in connection with the project;
- Any minutes and/or verbatim transcripts of all information sessions, public meetings, and public hearings held by the City in connection with the project;
- Any documentary or other evidence submitted to the City at such information sessions, public meetings and public hearings;
- Matters of common knowledge to the City, including, but not limited to federal, State, and local laws and regulations;
- The City's Zoning Code;
- Any documents expressly cited in these findings, in addition to those cited above; and
- Any other materials required for the record of proceedings by Public Resources Code section 21167.6, subdivision (e).

Without exception, any documents set forth above not found in the project files fall into one of two categories. Many of them reflect prior planning or legislative decisions of the City. (See *City of Santa Cruz v. Local Agency Formation Commission* (1978) 76 Cal.App.3d 381, 391-392; *Dominey v. Department of Personnel Administration* (1988) 205 Cal.App.3d 729, 738, fn. 6.) Other documents influenced the expert advice provided to City Staff or consultants. For that reason, such documents form part of the underlying factual basis for the City's decisions relating to approval of the project. (See Pub. Resources Code, § 21167.6, subd. (e)(10); *Browning-Ferris Industries v. City Council of City of San Jose* (1986) 181 Cal.App.3d 852, 866; *Stanislaus Audubon Society, Inc. v. County of Stanislaus* (1995) 33 Cal.App.4th 144, 153, 155.)

FINDINGS REQUIRED UNDER CEQA

Public Resources Code section 21002 provides that "public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects." The same statute provides that the procedures required by CEQA "are intended to assist public agencies in systematically identifying both the significant effects of projects and the feasible alternatives or feasible mitigation measures which will avoid or substantially lessen such significant effects." Public Resources Code section 21002 goes on to provide that "in the event [that] specific economic, social, or other conditions make infeasible such project alternatives or such mitigation measures, individual projects may be approved in spite of one or more significant effects thereof."

The mandate and principles announced in Public Resources Code section 21002 are implemented, in part, through the requirement that agencies must adopt findings before approving projects for which EIRs are required. For each significant environmental effect identified in an EIR for a project, the approving agency must issue a written finding reaching one or more of three permissible conclusions. The first such finding is that changes or alterations have been required in, or incorporated into, the project which avoid or substantially lessen the significant

environmental effect as identified in the Final EIR. The second permissible finding is that such changes or alterations are within the responsibility and jurisdiction of another public agency and not the agency making the finding, and such changes have been adopted by such other agency or can and should be adopted by such other agency. The third potential conclusion is that specific economic, legal, social, technological, or other considerations, including provision of employment opportunities for highly trained workers, make infeasible the mitigation measures or project alternatives identified in the Final EIR. (CEQA Guidelines, § 15091.) Public Resources Code section 21061.1 defines “feasible” to mean “capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, legal, and technological factors.” CEQA Guidelines section 15364 adds another factor: “legal” considerations. (See also *Citizens of Goleta Valley v. Bd. of Supervisors* (1990) 52 Cal.3d 553, 565.) The CEQA findings required by Public Resources Code section 21002 were made when the General Plan EIR was certified by the City in 2006 and are incorporated by reference herein.

These findings supplement the Public Resources Code section 21002 findings and provide a roadmap to the analysis contained in the Appendix N Checklist, which explained that impacts related to buildout under the General Plan were adequately addressed in the General Plan EIR and determined that the project would not result in new or substantially more severe impacts that would not be substantially mitigated by uniformly applicable development policies or standards. There are no significant effects that substantial new information shows would be substantially more severe than anticipated by the General Plan EIR. Project alternatives were previously considered as part of the General Plan EIR and discussed by the City Council prior to its certification. Thus, the Appendix N Checklist determined no further CEQA review was required for the project.

In support of its approval of the project, the City makes the following findings pursuant to Public Resources Code sections 21080 and 21094.5 as well as CEQA Guidelines sections 15091 and 15183.3:

I. Aesthetics

Chapter 4.13 of the General Plan EIR addresses aesthetic impacts related to buildout under the General Plan. Given that the project is consistent with the site’s General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate aesthetic impacts similar to those analyzed in the General Plan EIR.

The project would not have a substantial adverse effect on a scenic vista. The project site is located within a fully developed business park, with well-established trees along all major roads in the vicinity and bordering each parcel. The project would not damage a designated scenic highway because US 50 is not a designated scenic highway. Additionally, due to the relatively flat topography of the area and the presence of numerous landscape trees on the project site and adjacent parcels, no scenic resources or vistas are visible from the project site, nor are there any nearby scenic resources or vistas that have views of the project site.

The project would comply with the City’s development standards and design guidelines, including the Rancho Cordova Design Guidelines, to ensure compatibility with the visual character of the

surrounding area (see Rancho Cordova Design Guidelines, pp. 2:88-2:90). While the project would replace the existing paved parking lot with several buildings, on-site structures would be consistent in massing, scale, and architectural style with existing structures in the area. The design, color, and materials have been designed to integrate and compliment the surrounding buildings and area.

The project would comply with the Municipal Code, including Chapter 23.725, regarding lighting and glare, to ensure the project would not result in significant impacts. Requirements in Chapter 23.725 ensure that light trespass and glare have negligible impact on surrounding property (especially residential) and roadways. Further, since the project site is surrounded by office uses, there would be no impact from nighttime spillover lighting interrupting sleeping patterns or otherwise causing a nuisance to neighboring residents.

Finding: The project is consistent with the General Plan land use designation for the project site, and aesthetic impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no impact or no impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the City finds that application of uniformly applicable policies and regulations, including the General Plan policies, Zoning Code (including Chapter 23.725), and Design Guidelines, would substantially mitigate any new or substantially more severe impacts related to scenic quality, light, and glare. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

II. Agriculture and Forest Resources

Chapter 4.2 of the General Plan EIR addresses impacts to agriculture and forestry resources related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate agriculture and forestry impacts similar to those analyzed in the General Plan EIR.

The project would not convert California Department of Conservation Farmland Mapping and Monitoring Program-designated Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use. The project site is a paved parking lot located in a developed business park. There are no agricultural lands, timberlands, forest lands, or non-disturbed environments on or adjacent to the project site.

The project would not conflict with existing zoning for agricultural use or a Williamson Act contract because the project site is not under a Williamson Act contract and is zoned Office Mixed Use.

The project area is designated as Urban and Built-Up Land in the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP). As a result, development of the project does not conflict with the zoning for, or cause rezoning of, forest land, timberland, or

timberland zoned Timberland Production. Therefore, it would not result in the loss of forest land or conversion of forest land to non-forest use.

Finding: The project is consistent with the General Plan land use designation for the project site, and agricultural and forestry impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any new or substantially more severe agricultural and forestry impacts than anticipated in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

III. Air Quality

Chapter 4.6 of the General Plan EIR addresses impacts to air quality related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate air quality impacts similar to those analyzed in the General Plan EIR.

The project would not conflict with or obstruct implementation of any applicable air quality plan. As stated, its land use was evaluated in the General Plan EIR. As an infill site, it would produce 32 to 57 percent less air pollutant emission per capita, according to the EPA. It is also projected to result in a 57 percent reduction in per capita VMT, which would reduce vehicle emissions.

The project would not result in cumulatively considerable net increase in any criteria pollutant beyond those previously analyzed in the General Plan EIR. Sacramento County is currently designated nonattainment with respect to ozone and PM₁₀; thus, buildout consistent with the General Plan EIR was determined to be a significant and unavoidable impact. The project would reduce cumulatively considerable increases in ozone and PM₁₀, as well as PM_{2.5}, to below SMAQMD's significance thresholds through compliance with the SMAQMD rules and regulations, including application of best available control technologies (BACT) and best management practices (BMPs).

The project would not expose sensitive receptors to substantial pollutant concentrations. The project's floor area ratio is 0.63, which is less than half of the floor area allowed in the General Plan. Because the project is consistent with the development density established in the General Plan, the operational effects of development of the site would have been considered in the EIR, including vehicle trips on US 50 and the emissions associated with those trips. Further, there are no sensitive receptors within 1,500 feet of the project site; the nearest residential units are approximately 2,000 feet to the north of the project site. Additionally, the types of uses proposed as part of the project are not considered to be associated with the generation of substantial TAC emissions.

The project is not anticipated to result in objectionable odors or substantial operational dust emissions. Additionally, it would implement SMAQMD rules and regulations that ensure construction would not result in substantial dust emissions.

Finding: The project is consistent with the General Plan land use designation for the project site, and air quality impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant air quality impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no air quality impact or no air quality impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the City finds that application of uniformly applicable policies and regulations, including the General Plan and SMAQMD rules and regulations, including application of BACT and BMPs, would substantially mitigate any new or substantially more severe impacts related to cumulatively considerable net increases of PM₁₀ and ozone. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

IV. Biological Resources

Chapter 4.10 of the General Plan EIR addresses biological resource impacts related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate biological resource impacts similar to those analyzed in the General Plan EIR.

The project would not have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or the U.S. Fish and Wildlife Service. The project site is currently a paved parking lot within a developed business park, with trees located on and surrounding the site. During nesting season, there is the potential for protected birds to be temporarily present on the project site due to migratory and nesting habits. The project would adhere to General Plan Action NR.1.1.4 and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance. If nesting activity is observed, consultation with the Planning Department shall be conducted in order to determine the appropriate mitigation, if any, required to minimize impacts to nesting birds.

The project would not have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations or by the California Department of Fish and Wildlife or the U.S. Fish and Wildlife Service because the project site is a paved parking lot.

The project would not have a substantial adverse effect on state or federally protected wetlands through direct removal, filling, hydrological interruption, or other means because it does not contain any wetlands, waterways, riparian habitats, or other sensitive communities.

The project would not substantially interfere with the movement of any wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife

nursery sites. While there is the potential for protected birds to be temporarily present on the project site due to migratory and nesting habits during nesting season, the project would adhere to Action NR.1.1.4 in the General Plan and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance. If nesting activity is observed, consultation with the Planning Department shall be conducted in order to determine the appropriate mitigation, if any, required to minimize impacts to nesting birds.

The project would not conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance. While the project would remove some mature trees in parking lot green islands, the project would comply with the City's requirements regarding protected trees (Chapter 19:12 of the Municipal Code). Specifically, the project would comply with the City's Tree Ordinance, which requires that the removal of trees with a diameter at standard height 12" or more be replaced at a minimum ratio of 1:1 or otherwise compensated through payment into the City's tree program fund.

The project would not conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan because there are no nearby or onsite conservation areas which would be impacted by construction and operational activities.

Finding: The project is consistent with the General Plan land use designation for the project site, and biological resource impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant biological resource impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no biological resource impact or no biological resource impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the City finds that application of uniformly applicable policies and regulations, including General Plan Action NR 1.1.4 and Municipal Code Chapter 19:12, would substantially mitigate any new or substantially more severe impacts related to protected species, movement of native resident wildlife species or wildlife nursery sites, and local tree preservation ordinances. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

V. Cultural Resources

Chapter 4.11 of the General Plan EIR addresses impacts to cultural resources related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate cultural impacts similar to those analyzed in the General Plan EIR.

The project would not cause a substantial adverse change in the significance of a historical resource pursuant to CEQA Guidelines section 15064.5 because no historic buildings or resources are on the project site.

The project would not cause a substantial adverse change in the significance of an archaeological resource pursuant to section 15064.5 because the project site is not located within archaeologically or culturally sensitive areas identified by the General Plan EIR, and, through compliance with General Plan Action CHR 1.3.2, cultural resources inadvertently discovered during construction would be protected.

The project would comply with the General Plan EIR's policies related to potential disturbances of interred human remains, including those outside dedicated cemeteries. By complying with California Health and Safety Code Sections 7050.5 and 7052, California Public Resources Code Section 5097, and General Plan Action CHR 1.3.2, the project would identify, preserve, and protect archaeological deposits and remains within the project site, if discovered during development.

Finding: The project is consistent with the General Plan land use designation for the project site, and cultural resource impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant cultural resource impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no cultural resource impact or no cultural resource impact that cannot be substantially mitigated by the uniformly applicable development policies or standards. For the reasons discussed above, the City finds that application of uniformly applicable development policies and regulations, including General Plan Action CHR 1.3.2, California Health and Safety Code sections 7050.5 and 7052, and California Public Resources Code section 5097, would substantially mitigate any new or substantially more severe impacts related to archeological resources and disturbance of human remains. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

VI. Energy

Though the General Plan EIR did not examine this issue, the project would not result in potentially significant impacts due to wasteful, inefficient, or unnecessary consumption of energy resources during construction or operation. The dormitories would be composed of modular units. Compared to typical construction assumed in the General Plan EIR, modular units are more energy efficient to construct, require less construction equipment on the project site, and result in less waste during construction. Less waste results in less energy demand for raw materials. Thus, the project would not result in potentially significant impacts due to wasteful, inefficient, or unnecessary consumption of energy resources during construction.

Operational energy use would be reduced compared to typical projects assumed in the General Plan EIR. The Project is an infill development and would reduce diesel and gasoline fuel consumption on a regional basis by reducing total student generated VMT. Housing students on the campus would result in a 57 percent reduction in VMT compared to the current regional average. Additionally, SACOG's 2020 Metropolitan Transportation Policy/Sustainable Communities Strategy (MTP/SCS) concluded that per capita energy consumption will decrease as

a result of implementation of the MTP/SCS. The proposed Project is consistent with the MTP/SCS in that it locates housing in an area designated as a High Frequency Transit Area for Sacramento County.

Additionally, the new buildings would be required to comply with the Building Energy Efficiency Standards (California Code of Regulations, Title 24, Parts 6 and 11, adopted by Municipal Code sections 16.26.030 and 16.38.030), which provide minimum efficiency standards related to various building features, including appliances, water and space heating and cooling equipment, building insulation and roofing, and lighting. Implementation of these standards would significantly reduce energy usage from the project. Further, the dormitories would likely be more energy-efficient than housing options available to students off campus, resulting in less energy demand per capita. By providing sustainable, energy efficient development, which incorporates energy-efficient technology, the project adheres to General Plan Policies LU.2.7, H.4.1, NR.7.1, NR.7.2 and NR.7.3. Moreover, at least 45 percent of the electricity provided by SMUD would be from renewable sources. Therefore, the project would not result in potentially significant operational impacts due to wasteful, inefficient, or unnecessary consumption of energy resources.

The project would not conflict with or obstruct a local plan for renewable energy or energy efficiency. As noted above, the project would comply with Municipal Code sections 16.26.030 and 16.38.030 and would adhere to General Plan Policies LU.2.7, H.4.1, NR.7.1, NR.7.2 and NR.7.3. Additionally, it is consistent with SACOG's MTP/SCS and would result in significant VMT reductions, compared to the current regional average, which exceeds the California Office of Planning and Research's (OPR's) recommended VMT reduction target.

Finding: The project would not result in potentially significant energy impacts. The project would comply with Municipal Code sections 16.26.030 and 16.38.030 and would adhere to General Plan Policies LU.2.7, H.4.1, NR.7.1, NR.7.2 and NR.7.3. The City specifically finds that these uniformly applicable development policies and standards would substantially mitigate potential energy impacts, reducing them to less than significant by reducing construction and operational energy consumption. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

VII. Geology and Soils

Chapter 4.8 of the General Plan EIR addresses geological and soil resources. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate geological and soil impacts similar to those analyzed in the General Plan EIR.

The project would not directly or indirectly cause potential substantial adverse effects (including the risk of loss, injury, or death) involving rupture of a known earthquake fault or strong seismic ground shaking. The California Geological Survey does not include Rancho Cordova on its list of cities affected by Alquist-Priolo Fault Zones, and there are no geologic or soil vulnerabilities associated with project development unanticipated by the City in its General Plan EIR. The project would adhere to the 2019 California Code of Regulations, Part 2, Title 24 (California Building Standards Code, adopted by Municipal Code section 16.04.030) (CBSC), as well as local, state,

and federal construction and earthquake design standards and regulations. Construction and operation would involve limited excavation and would not create new seismic events or exacerbate existing seismic hazards.

Substantial adverse effects related to liquefaction are not anticipated because the General Plan EIR planning area is considered at minimal risk for liquefaction, and all projects are required to comply with the local building design standards and regulations.

The project site does not contain historically-mapped landslides or steep or unstable slopes. Therefore, the project would not directly or indirectly cause potential substantial adverse effects involving landslides.

The project would not result in substantial soil erosion or the loss of topsoil because while grading and site preparation activities would disturb soils, the project would comply with General Plan policies and actions mitigating soil erosion and the City's Improvement Standards and Land Grading and Erosion Control Ordinance.

As discussed, the project site is not located on an unstable geologic unit or soil that would become unstable as a result of the project, or that could potentially result in landslide, subsidence, liquefaction, or collapse. Additionally, the project would comply with the CBSC, which would reduce the risk of lateral spreading.

Compliance with the CBSC's policies and engineering practices would minimize any risks associated with project development related to expansive soil.

The project would not result in impacts related to septic tanks or other alternative wastewater disposal systems because it would connect to existing County sewer services.

The project would not directly or indirectly destroy a unique paleontological resource or other unique geologic features through compliance with General Plan Action CHR 1.3.2, which protects paleontological resources inadvertently discovered during construction activities.

Finding: The project is consistent with the General Plan land use designation for the project site, and geology and soil impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant geology and soil impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no geology and soil impact or no geology and soil impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the City finds that application of uniformly applicable policies and regulations, including the City's Improvement Standards and Land Grading and Erosion Control Ordinance, as well as Municipal Code section 16.04.030, would substantially mitigate any new or substantially more severe impacts related to soil erosion, loss of topsoil, potential soil instability, and expansive soils. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

VIII. Greenhouse Gas Emissions

The General Plan EIR did not examine impacts from greenhouse gas (GHG) emissions. Nevertheless, the project would not result in significant impacts related GHG emissions. SMAQMD's screening thresholds were used to evaluate whether the project would result in GHG emissions that may have a significant impact on the environment. For both construction and operational emissions, the project would not exceed SMAQMD's GHG emission screening thresholds.

The project would not conflict with any plan, policy, or regulation for the purpose of reducing GHG emissions. As stated above, the project would not exceed SMAQMD's thresholds of significance for GHGs. Additionally, the project would result in a 57 percent reduction in per capita VMT compared to current regional average, which exceeds OPR's recommended 15 percent reduction target. The modular construction is anticipated to require less energy and reduced vehicle trips during construction, which would reduce construction-related GHG emissions. The project would comply with energy efficiency requirements mandated in Municipal Code sections 16.26.030 and 16.38.030, which would reduce operational GHG emissions by requiring increased energy efficiency.

Finding: The project would not result in potentially significant GHG emission impacts. The project would implement and comply with SMAQMD's screening thresholds for evaluating whether the project would result in GHG emissions that may have a significant impact on the environment. Additionally, it would comply with Municipal Code sections 16.26.030 and 16.38.030. The City specifically finds that these uniformly applicable development policies and standards would substantially mitigate potential energy impacts, reducing them to less than significant by reducing construction and operational GHG emissions. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

IX. Hazards and Hazardous Materials

Chapter 4.4 of the General Plan EIR addresses impacts to hazards and hazardous materials related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate hazards and hazardous material impacts similar to those analyzed in the General Plan EIR.

The project would not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials because the construction and operation of a student housing project does not necessitate the transport, use, or disposal of hazardous materials.

While the project could include hazardous materials standard to construction activities such as fuels, lubricants, paint, and solvents, the project would adhere to the applicable local, state, and federal regulations on the use, storage, and transport of these materials. The project would not create a significant hazard to the public or the environment through reasonably foreseeable upset or accident conditions involving the release of hazardous materials into the environment through

ITEM 11.1.

ATTACHMENT 5 Exhibit B to the Resolution

compliance with local, state, and federal regulations and General Plan policies relating to the proper handling of potentially hazardous materials.

The project is not within 0.25 of an existing or planned public school site. Construction activities would comply with all local, state, and federal regulations and policies regarding the safe handling and storage of hazardous materials; no risks would arise from project operation.

The project is not located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5.

The project is located approximately two miles northeast of the Mather Airport. The project would not result in a safety hazard or excessive noise for people residing or working in the project area because the project site is not located within the 60 dBA Community Noise Equivalent Level (CNEL) contour for Mather Airport (Sacramento County 2020), and as such, on-site residences would not be exposed to airport-related noise in excess of City standards. Additionally, the site is not located with the Mather Airport safety zone.

The project would not impair the implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan because the project does not include alterations to any major roadway or travel routes for evacuations and emergency response.

The project would not expose people or structures, either directly or indirectly, to a significant risk of loss, injury, or death involving wildland fires because the project site is within an urbanized area and is not adjacent to or intermixed with wildlands.

Finding: The project is consistent with the General Plan land use designation for the project site, and hazards and hazardous materials impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant hazards and hazardous materials impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no hazards and hazardous materials impact or no impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the City finds that compliance with local, state, and federal regulations and General Plan policies relating to the proper handling of hazardous materials would substantially mitigate any new or substantially more severe impacts related to hazards to the public or the environment through reasonably foreseeable conditions involving the release of hazardous materials. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

X. Hydrology and Water Quality

Chapter 4.9 of the General Plan EIR addresses impacts to hydrology and water quality related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development

anticipated by the General Plan EIR. Therefore, the project would generate hydrology and water quality impacts similar to those analyzed in the General Plan EIR.

The project would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality as it would comply with Rancho Cordova's Standard Construction Specifications for Erosion and Sediment Control and Municipal Code Chapters 15.12 (Stormwater Management and Discharge Control) and Chapter 16.44 (Land Grading and Erosion Control) to reduce erosion and runoff associated with construction activities. Additionally, the project would increase the permeable surface area, so it would not substantially alter or negatively impact the drainage patterns or runoff rates or volumes to the city stormwater system.

The project would not substantially decrease groundwater supplies or interfere substantially with groundwater recharge because the project would be consistent with the overall growth anticipated in the General Plan, associated water demands, and groundwater impacts addressed in the General Plan EIR. The project would create pervious surfaces as part of its drainage and water quality control feature and would not involve the creation of a well.

The project would not substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, increase the rate or amount of surface runoff in a manner which would result in flooding, create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff, or impede or redirect flood flows.

The project would not risk release of pollutants due to project inundation in flood hazard, tsunami, or seiche zones because the project is not located in a flood hazard area and includes water quality control features.

The project would not conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan because the project would connect into the existing drainage facilities adjacent to the project site and would create pervious surfaces as part of its drainage and water quality control features. Additionally, the project would comply with all local hydrological design standards and regulations. Specifically, the project would adhere to General Plan Action ISF.2.4.1, which requires all projects to secure an assured, legally entitled water supply and delivery system with existing infrastructure. The project will obtain water service from Golden State Water Company.

Finding: The project is consistent with the General Plan land use designation for the project site, and hydrology and water quality impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant hydrology and water quality impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no hydrology and water quality impact or no impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the

City finds that application of uniformly applicable policies and regulations, including General Plan Action ISF.2.4.1, and Rancho Cordova's Standard Construction Specifications for Erosion and Sediment Control, Municipal Code Chapters 15.12 and 16.44 would substantially mitigate any new or substantially more severe impacts related to water quality. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XI. Land Use and Planning

Chapter 4.1 of the General Plan EIR addresses impacts to land use and planning related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate land use and planning impacts similar to those analyzed in the General Plan EIR.

The project would not physically divide an established community because the project site is currently developed as a paved parking lot. Additionally, the project would not isolate any existing land uses, is consistent with the scale and intensity of existing adjacent land uses, and is sited within a planned industrial park.

The project site is currently zoned and designated Office Mixed Use. Further, the project does not conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect.

Finding: The project is consistent with the General Plan land use designation for the project site, and land use and planning impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any new or substantially more severe land use and planning impacts than anticipated in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XII. Mineral Resources

Chapter 4.8 of the General Plan EIR addresses impacts to mineral resources related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would result in impacts to mineral resources similar to those analyzed in the General Plan EIR.

The project would not result in the loss of a known mineral resource because there are no mineral resource excavation activities in the project area and the project site and surrounding area are not located within a mineral resource overlay zone.

Finding: The project is consistent with the General Plan land use designation for the project site, and mineral resource impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any new or substantially more severe mineral

resource impacts than anticipated in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XIII. Noise

Chapter 4.7 of the General Plan EIR addresses noise impacts related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate noise impacts similar to those analyzed in the General Plan EIR.

The project would not generate a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or in other applicable local, state, or federal standards. Project construction would generate maximum noise levels ranging from 85 to 90 dB at a distance of 50 feet, and construction activities would occur between the hours of 6 a.m. and 8 p.m. during weekdays, and between the hours of 7 a.m. and 8 p.m. on weekends, exempting the project from the provisions of the Rancho Cordova Noise Ordinance (Municipal Code Section 6.68.090(E)). Construction noise would be temporary, estimated to occur during 2020 to 2021. The nearest residential uses are approximately 2,000 feet north of the project site. Through implementation of Municipal Code requirements limiting the hours of construction noise, the project would avoid generating noise during the most sensitive night and early morning hours, minimizing potential disturbance of sensitive receptors in the vicinity. During operation, the project would generate fewer vehicle trips than the allowable land use designations identified in the General Plan and evaluated in the General Plan EIR, such that the potential roadway noise levels would not exceed noise levels anticipated by the General Plan EIR (General Plan EIR Table 4.7-8 at 4.7-23 – 4.7-25).

The project would not generate excessive groundborne vibration or groundborne noise levels. While the use of heavy equipment at the project site could generate some localized vibration levels, on-site equipment would largely consist of rubber-tired loaders and other equipment that would not generate substantial vibration beyond 25 feet of distance between source and receptor. As discussed, project construction activities would comply with the Rancho Cordova Noise Ordinance (Municipal Code Section 6.68.090(E)). The nearest residential uses are approximately 2,000 feet north of the project site, so based on the distance between potential receptors and the project site and compliance with the Municipal Code, on-site activities would not generate substantial vibration or groundborne noise.

While the project is located within two miles of Mather Airport, it is not within the 60 dBA CNEL contour and would not expose people residing or working in the project area to excessive levels of airport-related noise.

Finding: The project is consistent with the General Plan land use designation for the project site, and noise impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant noise impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in

the General Plan EIR, the project would result in either no noise impact or no noise impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the City finds that application of uniformly applicable policies and regulations, including Rancho Cordova Noise Ordinance (Municipal Code Section 6.68.090(E)), would substantially mitigate any new or substantially more severe impacts related to a substantial increase in ambient noise levels in excess of noise standards. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XIV. Population and Housing

Chapter 4.3 of the General Plan EIR addresses impacts to population and housing related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate population and housing impacts similar to those analyzed in the General Plan EIR.

The General Plan EIR determined buildout would result in significant and unavoidable population and housing impacts. The General Plan EIR anticipated a growth in population of 74,289. The project would have no unplanned direct or indirect impact on the size of the student population or nearby communities. Because the project is consistent with the City's General Plan land use designation for the project site, population impacts associated with buildout of the site were analyzed in the General Plan EIR. Therefore, population and housing impacts would not exceed those analyzed in the General Plan EIR. Further, there is no substantial new information that shows that the project would result in a more severe adverse impact than discussed in the General Plan EIR.

The project does not displace existing housing or persons and would not necessitate the construction of replacement housing because the project site is currently a paved parking lot, located within a developed commercial business park.

Finding: The project is consistent with the General Plan land use designation for the project site, and population and housing impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any new or substantially more severe population and housing impacts than anticipated in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XV. Public Services

Chapter 4.12 of the General Plan EIR addresses impacts to public services related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate public service impacts similar to those analyzed in the General Plan EIR.

The project would not require the construction of new facilities for fire protection and law enforcement. The project would pay its fair share costs of annexation into the Police Services CFD.

The project would be required to pay school impact fees, which constitute full and complete mitigation of the impacts for the planning, use, development, or provision of adequate school facilities (Gov. Code, § 65995, subd. (h)). Further, the project would not impact school populations because it would serve a transient student population in a dormitory setting, not families with school-aged children.

The project would consist of infill development that would not result in substantial population growth. Therefore, it would not trigger the need for new park facilities or other public facilities.

Finding: The project is consistent with the General Plan land use designation for the project site, and impacts to public services associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant impacts to public services that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no impact to public services or no impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the City finds that application of uniformly applicable policies and regulations, such as imposition of fair cost fees would substantially mitigate any new or substantially more severe impacts related to the provision of police services and schools. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XVI. Recreation

Chapter 4.12 of the General Plan EIR addresses impacts to recreational facilities related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would not accelerate substantial deterioration of existing parks and recreational facilities or require the construction or expansion of recreational facilities beyond what was anticipated in the General Plan EIR.

Finding: The project is consistent with the General Plan land use designation for the project site, and impacts related to recreational facilities associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any new or substantially more severe impacts related to recreational facilities than anticipated in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XVII. Transportation

Chapter 4.5 of the General Plan EIR addresses impacts to transportation related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate transportation impacts similar to those analyzed in the General Plan EIR.

The project would not conflict with existing programs, plans, ordinances, or policies addressing the circulation system. Project development would result in an intensification of development at the project site, but would not modify existing vehicle circulation in the area through roadway modifications. Further, the project would include the installation of on-site bicycle parking and pedestrian circulation measures, both to and from California Northstate University and between on-site uses.

The project would not conflict with or be inconsistent with CEQA Guidelines section 15064.3(b). Locating students closer to their destination reduces VMT and is consistent with regional efforts and the intent of residential infill development. The project's VMT per capita represents 43 percent of the current regional average (a 57 percent reduction), which exceeds the 15 percent target reduction recommended by OPR.

The project would have no impacts related to increasing design feature hazards or resulting in adequate emergency access. As stated, the project would not modify existing vehicle circulation in the area through roadway modifications. Further, internal roadways would be designed in accordance with City standards to allow for the safe passage of emergency vehicles in the event of a call for service.

Finding: The project is consistent with the General Plan land use designation for the project site, and transportation impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any new potentially significant transportation impacts or in substantially more severe transportation impacts than anticipated in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XVIII. Tribal Cultural Resources

Chapter 4.11 of the General Plan EIR addresses impacts to cultural resources, including tribal cultural resources, related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate tribal cultural resource impacts similar to those analyzed in the General Plan EIR.

The project would not cause a substantial adverse change in the significance of a tribal cultural resource. The project area is not located within archaeological or culturally sensitive areas identified in the General Plan EIR. Further, if tribal cultural resources or human remains were accidentally discovered during construction, the project would implement General Plan Action CHR 1.3.2, which protects cultural resources, including tribal cultural resources, and human remains accidentally discovered during construction. Action CHR 1.3.2 specifically requires the Planning Department be notified if cultural resources are uncovered during construction and that construction in the vicinity stop until an expert is retained to evaluate the finds and recommends appropriate action. Additionally, it requires the Planning Department and County Coroner be notified if any human remains are uncovered, and that if the remains are determined to be Native

American, the procedures outlined in CEQA Guidelines section 15064.5, subdivisions (d) and (e), shall be followed.

Finding: The project is consistent with the General Plan land use designation for the project site, and tribal cultural resource impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any significant tribal cultural resource impacts that are substantially more severe than anticipated in the General Plan EIR. To the extent any impacts were not analyzed in the General Plan EIR, the project would result in either no tribal cultural resource impact or no tribal cultural resource impact that cannot be substantially mitigated by uniformly applicable development policies or standards. For the reasons discussed above, the City finds that application of General Plan Action CHR 1.3.2 — a uniformly applicable development policy — would substantially mitigate any new or substantially more severe impacts related to tribal cultural resources. There are no significant effects that substantial new information shows would be more severe than discussed in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XIX. Utilities and Service Systems

Chapter 4.12 of the General Plan EIR addresses impacts to utilities and service systems related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would result in impacts related to utility and service systems similar to those analyzed in the General Plan EIR.

The General Plan EIR determined the General Plan would result in significant and unavoidable impacts related to new or expanded water and wastewater infrastructure. The General Plan EIR determined buildout of the General Plan would not result in significant impacts related to electric power, natural gas, or telecommunication facilities. Because the project is consistent with the City's General Plan land use designation for the project site, impacts associated with buildout of the site were analyzed in the General Plan EIR. Therefore, impacts related to the construction of new or expanded facilities would not exceed those analyzed in the General Plan EIR. Further, there is no substantial new information that shows that the significant effect would have a more severe adverse impact than anticipated by the General Plan EIR. Further, City staff have reviewed the demands associated with the project and determined that existing facilities related to water, wastewater, telecommunications, and electricity are adequate to accommodate the demands of the project without requiring additional infrastructure (City of Rancho Cordova 2020b).

The General Plan EIR determined that an adequate water supply likely existed to serve buildout of the City within its current corporate limits, but it was unknown whether the City's surplus supplies would be adequate to serve buildout beyond the corporate limits. The project would be located within the City, not a Planning Area; therefore, it would have an adequate water supply. Further, pursuant to General Plan Action ISF.2.4.1, the project has confirmed it has an assured water supply and delivery system available. For the reasons discussed above, the project would not have a more severe adverse impact than anticipated by the General Plan EIR.

There is adequate landfill capacity for solid waste generated by the project, and the project would comply with all statutes and regulations related to solid waste and would not impair the attainment of solid waste reduction goals. Specifically, the project would comply with the California Integrated Waste Management Act of 1989 (AB 939), which requires diversion of a minimum of 50 percent of discarded materials away from disposal in landfills. The project would also comply with General Plan policies and actions and Municipal Code requirements in Chapters 6.20, 6.21, and 6.92 regarding waste management and recycling.

Finding: The project is consistent with the General Plan land use designation for the project site, and impacts related to utilities and service systems associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any new potentially significant impacts related to utilities or in substantially more severe impacts than anticipated in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XX. Wildfire

Chapter 4.12 of the General Plan EIR addresses wildfire impacts related to buildout under the General Plan. Given that the project is consistent with the site's General Plan land use and zoning designations, it is consistent with the type and intensity of development anticipated by the General Plan EIR. Therefore, the project would generate wildfire impacts similar to those analyzed in the General Plan EIR.

The project would not impair an adopted emergency response plan or emergency evacuation plan as it would not modify the existing roadway and circulation network, would not affect emergency vehicle access to or past the project site, or impair evacuation routes.

Further, the project would not exacerbate wildfire risks as the project site is relatively flat, developed with a paved parking lot, does not interface with natural habitat or open grassy fields, and is not located within a State Responsibility Area classified as either a Very High or High Fire Hazard Severity Zone. Accordingly, the project also would not expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes.

Finding: The project is consistent with the General Plan land use designation for the project site, and wildfire impacts associated with buildout were anticipated by and addressed in the General Plan EIR. The project would not result in any new or substantially more severe wildfire impacts than anticipated in the General Plan EIR. Therefore, pursuant to CEQA Guidelines section 15183.3, no further CEQA review is required.

XXI. Mandatory Findings of Significance

- a. During nesting season, there is potential for protected birds to be temporarily present on-site. The project would adhere to General Plan Action NR.1.1.4 and would conduct a preconstruction nest survey for protected bird species prior to removal of trees and/or site disturbance. If nesting activity is observed, consultation with the Planning Department shall be conducted in order to determine the appropriate mitigation, if any, required to minimize

impacts to nesting birds. While the project would remove some mature trees, the project would comply with the City's Tree Ordinance, which in part requires that the removal of certain trees be replaced at a minimum ratio of 1:1 or otherwise compensated through payment into the City's tree program fund.

The site is currently developed as a parking lot and is surrounded by development. There are no historic buildings or resources on the project site, and the project site is not located within archaeologically or culturally sensitive areas identified by the General Plan EIR. If archeological, tribal cultural, or human remains were accidentally discovered during construction, the project would comply with General Plan Action CHR 1.3.2, California Health and Safety Code sections 7050.5 and 7052, and California Public Resources Code section 5097 to ensure there would be no significant impacts.

Due to the above, the project would not: 1) degrade the quality of the environment; 2) substantially reduce or impact the habitat of fish or wildlife species; 3) cause fish or wildlife populations to drop below self-sustaining levels; 4) threaten to eliminate a plant or animal community; 5) reduce the number or restrict the range of a rare or endangered plant or animal; or 6) eliminate important examples of the major periods of California history or prehistory. Therefore, impacts associated with biological, cultural, and tribal resources have been adequately addressed and would not differ from those previously identified in the General Plan EIR. No further environmental review is required.

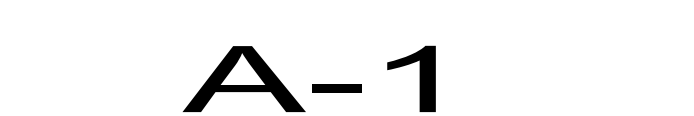
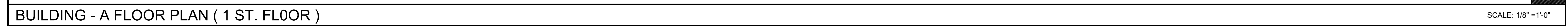
- b. The project was included in the General Plan EIR's future development assumptions, which identified potentially significant and unavoidable cumulative impacts with respect to land use, agricultural resources, transportation, air quality, noise, mineral resources, biological resources, and utilities. However, as an infill development, the project would not contribute to cumulative impacts arising from greenfield development such as agricultural resources, mineral resources, or biological resources due to the loss of habitat. Further, the project's contribution to cumulative impacts identified in the City's General Plan EIR would not result in a new or more significant cumulative impact determination than was previously identified. As discussed above, cumulative impacts with respect to land use, transportation, air quality, noise, GHG emissions, and utilities, were determined to be either within the scope of the City's General Plan EIR, result in no impact, or be substantially mitigated due to the implementation of uniformly applicable development policies. As detailed throughout these findings, the project would implement and comply with uniformly applicable development policies and standards that would substantially mitigate any impacts that were not addressed in the General Plan EIR or that would be substantially more severe than anticipated by the General Plan EIR. Therefore, no further environmental review is required.
- c. The project would not cause substantial adverse effects to human beings insofar as air quality, GHG emissions, geology and soils, hazards and hazardous materials, and noise impacts are concerned. No further environmental review is required.

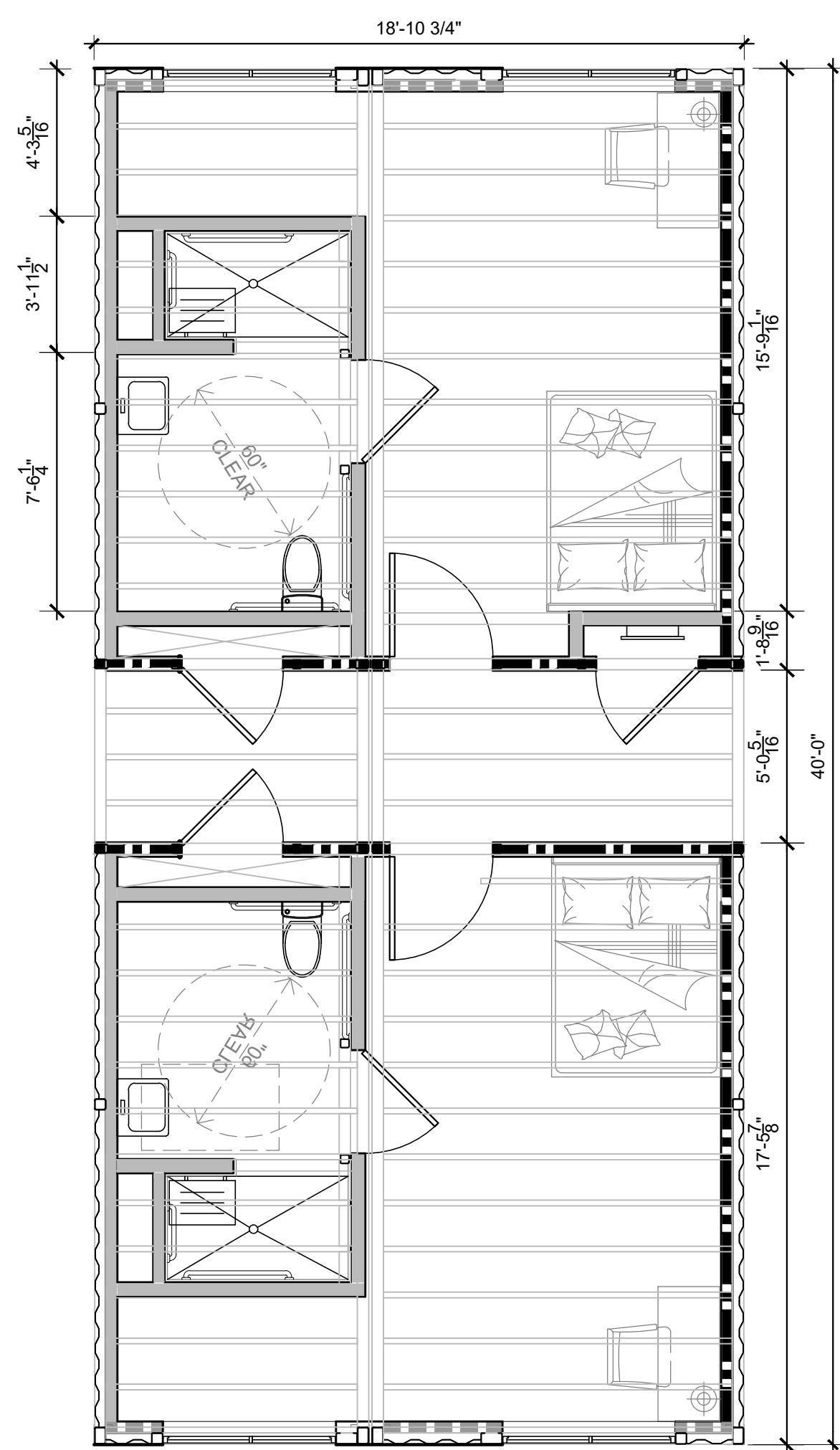
LEGAL EFFECT OF FINDINGS

These findings constitute the City's best efforts to set forth the evidentiary and policy bases for its decision to approve the Appendix N Checklist prepared pursuant to Public Resources Code section 21094.5 and CEQA Guidelines section 15183.3 in a manner consistent with the requirements of CEQA. To the extent that these findings conclude that various mitigation measures outlined in the 2006 General Plan EIR are feasible and have not been modified, superseded or withdrawn, the City hereby binds itself to implement these measures. Upon City-adoption of the ordinances approving the Appendix N Checklist, these findings will constitute a binding set of obligations.

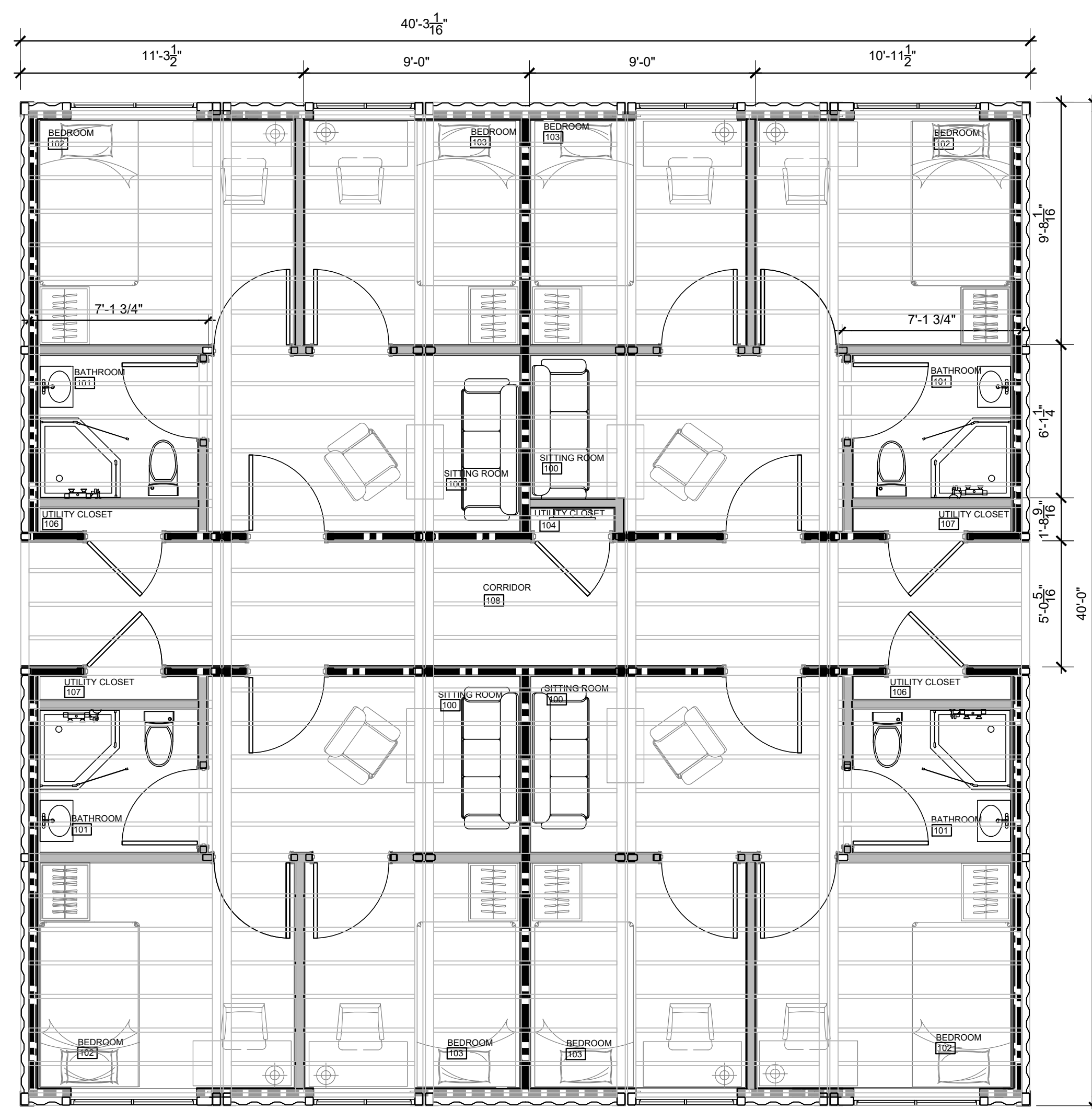


Page 223 of 1344

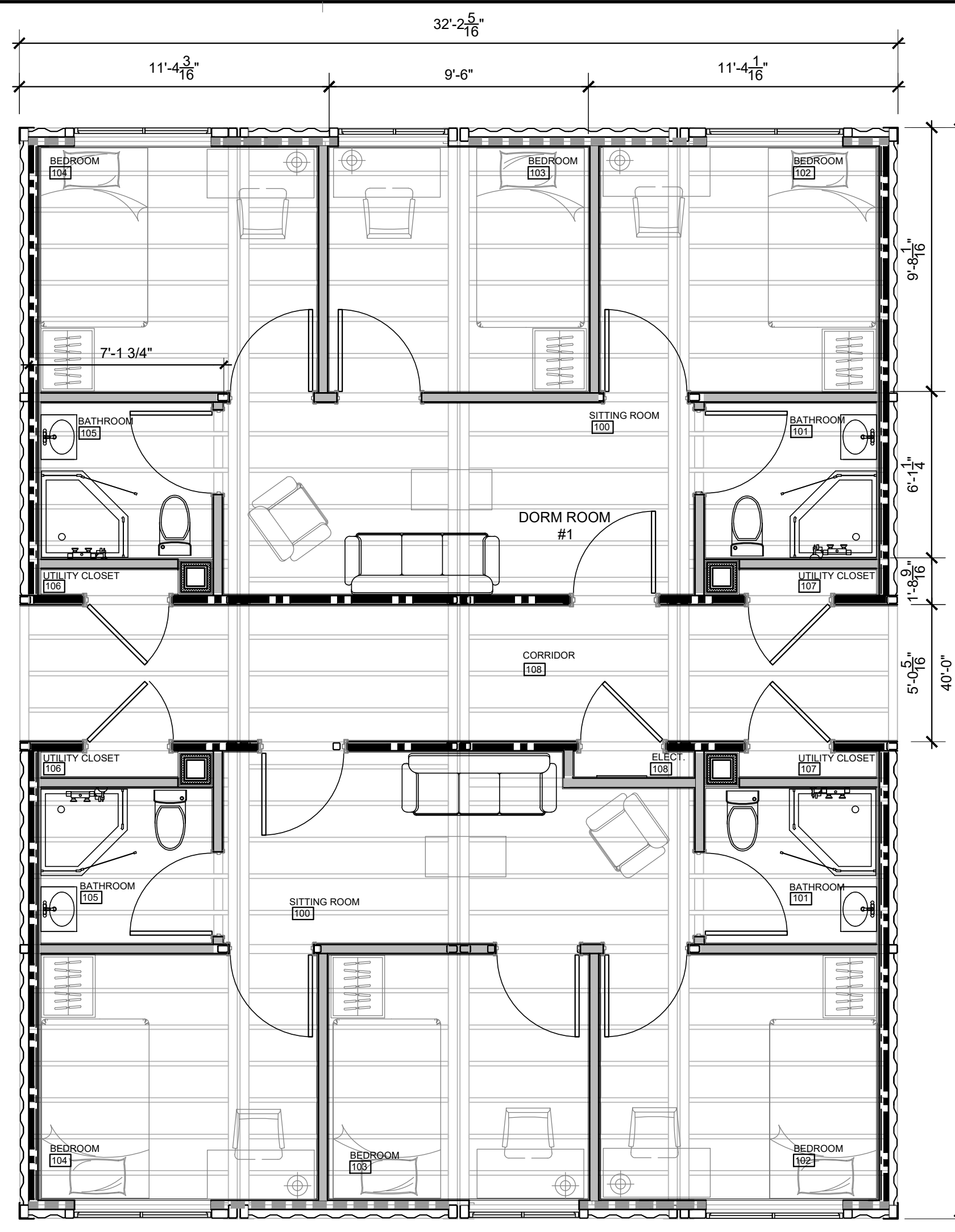




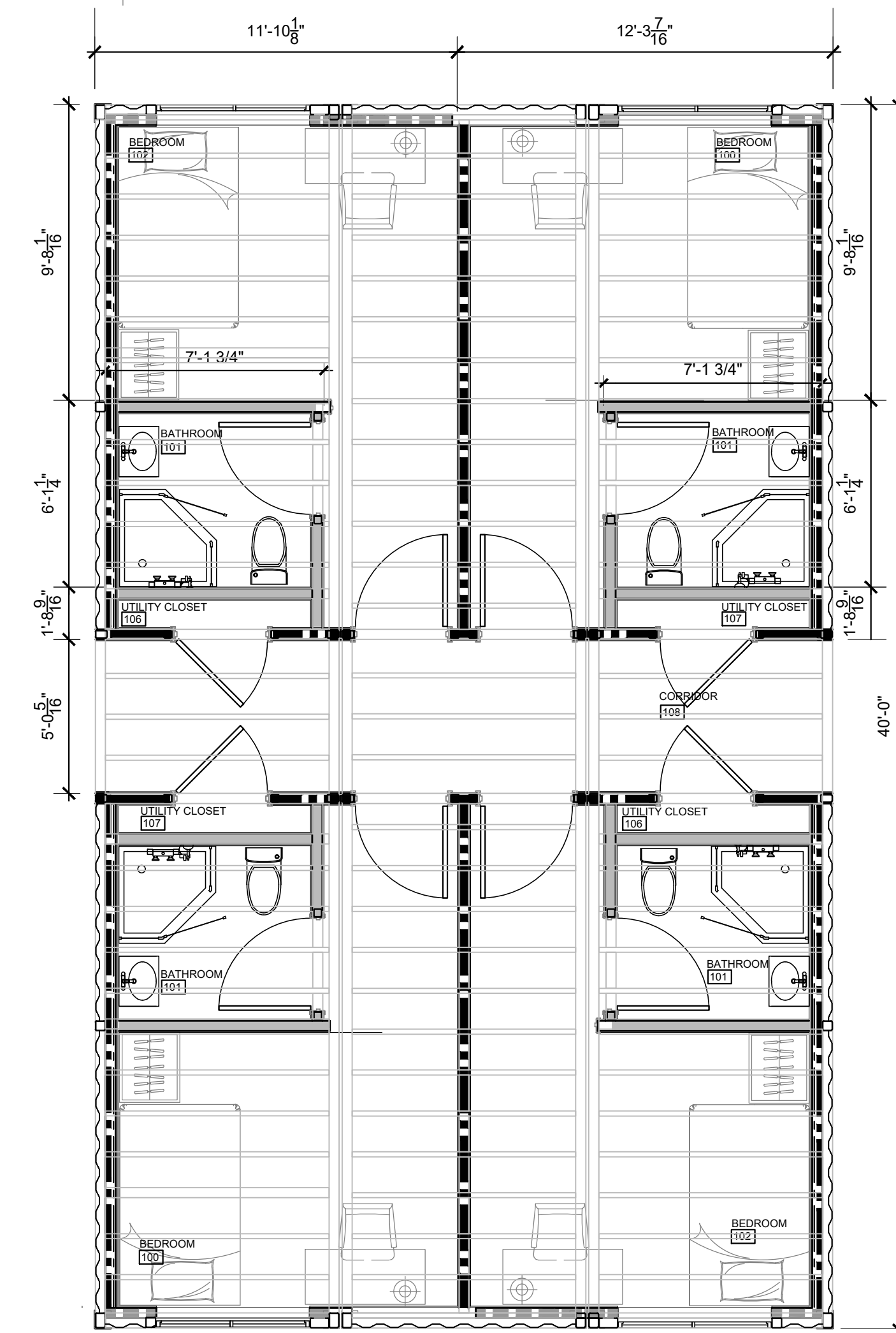
UNIT-1A FLOOR PLAN



UNIT-2 FLOOR PLAN



UNIT-3 FLOOR PLAN



UNIT-1 FLOOR PLAN



ARCHITECT

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, DUPLICATED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:
CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 218-17-A1FLOORPLAN

PROJECT NO: 272-19

PERMIT NO.

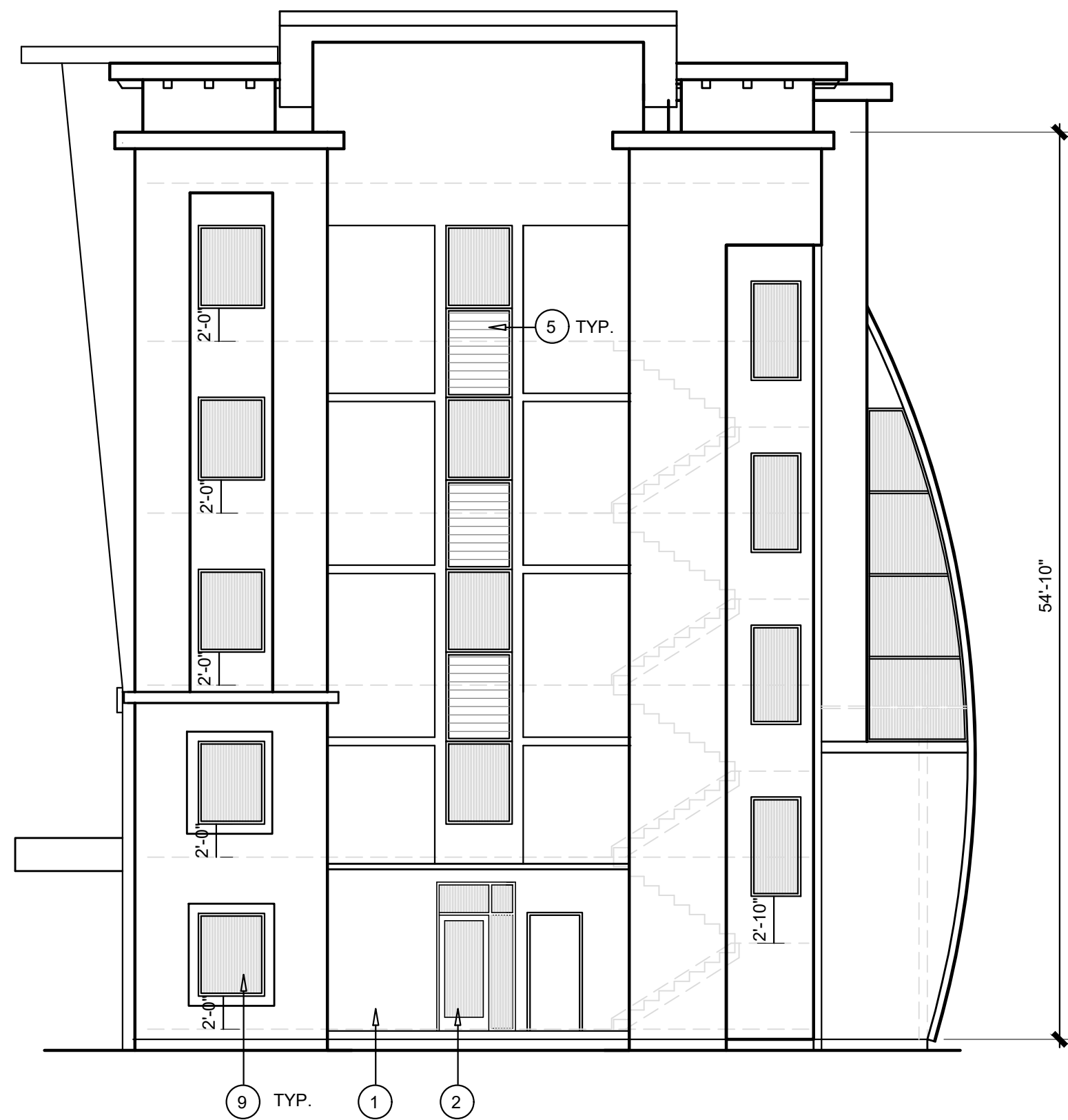
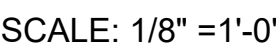
REVISIONS	BY

DESCRIPTION:

FLOOR PLAN
BUILDING -A

SHEET

A-1.1



ITEM NO.	DESCRIPTION	FINISH
①	STUCCO - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
②	ALUMINUM STOREFRONT SYSTEM	COLOR: CLEAR ANODIZED FINISH GLASS: CLEAR 1" INSULATED
③	ALUMINUM WALL PANEL SYSTEM	COLOR: GRAY
④	ALUMINUM CANOPY	COLOR: WHITE
⑤	ALUMINUM PANEL	COLOR: GRAY
⑥	STUCCO TRIM - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
⑦	LIGHT FIXTURE	COLOR: WHITE
⑧	FIBER CEMENT SIDING BY HARDIE	COLOR: INDULGENT SW 6969 - BY SHERWIN WILLIAMS
⑨	ALUMINUM WINDOW	COLOR: CLEAR ANODIZED FINISH GLASS: BLUE TINT 1" INSULATED
⑩	STUCCO PARAPET - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS

NEW STUDENT
DORMITORY
BUILDING

SHEET

A-2



BUILDING -A NORTH ELEVATION

SCALE: 1/8" =1'-0"

TYP. EXTERIOR FINISH SCHEDULE

ITEM NO.	DESCRIPTION	FINISH
1	STUCCO - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
2	ALUMINUM STOREFRONT SYSTEM	COLOR: CLEAR ANODIZED FINISH GLASS: CLEAR 1" INSULATED
3	ALUMINUM WALL PANEL SYSTEM	COLOR: GRAY
4	ALUMINUM CANOPY	COLOR: WHITE
5	ALUMINUM PANEL	COLOR: GRAY
6	STUCCO TRIM - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
7	LIGHT FIXTURE	COLOR: WHITE
8	FIBER CEMENT SIDING BY HARDIE	COLOR: INDULGENT SW 6969 - BY SHERWIN WILLIAMS
9	ALUMINUM WINDOW	COLOR: CLEAR ANODIZED FINISH GLASS: BLUE TINIT 1" INSULATED
10	STUCCO PARAPET - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:

CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A1.2EXTTEELEV

PROJECT NO: 272-19

PERMIT NO:

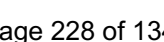
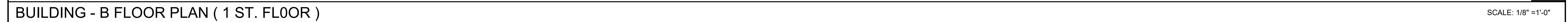
REVISIONS	BY

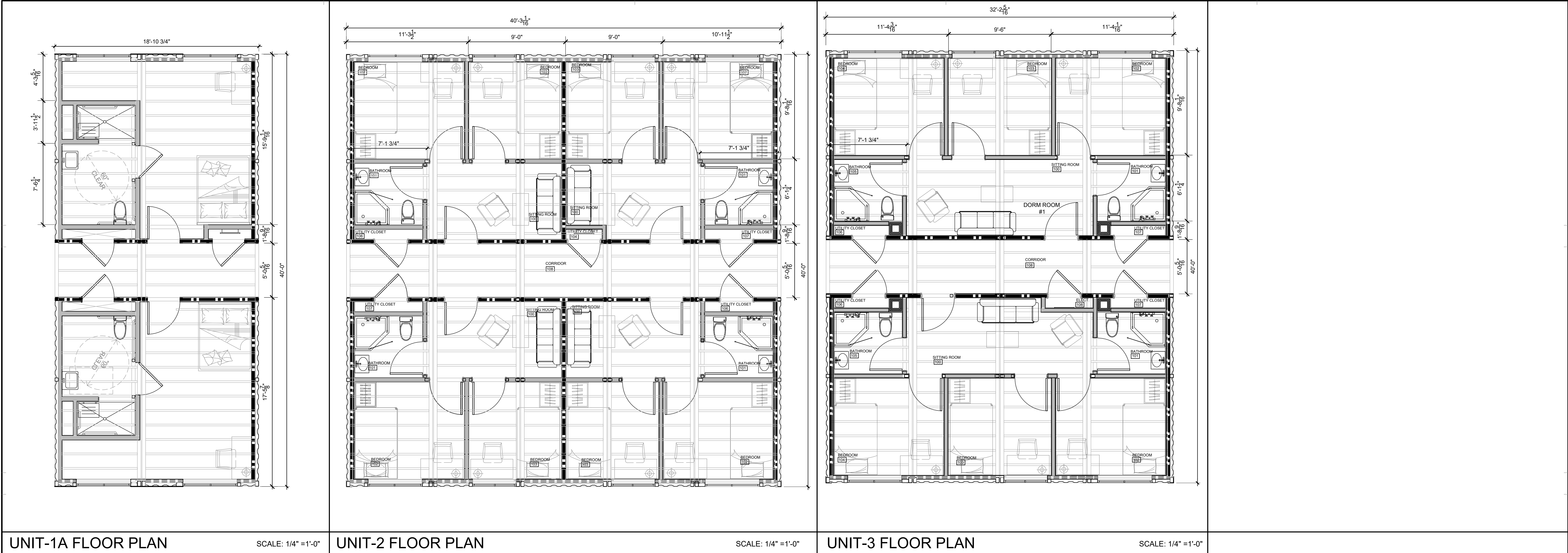
DESCRIPTION:

BUILDING -A
EXTERIOR
ELEVATIONS

SHEET

A-2.1





2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, DUPLICATED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA NORTHSTATE UNIVERSITY

NEW STUDENT DORMITORY BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:
CALIFORNIA NORTHSTATE UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOVA, CA 95670

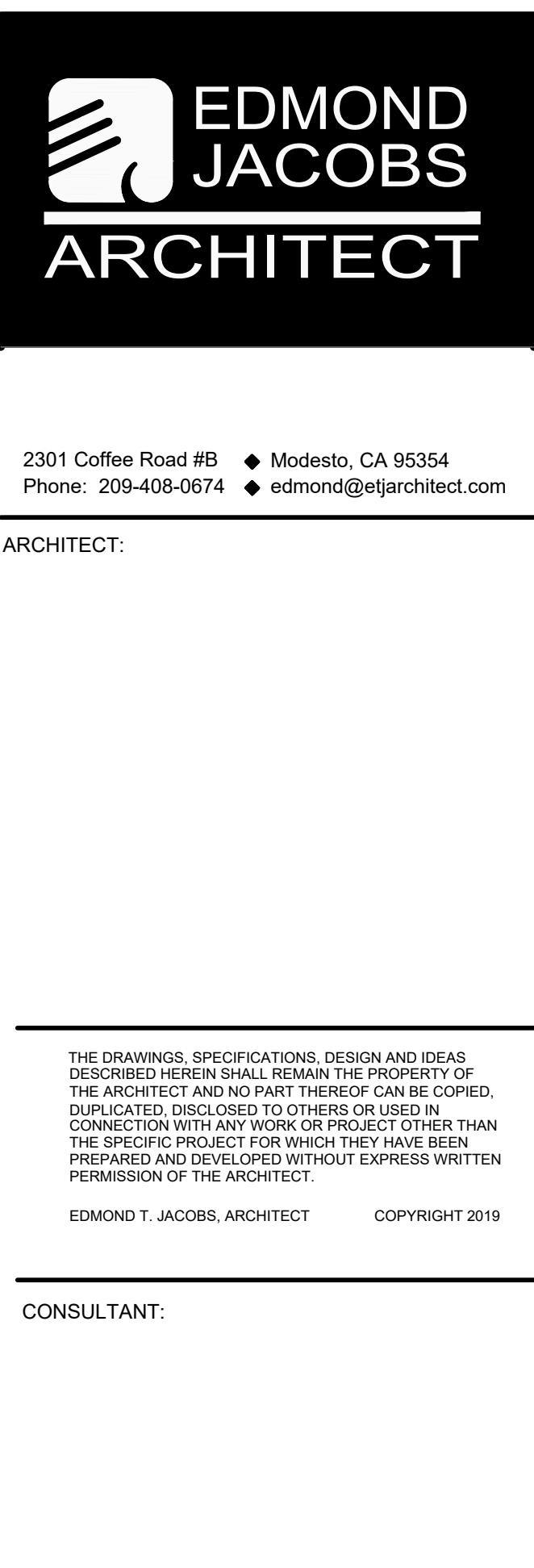
DATE:	MARCH 24, 2020
DRAWN:	ETJ
FILE:	272-19A-3.1
PROJECT NO:	272-19
PERMIT NO:	
REVISIONS	BY

DESCRIPTION:

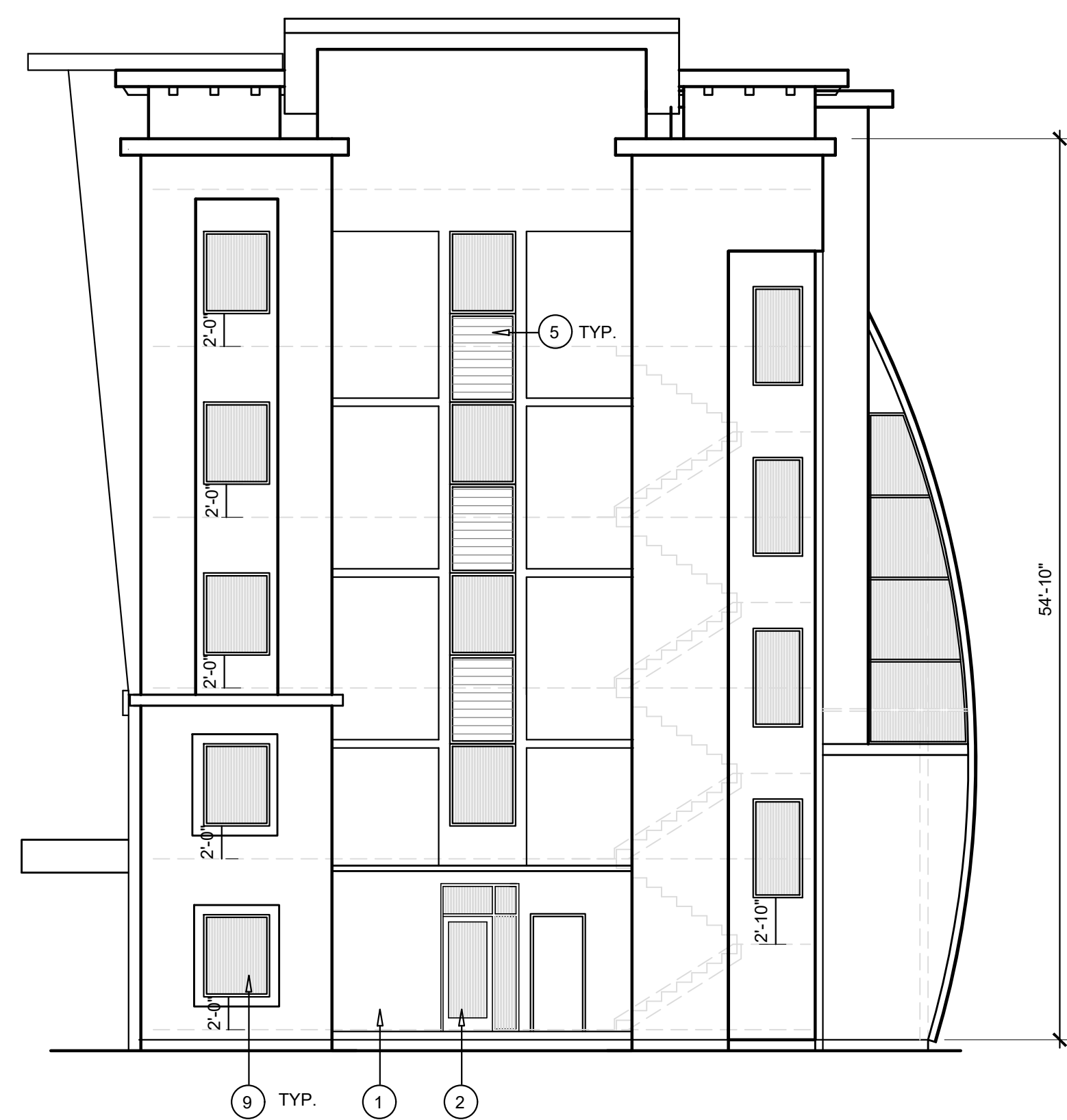
FLOOR PLAN
BUILDING -B

SHEET

A-3.1



SCALE: 1/8" = 1'-0"



SCALE: 1/8" = 1'-0"

SCALE: 1/8" = 1'-0"

TYP. EXTERIOR FINISH SCHEDULE		
ITEM NO.	DESCRIPTION	FINISH
①	STUCCO - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
②	ALUMINUM STOREFRONT SYSTEM	COLOR: CLEAR ANODIZED FINISH GLASS: CLEAR 1" INSULATED
③	ALUMINUM WALL PANEL SYSTEM	COLOR: GRAY
④	ALUMINUM CANOPY	COLOR: WHITE
⑤	ALUMINUM PANEL	COLOR: GRAY
⑥	STUCCO TRIM - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
⑦	LIGHT FIXTURE	COLOR: WHITE
⑧	FIBER CEMENT SIDING BY HARDIE	COLOR: INDULGENT SW 6969 - BY SHERWIN WILLIAMS
⑨	ALUMINUM WINDOW	COLOR: CLEAR ANODIZED FINISH GLASS: BLUE TINT 1" INSULATED
⑩	STUCCO PARAPET - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS

PROJECT ADDRESS

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:

CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A4

PROJECT NO: 272-19

PERMIT NO:

REVISIONS

DESCRIPTION:

BUILDING -B EXTERIOR ELEVATIONS

SHEET

A-4



BUILDING -B SOUTH ELEVATION

SCALE: 1/8" =1'-0"

TYP. EXTERIOR FINISH SCHEDULE		
ITEM NO.	DESCRIPTION	FINISH
①	STUCCO - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
②	ALUMINUM STOREFRONT SYSTEM	COLOR: CLEAR ANODIZED FINISH GLASS: CLEAR 1" INSULATED
③	ALUMINUM WALL PANEL SYSTEM	COLOR: GRAY
④	ALUMINUM CANOPY	COLOR: WHITE
⑤	ALUMINUM PANEL	COLOR: GRAY
⑥	STUCCO TRIM - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
⑦	LIGHT FIXTURE	COLOR: WHITE
⑧	FIBER CEMENT SIDING BY HARDIE	COLOR: INDULGENT SW 6969 - BY SHERWIN WILLIAMS
⑨	ALUMINUM WINDOW	COLOR: CLEAR ANODIZED FINISH GLASS: BLUE TINT 1" INSULATED
⑩	STUCCO PARAPET - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:

CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A4.1

PROJECT NO: 272-19

PERMIT NO:

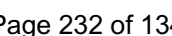
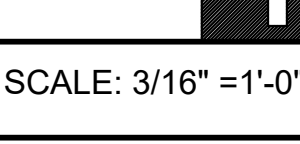
REVISIONS	BY

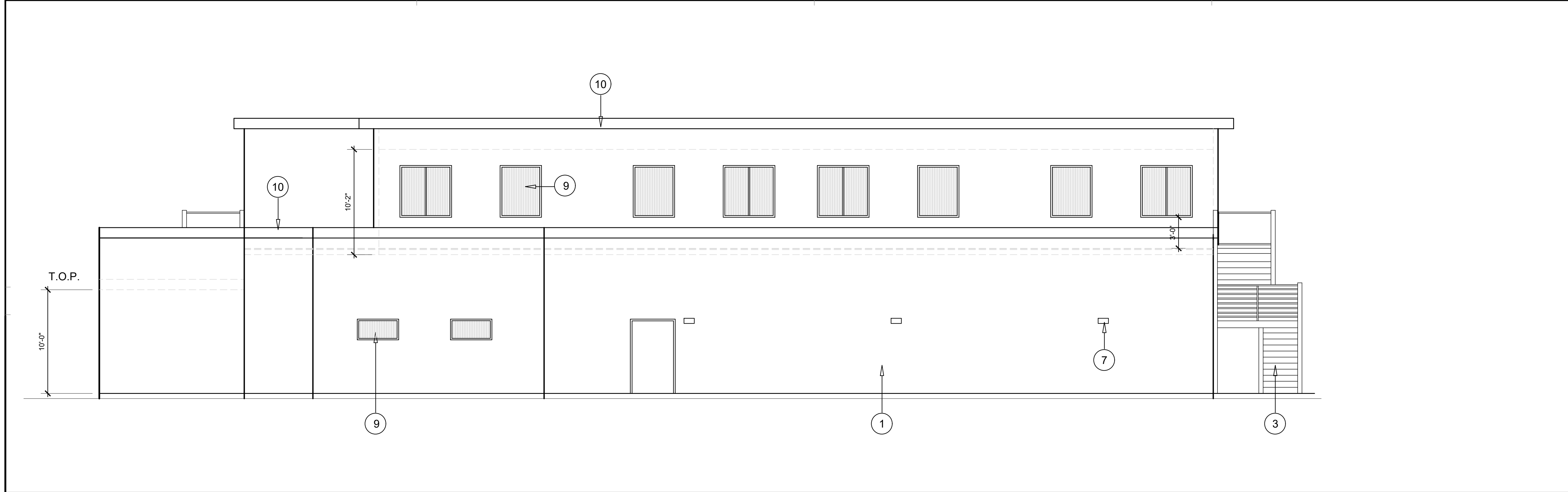
DESCRIPTION:

BUILDING -B
EXTERIOR
ELEVATIONS

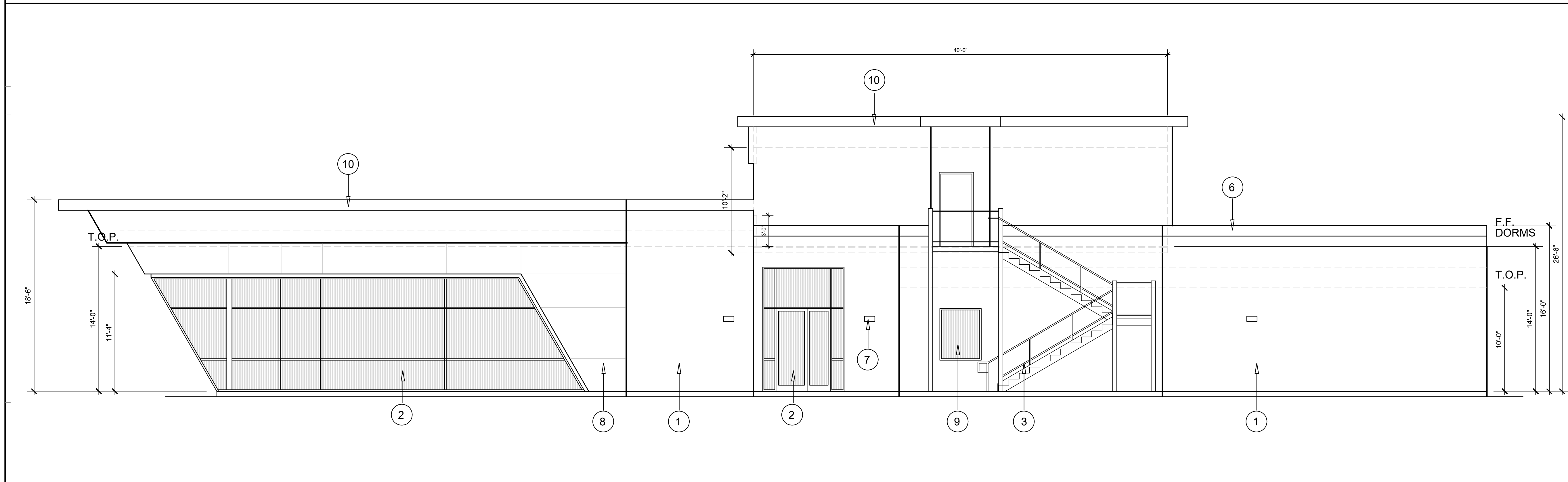
SHEET

A-4.1

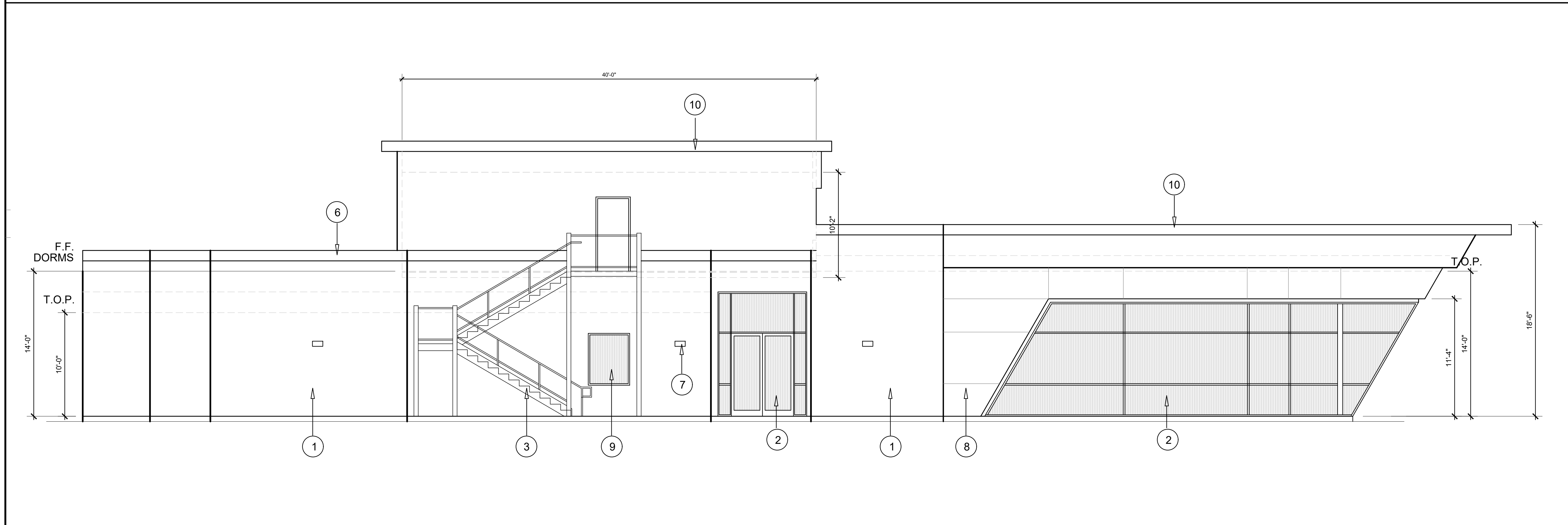




SOUTH ELEVATIONSCALE: 3/16" = 1'-0"



WEST ELEVATIONSCALE: 3/16" = 1'-0"



EAST ELEVATIONSCALE: 3/16" = 1'-0"

EXTERIOR ELEVATIONS KEY NOTES		
NO.	DESCRIPTION	FINISH
①	STUCCO - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
②	ALUMINUM STOREFRONT SYSTEM	COLOR: CLEAR ANODIZED FINISH GLASS: CLEAR 1" INSULATED
③	METAL STAIR	COLOR: FASHONABLE GRAY
④	NOT USED	
⑤	ALUMINUM CANOPY	COLOR: WHITE
⑥	STUCCO TRIM - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS
⑦	LIGHT FIXTURE	COLOR: WHITE
⑧	FIBER CEMENT SIDING BY HARDIE	COLOR: INDULGENT SW 6969 - BY SHERWIN WILLIAMS
⑨	ALUMINUM WINDOW	COLOR: CLEAR ANODIZED FINISH GLASS: BLUE TINIT 1" INSULATED
⑩	STUCCO PARAPET - DRYVIT SYSTEM	SAND FINISH COLOR: PER COLOR CHART AND COLORED ELEVATIONS



2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, DUPLICATED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.
EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:

CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOVA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A6

PROJECT NO: 272-19

PERMIT NO:

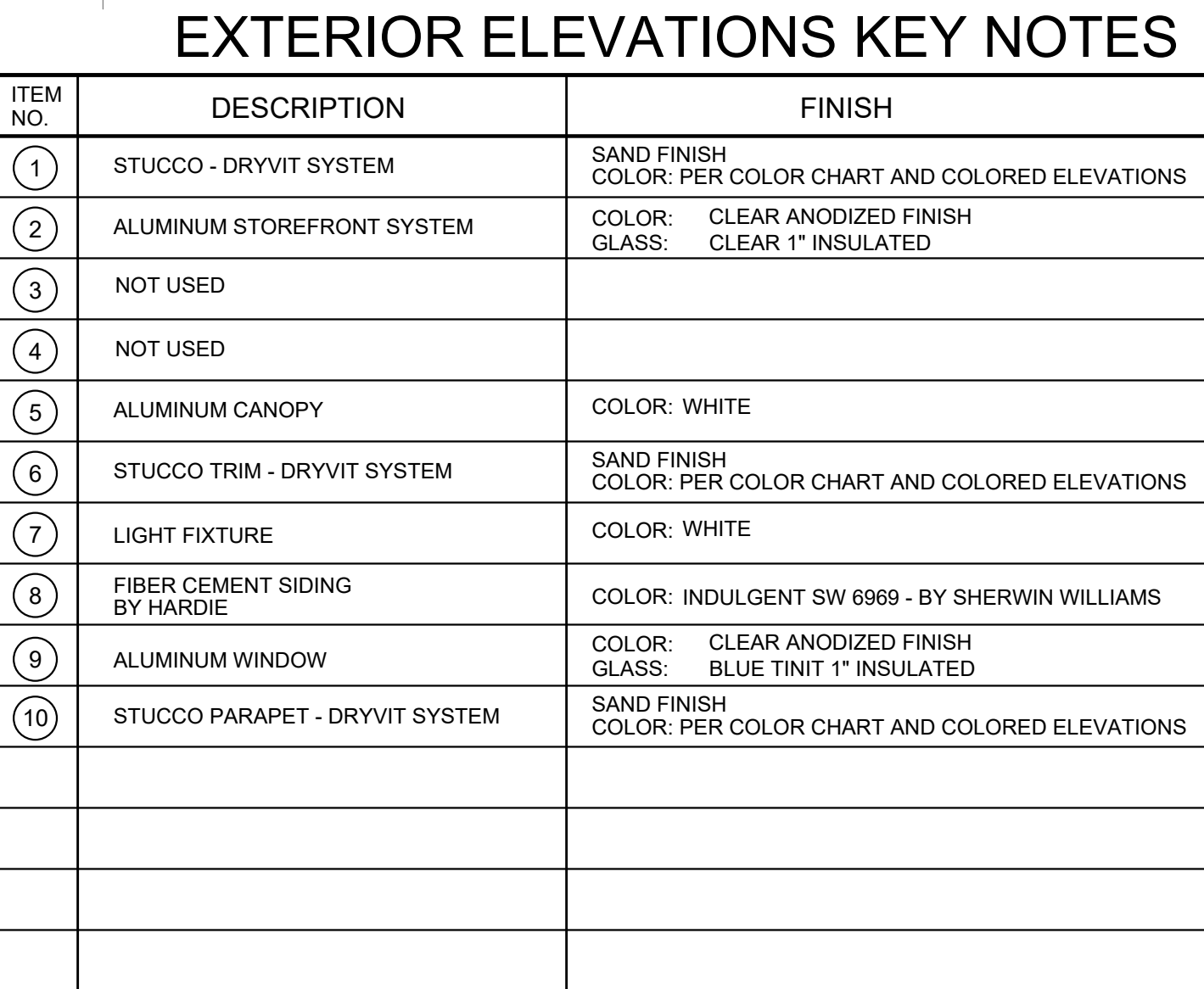
REVISIONS	BY

DESCRIPTION:

BUILDING-C
CAFETERIA
EXT. ELEVATIONS

SHEET

A-6



ARCHITECT:

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT: CALIFORNIA NORTHSTATE UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A6.1

PROJECT NO: 272-19

PERMIT NO:

REVISIONS	BY

DESCRIPTION:

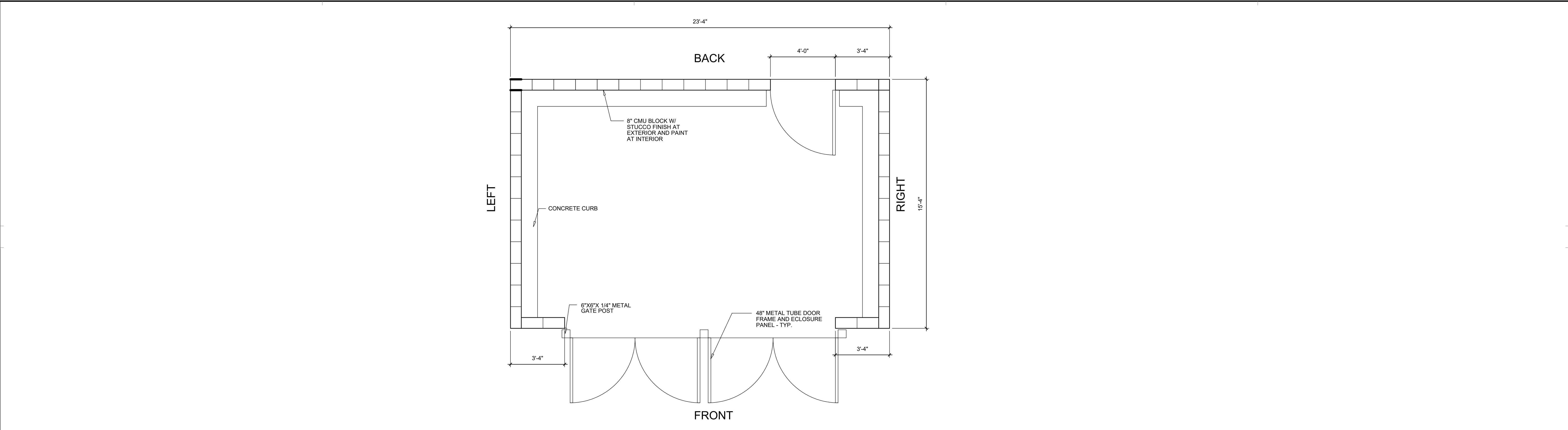
BUILDING -C
CAFETERIA
EXT. ELEVATIONS

SHEET

A-6.1

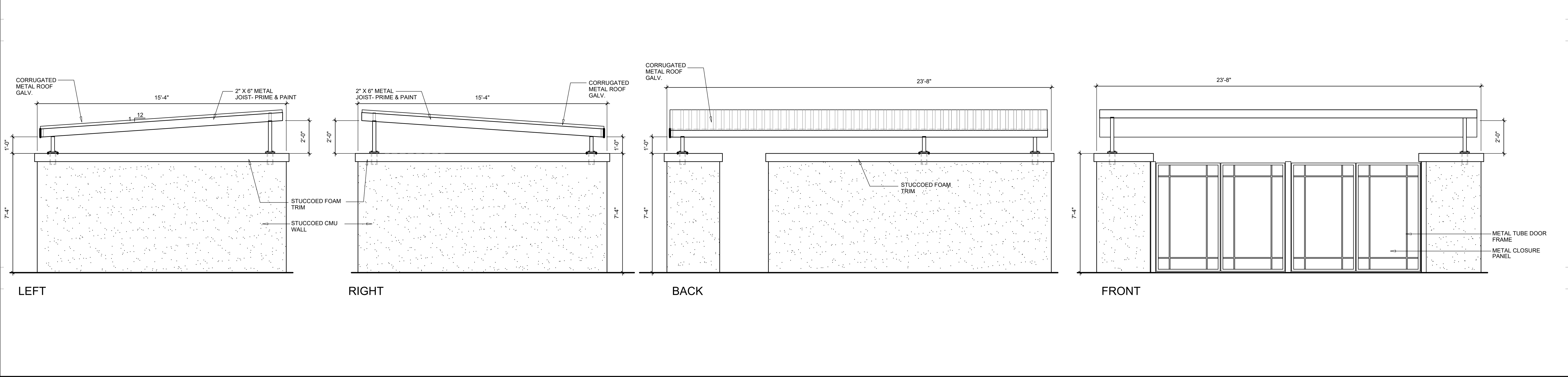


SCALE: 3/16" = 1'-0"



TRASH ENCLOSURE FLOOR PLAN

SCALE: 3/8" =1'-0"



TRASH ENCLOSURE ELEVATIONS

SCALE: 3/8" =1'-0"



EDMOND
JACOBS
ARCHITECT

2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, DULICATED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:

CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: JANUARY 30, 2020

DRAWN: ETJ

FILE: 272-19-A7

PROJECT NO: 272-19

PERMIT NO:

REVISIONS	BY

DESCRIPTION:

TRASH ENCLOSURE
PLAN AND
ELEVATIONS

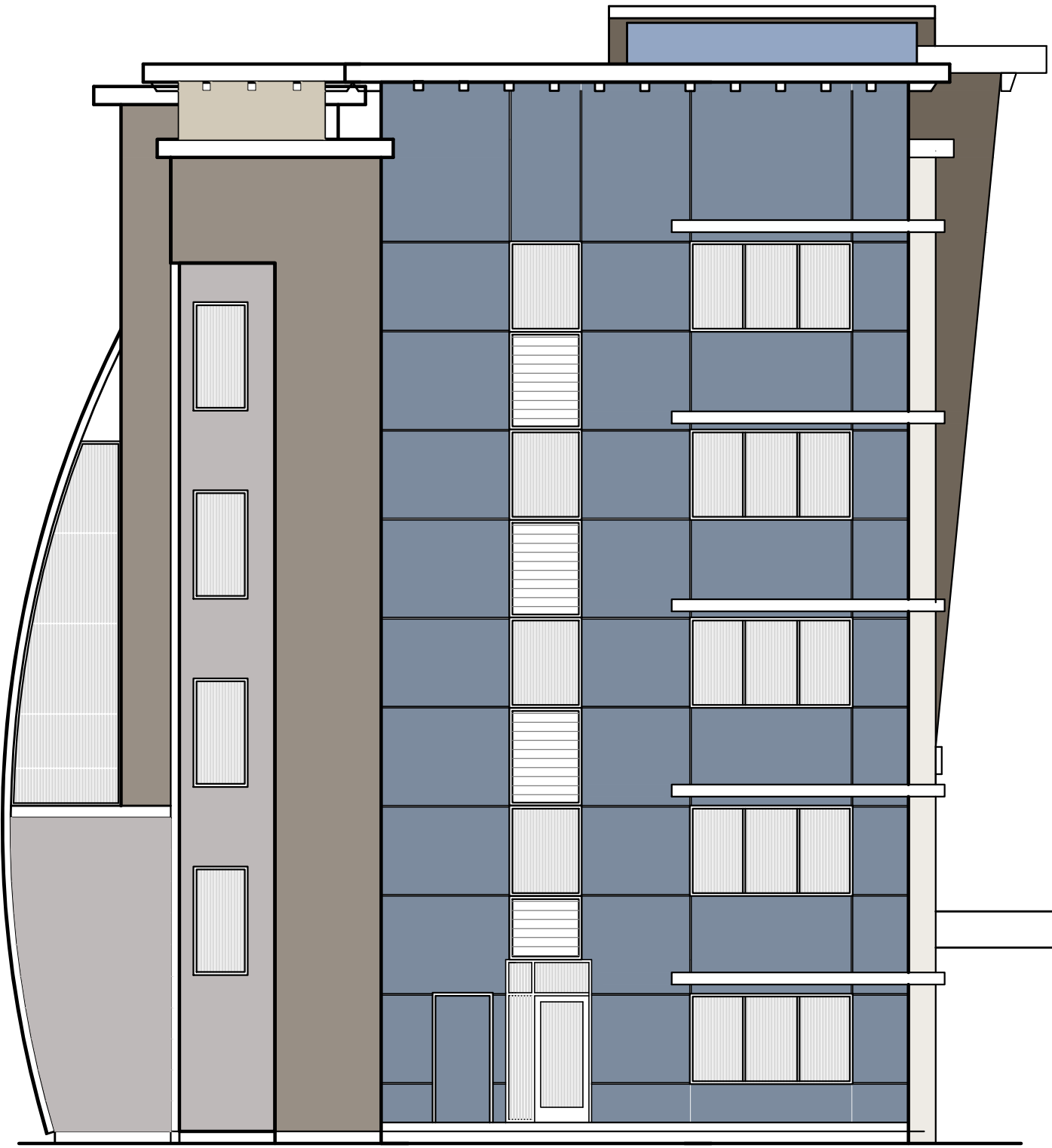
SHEET

A-7



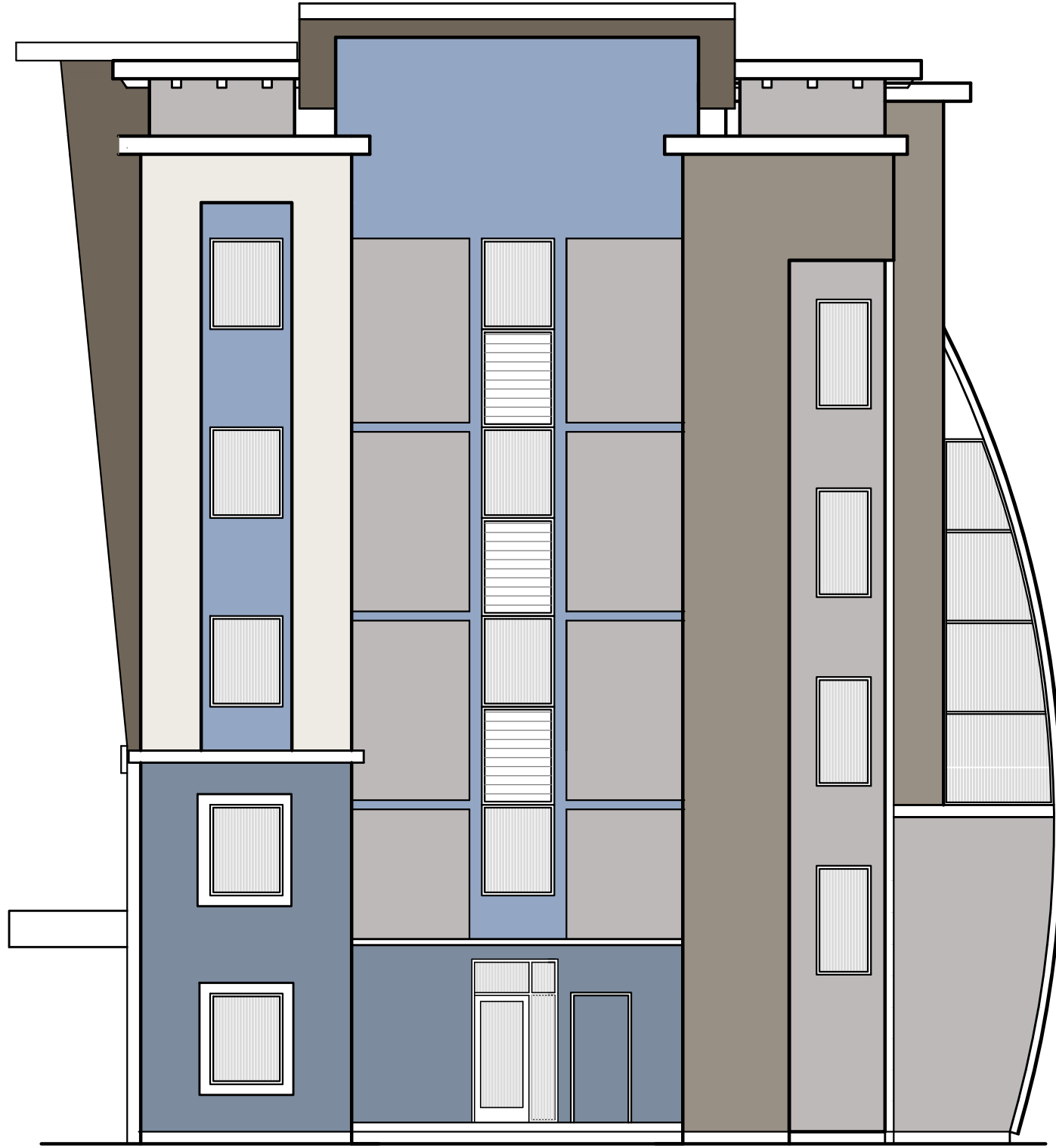
BUILDING -A SOUTH ELEVATION

SCALE: 1/8" =1'-0"



BUILDING -A WEST ELEVATION

SCALE: 1/8" =1'-0"



BUILDING -A EAST ELEVATION

SCALE: 1/8" =1'-0"

SAND FINISH
COLOR: SNOWBOUND SW 7004 BY SHERWIN WILLIAMS

SAND FINISH
COLOR: FASHIONABLE GRAY SW 6275 BY SHERWIN WILLIAMS

SAND FINISH
COLOR: COSMOS SW 6528 BY SHERWIN WILLIAMS

SMOOTH FINISH
COLOR: BRACING BLUE SW 6242 BY SHERWIN WILLIAMS

SMOOTH FINISH
COLOR: ELEPHANT EAR SW 9168 BY SHERWIN WILLIAMS

EXTERIOR COLORS



2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@etjarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, DUPLICATED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.
EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:
CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOVA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A-8

PROJECT NO: 272-19

PERMIT NO:

REVISIONS

BY

DESCRIPTION:

BUILDING -A
COLOR
ELEVATIONS

SHEET

A-8



BUILDING -A NORTH ELEVATION

SCALE: 1/8" =1'-0"

	SAND FINISH COLOR: SNOWBOUND SW 7004 BY SHERWIN WILLIAMS
	SAND FINISH COLOR: FASHIONABLE GRAY SW 6275 BY SHERWIN WILLIAMS
	SAND FINISH COLOR: COSMOS SW 6528 BY SHERWIN WILLIAMS
	SMOOTH FINISH COLOR: BRACING BLUE SW 6242 BY SHERWIN WILLIAMS
	SMOOTH FINISH COLOR: ELEPHANT EAR SW 9168 BY SHERWIN WILLIAMS

EXTERIOR COLORS



2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, REPRODUCED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:

CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE:	MARCH 24, 2020
DRAWN:	ETJ
FILE:	272-19-A8.1
PROJECT NO:	272-19
PERMIT NO:	
REVISIONS	BY

DESCRIPTION:

BUILDING - A
COLOR
ELEVATIONS

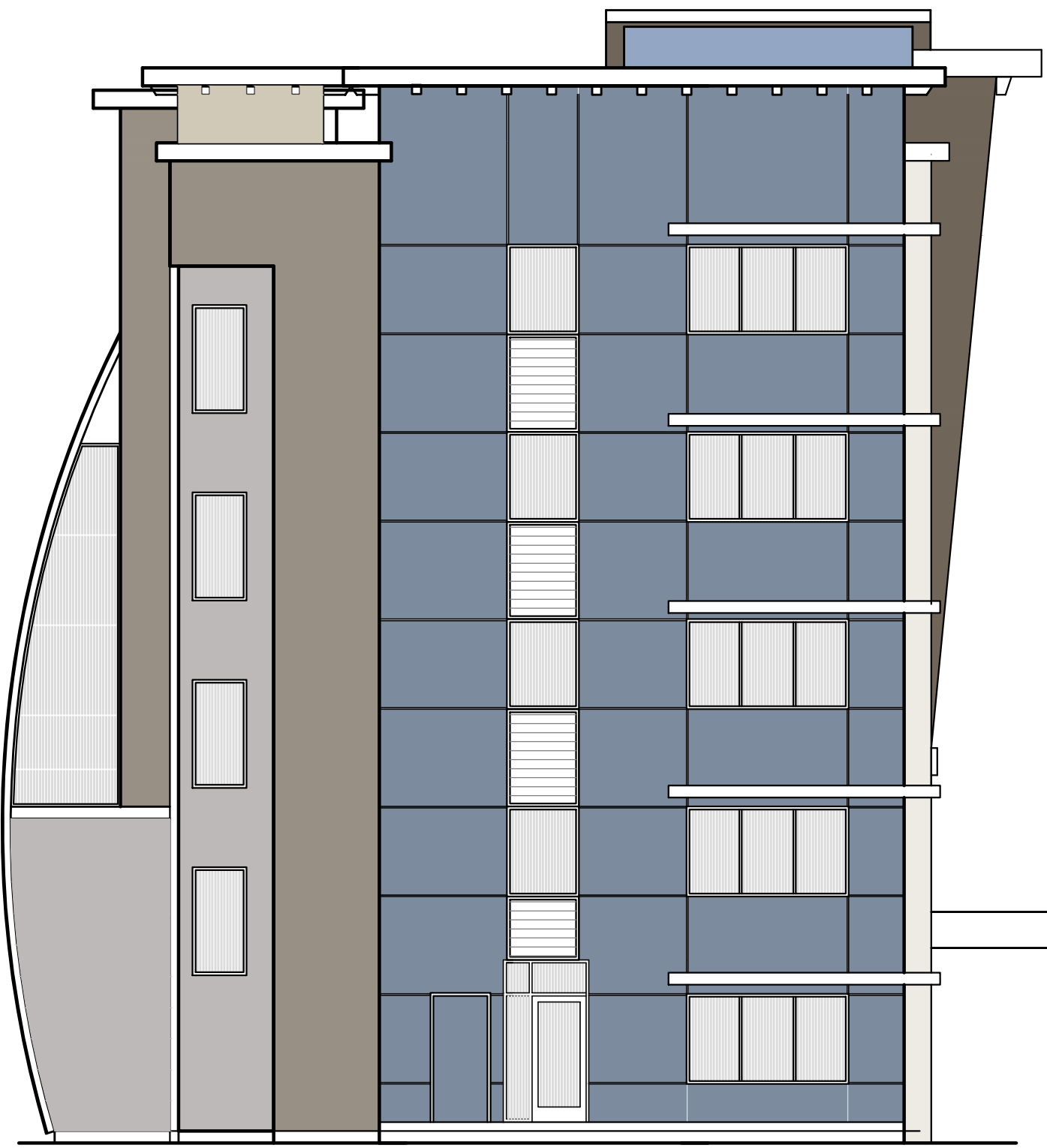
SHEET

A-8.1



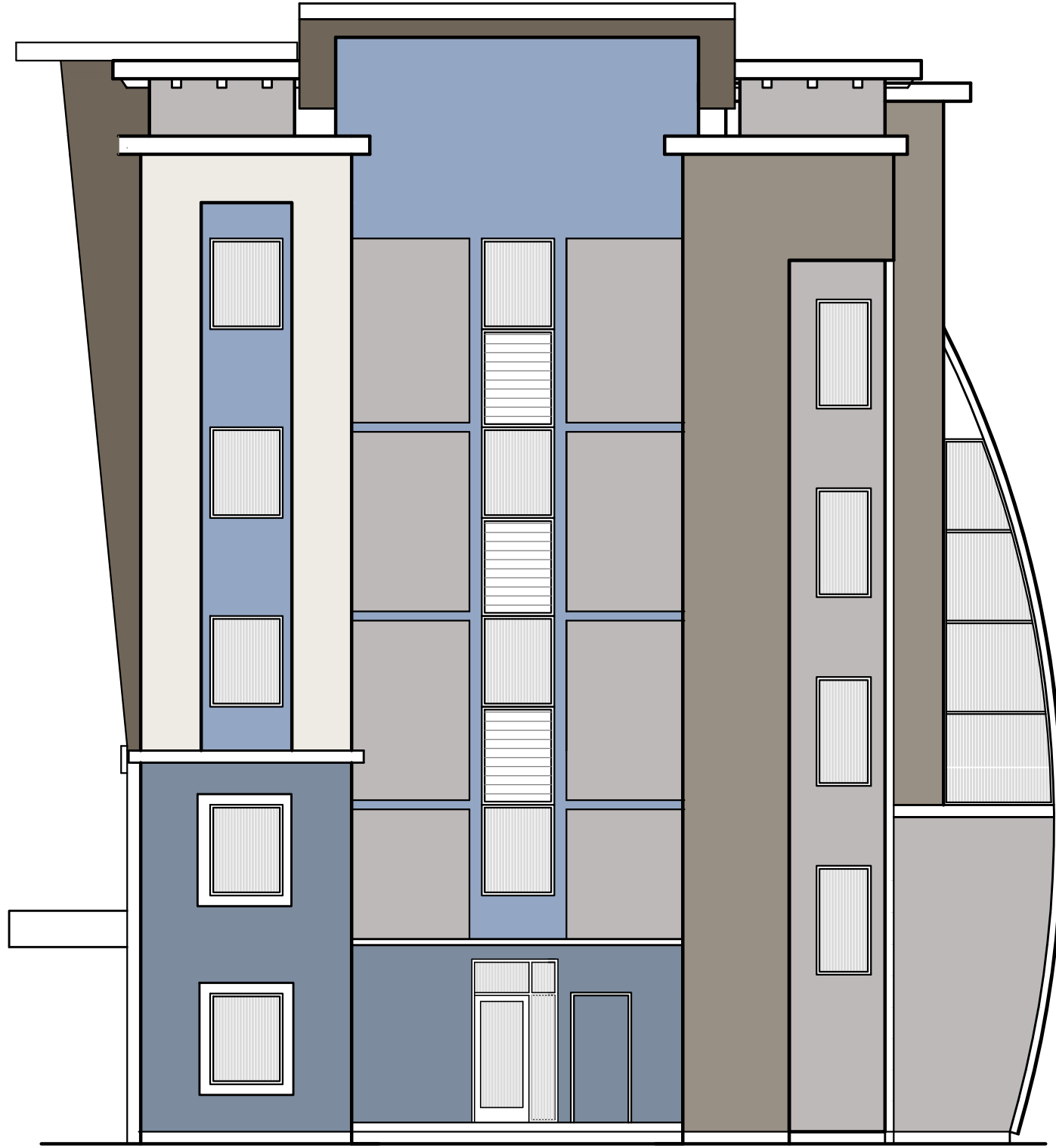
BUILDING -B NORTH ELEVATION

SCALE: 1/8" =1'-0"



BUILDING -B EAST ELEVATION

SCALE: 1/8" =1'-0"



BUILDING -B WEST ELEVATION

SCALE: 1/8" =1'-0"

SAND FINISH
COLOR: SNOWBOUND SW 7004 BY SHERWIN WILLIAMS

SAND FINISH
COLOR: FASHIONABLE GRAY SW 6275 BY SHERWIN WILLIAMS

SAND FINISH
COLOR: COSMOS SW 6528 BY SHERWIN WILLIAMS

SMOOTH FINISH
COLOR: BRACING BLUE SW 6242 BY SHERWIN WILLIAMS

SMOOTH FINISH
COLOR: ELEPHANT EAR SW 9168 BY SHERWIN WILLIAMS

EXTERIOR COLORS



2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, DUPLICATED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:
CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A-9

PROJECT NO: 272-19

PERMIT NO:

REVISIONS	BY

DESCRIPTION:

BUILDING -B
COLOR
ELEVATIONS

SHEET

A-9



BUILDING -B SOUTH ELEVATION

SCALE: 1/8" =1'-0"

- SAND FINISH
COLOR: SNOWBOUND SW 7004 BY SHERWIN WILLIAMS
- SAND FINISH
COLOR: FASHIONABLE GRAY SW 6275 BY SHERWIN WILLIAMS
- SAND FINISH
COLOR: COSMOS SW 6528 BY SHERWIN WILLIAMS
- SMOOTH FINISH
COLOR: BRACING BLUE SW 6242 BY SHERWIN WILLIAMS
- SMOOTH FINISH
COLOR: ELEPHANT EAR SW 9168 BY SHERWIN WILLIAMS

EXTERIOR COLORS



2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, REPRODUCED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:

CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A9.1

PROJECT NO: 272-19

PERMIT NO:

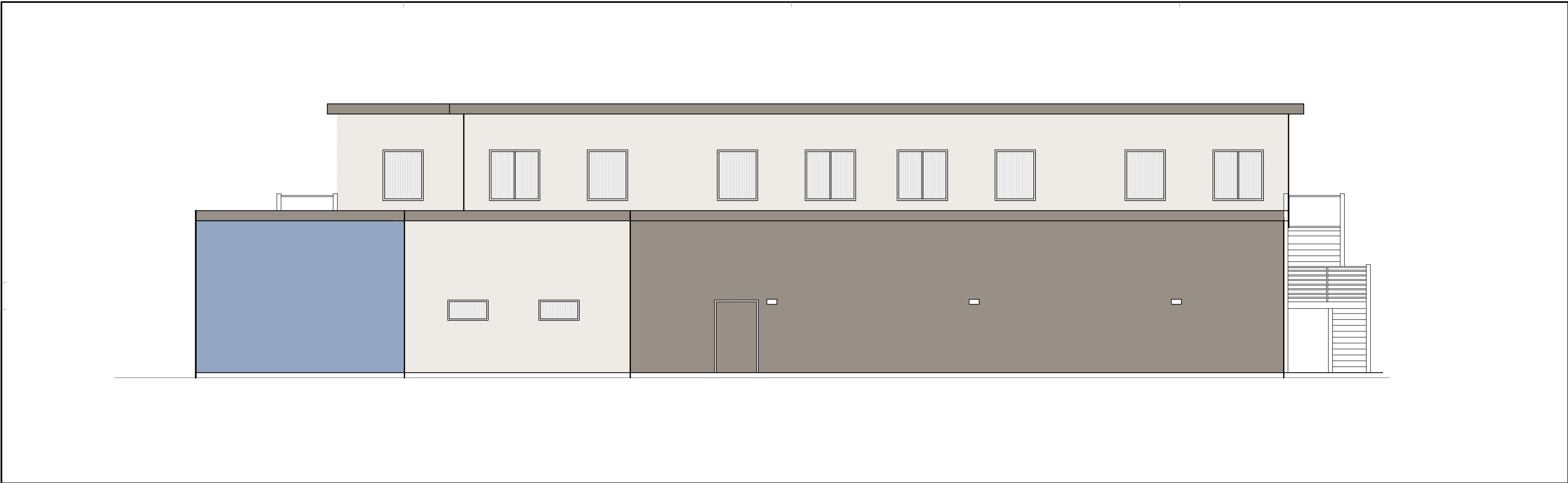
REVISIONS	BY

DESCRIPTION:

BUILDING -B
COLOR
ELEVATIONS

SHEET

A-9.1



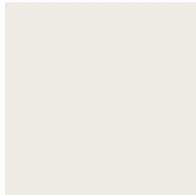
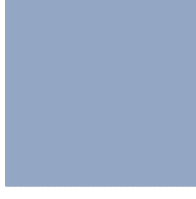
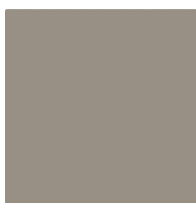
SOUTH ELEVATIONSCALE: 3/16" =1'-0"



WEST ELEVATIONSCALE: 3/16" =1'-0"



EAST ELEVATIONSCALE: 3/16" =1'-0"

-  SAND FINISH
COLOR: SNOWBOUND SW 7004 BY SHERWIN WILLIAMS
-  SAND FINISH
COLOR: FASHIONABLE GRAY SW 6275 BY SHERWIN WILLIAMS
-  SAND FINISH
COLOR: COSMOS SW 6528 BY SHERWIN WILLIAMS
-  SMOOTH FINISH
COLOR: BRACING BLUE SW 6242 BY SHERWIN WILLIAMS
-  SMOOTH FINISH
COLOR: ELEPHANT EAR SW 9168 BY SHERWIN WILLIAMS



2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, DUPLICATED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:
CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE:	MARCH 24, 2020
DRAWN:	ETJ
FILE:	272-19-A10
PROJECT NO:	272-19
PERMIT NO:	
REVISIONS	BY

DESCRIPTION:
BUILDING -C
CAFETERIA COLOR
ELEVATIONS

SHEET

A-10



NORTH ELEVATION

SCALE: 3/16" =1'-0"



2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, REPRODUCED, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORY
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:
CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOCA, CA 95670

DATE: MARCH 24, 2020

DRAWN: ETJ

FILE: 272-19-A10

PROJECT NO: 272-19

PERMIT NO:

REVISIONS	BY

DESCRIPTION:

BUILDING -C
CAFETERIA COLOR
ELEVATIONS

SHEET

A-10.1



2301 Coffee Road #B ♦ Modesto, CA 95354
Phone: 209-408-0674 ♦ edmond@ejarchitect.com

ARCHITECT:

THE DRAWINGS, SPECIFICATIONS, DESIGN AND IDEAS DESCRIBED HEREIN SHALL REMAIN THE PROPERTY OF THE ARCHITECT AND NO PART THEREOF CAN BE COPIED, REPRODUCED, Duplicated, DISCLOSED TO OTHERS OR USED IN CONNECTION WITH ANY WORK OR PROJECT OTHER THAN THE SPECIFIC PROJECT FOR WHICH THEY HAVE BEEN PREPARED AND DEVELOPED WITHOUT EXPRESS WRITTEN PERMISSION OF THE ARCHITECT.

EDMOND T. JACOBS, ARCHITECT COPYRIGHT 2019

CONSULTANT:



Sam Harned
Landscape
Architecture
P.O. Box 2275
Oakdale, CA 95361
209-330-7376
www.samharned.com

PROJECT ADDRESS:

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT
DORMITORIES
BUILDING

PROSPECT PARK DR.
APN # 072-0600-002-00
RANCHO CORDOVA, CA 95670

CLIENT:
CALIFORNIA NORTHSTATE
UNIVERSITY

2910 PROSPECT PARK DR.
RANCHO CORDOVA, CA 95670

DATE: MAY 04, 2020

DRAWN: RSH

FILE: 19-045-PrelimRev01

PROJECT NO: 272-19 (SHLA 19-045)

PERMIT NO:

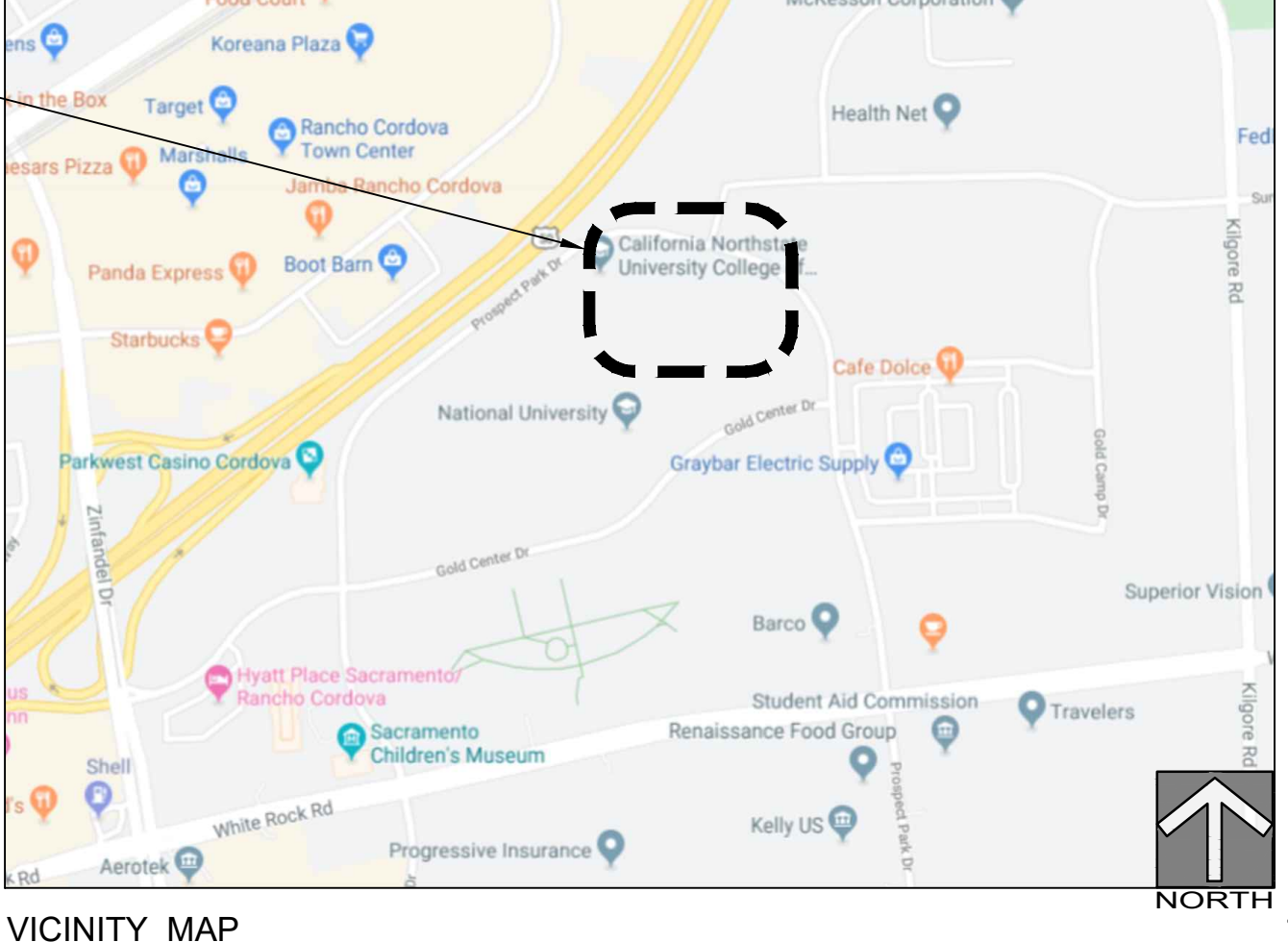
REVISIONS	BY

DESCRIPTION:

PRELIMINARY
LANDSCAPE PLAN

SHEET

L-O.1



VICINITY MAP
not to scale

PRELIMINARY PLANT PALETTE

The Preliminary Plant Palette represents a sampling of the types of plants selected for this project that are suitable for the location and design concept. Plants in the final plan will be selected from this list. Not all plants in the list below will be used and additional plants may be incorporated with the final plans, but the overall design concept represented will be maintained.

Trees
Trees shall be a mix of 15-gallon (min.) and 24" box size. Minimum 25% of trees will be 24" box trees, and 30% of the required trees shall be evergreen; final location of these trees to be determined with improvement plans.

BOTANICAL NAME	COMMON NAME	SIZE	H x W or SPACING	WATER USE RATING
Parking Lot Trees - 21 ea. (min. 10 to be evergreen)				
Celtis occidentalis	Common Hackberry	15-gal	45'x35'	Mod.
Pistacia chinensis 'Keith Davey'	Chinese Pistache	15-gal	40'x35'	Low
Ulmus parvifolia	Chinese Evergreen Elm	15-gal	50'x40'	Mod.
Quercus ilex	Holly Oak	15-gal	40'x50'	Low
Shade Trees - 8 ea.				
Acer rubrum var.	Red Maple	15-gal	40'x25'	Mod.
Platanus racemosa	California Sycamore	15-gal	50'x40'	Low
Quercus lobata	Valley Oak	15-gal	50'x40'	Low
Ulmus parvifolia	Chinese Elm	15-gal	50'x40'	Mod.
Zelkova serrata	Zelkova	15-gal	40'x35'	Mod.
Evergreen / Screen Trees - 5 ea.				
Pinus eldarica	Afghan Pine	15-gal	50'x20'	Low
Pinus pinea	Stone Pine	15-gal	30'x25'	Low
Rhus lancea	Sumac	15-gal	25'x30'	Low
Schinus molle	California Pepper Tree	15-gal	35'x35'	Low
Accent Trees - 15 ea.				
Acer palmatum	Japanese Maple	24" box	20'x20'	Mod.
Cercis canadensis 'Forest Pansy'	Redbud	24" box	20'x25'	Low
Lagerstroemia spp.	Crape Myrtle	24" box	20'x15'	Low

BOTANICAL NAME	COMMON NAME	SIZE	H x W or SPACING	WATER USE RATING
Shrubs				
Upright Evergreen Shrubs				
Cupressus sempervirens 'Tiny Towers'	Italian Cypress (dwarf)	15-gal	8' x 2'	Low
Juniperus virginiana 'Taylor'	Juniper	15-gal	30' x 3'	Low
Thuja occidentalis	Arborvitae	15-gal	12' x 3'	Mod.
Low Hedge				
Callistemon viminalis 'Little John'	Little John Bottlebrush	5-gal	3' x 3'	Low
Ilex vomitoria 'Nana'	Dwarf Yaupon Holly	5-gal	4' x 4'	Low
Nandina domestica 'Compacta'	Heavenly Bamboo	5-gal	4' x 3'	Low
Rhaphiolepis umbellata	Yedda Hawthorn	5-gal	42" x 42"	Mod.
Accent/Flowering Shrub				
Berberis thunbergii	Japanese Barberry	5-gal	5' x 5'	Mod.
Chondropetalum tectorum	Cape Rush	5-gal	3' x 3'	Low
Cistus purpureus	Rockrose	5-gal	4' x 4'	Low
Hemerocallis spp.	Evergreen Daylily	5-gal	3' x 3'	Mod.
Kniphofia hybrid	Red Hot Poker	5-gal	3' x 2'	Low
Lantana camara/hybrid	Lantana	5-gal	2' x 5'	Low
Phormium tenax	New Zealand Flax	5-gal	3' x 4'	Low
Salvia spp.	Sage	5-gal	3' x 3'	Low
Low Shrub				
Dietes vegeta	Fortnight Lily	5-gal	3' x 3'	Low
Nandina domestica 'Gulf Stream'	Heavenly Bamboo	5-gal	4' x 3'	Low
Pittosporum tobira 'Wheeler Dwarf'	Pittosporum	5-gal	2' x 4'	Mod.
Rhaphiolepis indica	India Hawthorn	5-gal	3' x 5'	Mod.

Vines				
Climbing vines planter at dumpster enclosures.				
Ficus pumila	Creeping Fig	1 gal.		Mod.
Parthenocissus tricuspidata	Boston Ivy	1 gal.		Mod.

Groundcovers
Ground cover shall be 1-gallon container size. Spacing varies per species.

BOTANICAL NAME	COMMON NAME	SIZE	H x W or SPACING	WATER USE RATING
Ornamental Grasses and Grasslike Plants				
Calamagrostis acutiflora 'KF'	Feather Reed Grass	1-gal	5' x 42"	Low
Lomandra longifolia 'Breeze'	Dwarf Mat Rush	1-gal	36" x 36"	Low
Muhlenbergia capillaris	Pink Muhly	1-gal	3' x 6'	Low
Muhlenbergia dubia	Pine Muhly	1-gal	30" x 30"	Low
Muhlenbergia rigens	Deer Grass	1-gal	4' x 4'	Low

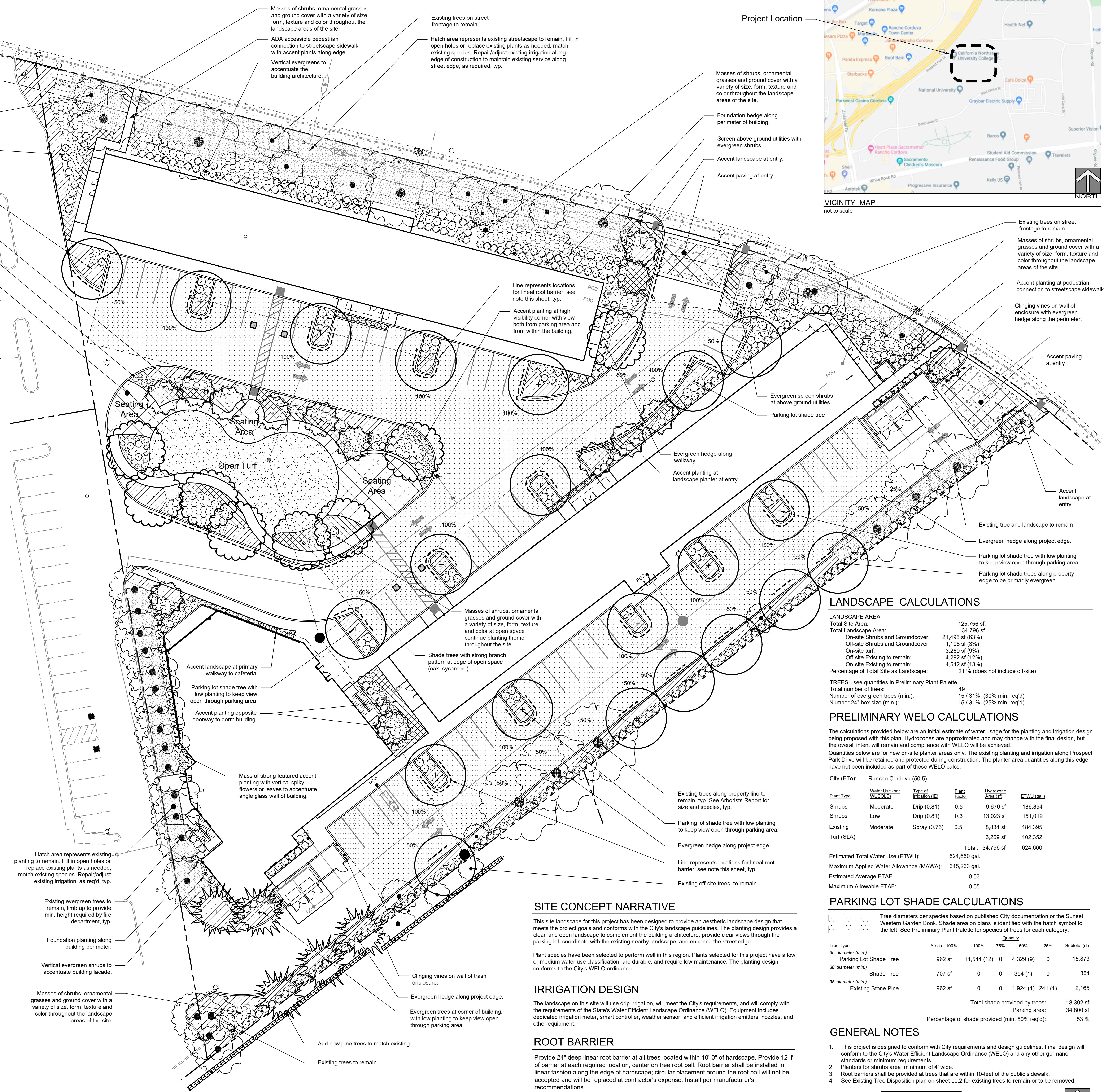
Accent Groundcover				
Dianella revoluta 'Little Rev'	Flax Lily	1-gal	30"x30"	Low
Hemerocallis spp.	Evergreen Daylily	1-gal	3' x 3'	Mod.
Lantana montevidensis	Trailing Lantana	1-gal	2' x 5'	Low
Liriope muscari	Lily Turf	1-gal	18" x 18"	Mod.
Phormium tenax	New Zealand Flax	1-gal	2' x 2'	Low
Teucrium chamaedrys	Germander	1-gal	24" o.c.	Low
Trachelospermum jasminoides	Star Jasmine	1-gal	2' x 7'	Mod.

Spreading Groundcover				
Baccharis pilularis	Dwarf Coyote Brush	1-gal	60" o.c.	Low
Juniperus spp.	Juniper	1-gal	60" o.c.	Low
Myoporum parvifolium	Myoporum	1-gal	60" o.c.	Low
Trachelospermum asiaticum	Asian Jasmine	1-gal	48" o.c.	Mod.

Turf				
Sod, tall type turf fescue or similar blend				

Existing Landscape Area, to remain
Existing landscape area to remain. To be left in native state or augmented with plants matching existing landscape to fill in holes, replace dead plants, or similar.

Mulch
Mulch to be evenly distributed throughout all planters. Mulch to be sourced from recycled material, shredded or chipped (Gonilla Hair is not acceptable), nitrogen stabilized, minimum of 1/4" wide, maximum 3/4". Install at min. 3" depth. Provide sample for approval prior to installation.



LANDSCAPE CALCULATIONS

LANDSCAPE AREA	
Total Site Area:	125,756 sf.
Total Landscape Area:	34,796 sf.
On-site Shrubs and Groundcover:	21,495 sf (63%)
Off-site Shrubs and Groundcover:	1,198 sf (3%)
On-site turf:	3,269 sf (9%)
Off-site Existing to remain:	4,292 sf (12%)
On-site Existing to remain:	4,542 sf (13%)
Percentage of Total Site as Landscape:	21% (does not include off-site)

TREES - see quantities in Preliminary Plant Palette
Total number of trees: 49
Number of evergreen trees (min.): 15 / 31%, (30% min. req'd)
Number 24" box size (min.): 15 / 31%, (25% min. req'd)

PRELIMINARY WELO CALCULATIONS

The calculations provided below are an initial estimate of water usage for the planting and irrigation design being proposed with this plan. Hydrozones are approximated and may change with the final design, but the overall intent will remain and compliance with WELO will be achieved.
Quantities below are for new on-site planter areas only. The existing planting and irrigation along Prospect Park Drive will be retained and protected during construction. The planter area quantities along this edge have not been included as part of these WELO calcs.

City (ETO):	Rancho Cordova (50.5)				
Plant Type	Water Use (per WUCOLS)	Type of Irrigation (IE)	Plant Factor	Hydrozone Area (sf)	ETWU (gal.)
Shrubs	Moderate	Drip (0.81)	0.5	9,670 sf	186,894
Shrubs	Low	Drip (0.81)	0.3	13,023 sf	151,019
Existing	Moderate	Spray (0.75)	0.5	8,834 sf	184,395
Turf (SLA)				3,269 sf	102,352
Total:				34,796 sf	624,660

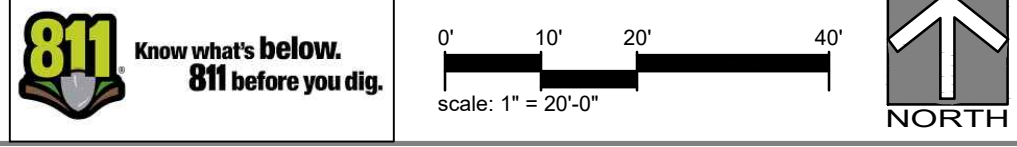
Estimated Total Water Use (ETWU): 624,660 gal.
Maximum Applied Water Allowance (MAWA): 645,263 gal.
Estimated Average ETAF: 0.53
Maximum Allowable ETAF: 0.55

PARKING LOT SHADE CALCULATIONS

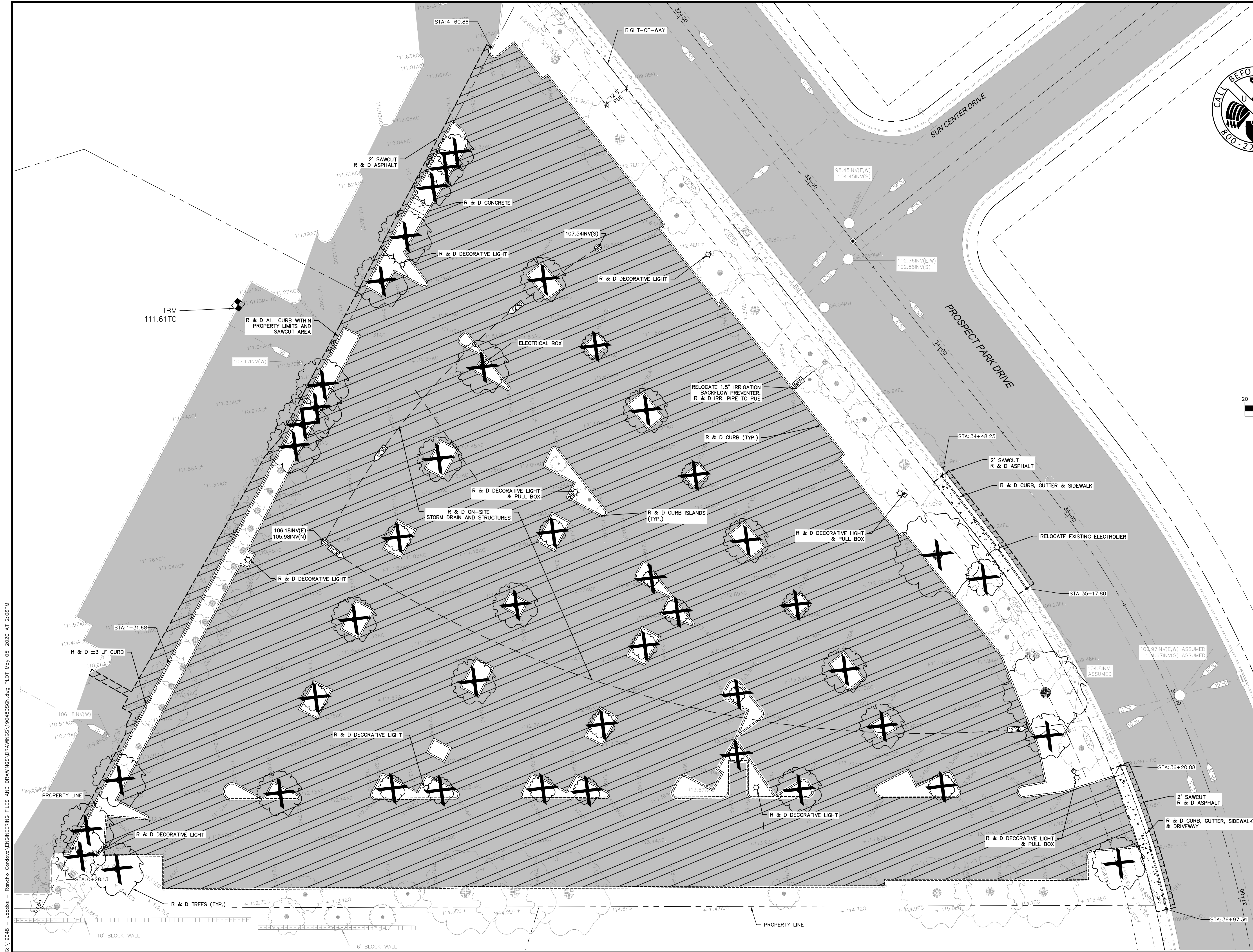
Tree diameters per species based on published City documentation or the Sunset Western Garden Book. Shade area on plans is identified with the hatch symbol to the left. See Preliminary Plant Palette for species of trees for each category.						
Tree Type	Area at 100%	100%	75%	50%	25%	Subtotal (sf)
35' diameter (min.) Parking Lot Shade Tree	962 sf	11,544 (12)	0	4,329 (9)	0	15,873
30' diameter (min.) Shade Tree	707 sf	0	0	354 (1)	0	354
35' diameter (min.) Existing Stone Pine	962 sf	0	0	1,924 (4)	241 (1)	2,165
Total shade provided by trees:						18,392 sf
Parking area:						34,800 sf
Percentage of shade provided (min. 50% req'd):						53%

GENERAL NOTES

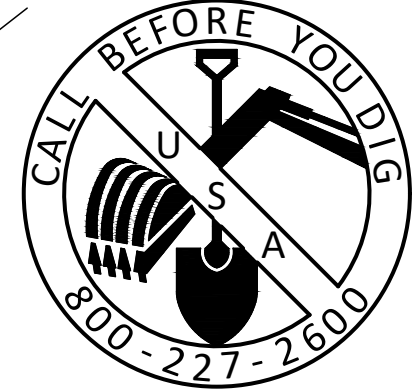
- This project is designed to conform with City requirements and design guidelines. Final design will conform to the City's Water Efficient Landscape Ordinance (WELO) and any other germane standards or minimum requirements.
- Planters for shrubs are a minimum of 4' wide.
- Root barriers shall be provided at trees that are within 10-feet of the public sidewalk.
- See Existing Tree Disposition plan on sheet L0.2 for existing trees to remain or to be removed.



G:\19048 - Jacobs - Rancho Cordova\ENGINEERING FILES AND DRAWINGS\DRAWINGS\19048DSGN.dwg PLOT May 05, 2020 AT 2:06PM



THE WATER & SEWER SERVICES SHOWN ARE SHOWN FIGURATIVELY ONLY. NO ATTEMPT WAS MADE TO LOCATE THE SERVICE. THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL SEWER SERVICES. THIS CAN BE DONE BY POTHOLING OR CLOSED CIRCUIT TELEVISION.

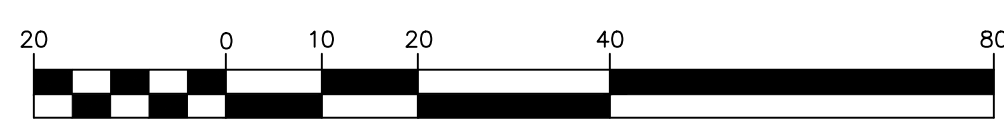
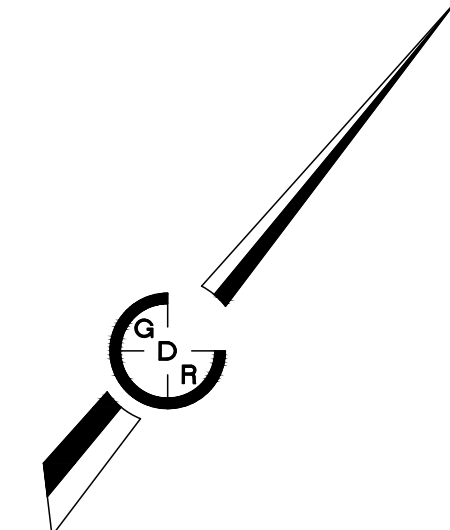


UNDERGROUND FACILITIES SHOWN WERE LOCATED BASED ON INFORMATION PROVIDED BY UTILITY COMPANIES AND BY MEASURING SURFACE FEATURES. NO ATTEMPT WAS MADE TO LOCATE OTHER UNDERGROUND FACILITIES THAT WERE NOT READILY APPARENT FROM A VISUAL INSPECTION OF SURFACE FEATURES.

CONTRACTOR SHALL VERIFY ACTUAL DEPTH AND LOCATION OF ALL EXISTING UTILITIES PRIOR TO CONSTRUCTION...CALL "UNDERGROUND SERVICE ALERT" (U.S.A.), (TOLL FREE (800) 227-2600 PRIOR TO TRENCHING, GRADING, EXCAVATION, DRILLING, PIPE PUSHING, PLANTING TREES, DIGGING POST HOLES FOR FENCES, ETC.(U.S.A.) WILL SUPPLY INFORMATION OR LOCATE AND MARK ANY UNDERGROUND FACILITIES.

NOTE:
EXISTING UNDERGROUND FACILITIES SHOWN ARE APPROXIMATE LOCATIONS IN ACCORDANCE WITH THE UTILITY COMPANIES. EXACT LOCATIONS ARE NOT INDICATED BY THESE UTILITY COMPANIES.

ANY FOUND MONUMENTS AND BENCHMARKS SHOWN HEREON SHALL BE PROTECTED IN-PLACE. IF ANY ARE DESTROYED BY CONSTRUCTION, NEW MONUMENTS SHALL BE REPLACED AND A CORNER RECORD FILED PER SECTION 8771(B)(C) OF THE PROFESSIONAL LAND SURVEYORS' ACT.



SCALE: 1" = 20'

DEMO PAVING LEGEND

- ASPHALT.
- CONCRETE SIDEWALK



DATE SIGNED:

CAUTION:
UNAUTHORIZED CHANGES AND USES

THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE FOR OR LIABLE FOR UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS. ALL CHANGES TO THE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS AND THE CITY ENGINEER.

DESCRIPTION	DATE	BY

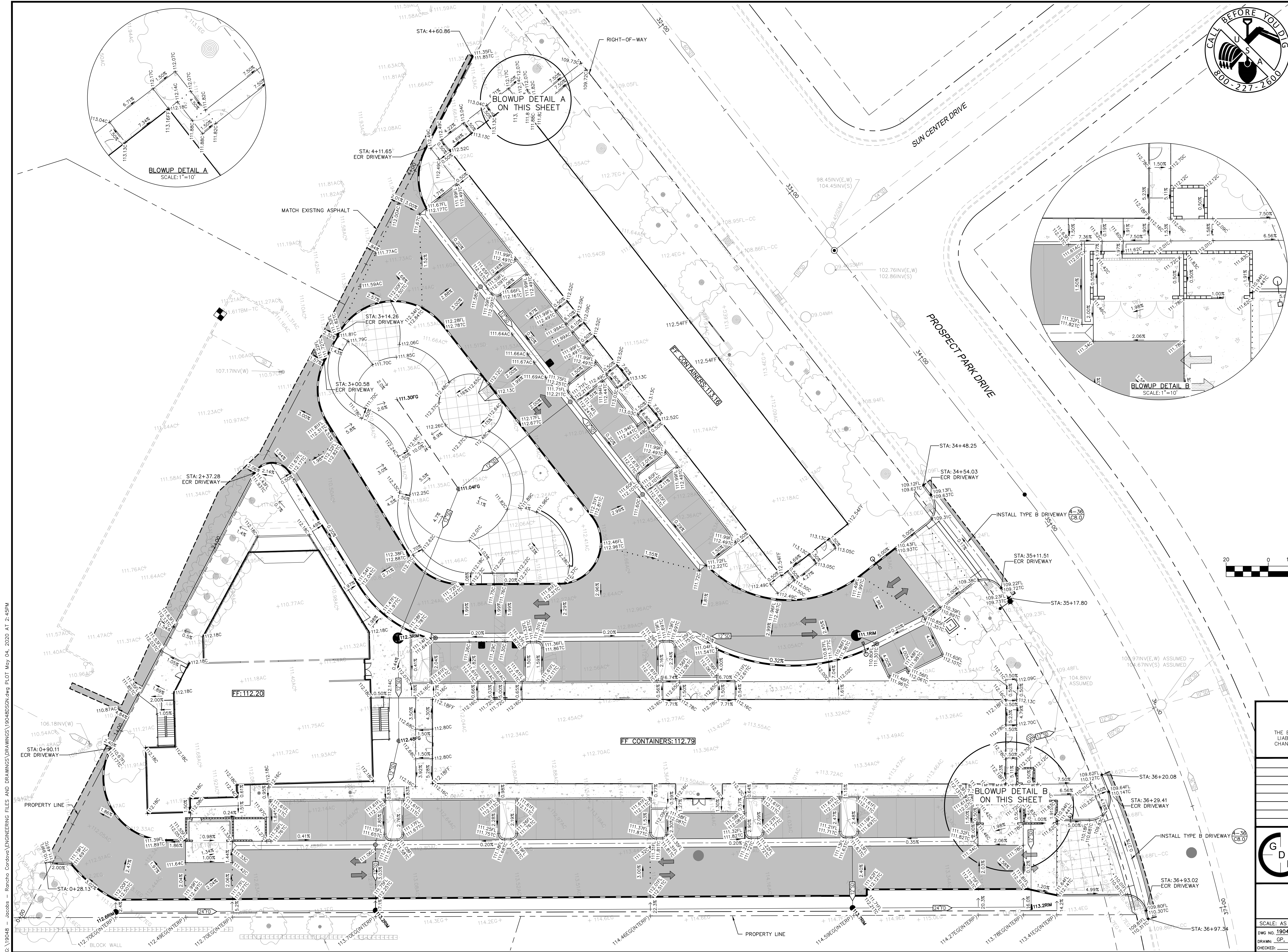
GDR ENGINEERING, INC.
ENGINEERING/SURVEYING/PLANNING
3525 MITCHELL ROAD, SUITE G Ceres, CA 95307
TELEPHONE: (209) 538-3360 FAX: (209) 538-7370
E-MAIL: GDRENGINEERING@GDRENGRC.COM

2910 PROSPECT PARK DRIVE
RANCHO CORDOVA, CA
TOPOGRAPHY MAP

SCALE: AS SHOWN	DATE: 05/05/2020
DWG NO. 19048DSGN.dwg	LAYOUT C3-T&D
DRAWN: GP, JA	SHEET: C3 of 14
CHECKED:	FILE NO. 19048

PRELIMINARY NOT FOR CONSTRUCTION

G:\19048 - Jacobs - Ranchito Cordova\ENGINEERING FILES AND DRAWINGS\DRAWINGS\19048DSGN.dwg PLOT May 04, 2020 AT 2:45PM

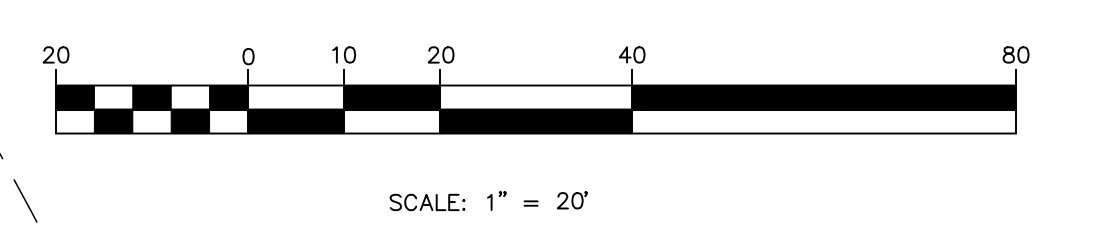
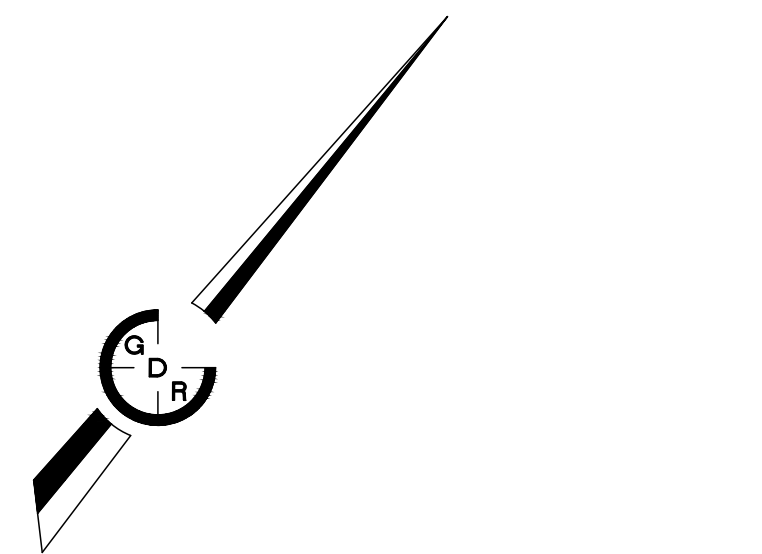


UNDERGROUND FACILITIES SHOWN WERE LOCATED BASED ON INFORMATION PROVIDED BY UTILITY COMPANIES AND BY MEASURING SURFACE FEATURES. NO ATTEMPT WAS MADE TO LOCATE OTHER UNDERGROUND FACILITIES THAT WERE NOT READILY APPARENT FROM A VISUAL INSPECTION OF SURFACE FEATURES.

CONTRACTOR SHALL VERIFY ACTUAL DEPTH AND LOCATION OF ALL EXISTING UTILITIES PRIOR TO CONSTRUCTION...CALL "UNDERGROUND SERVICE ALERT" (U.S.A.), (TOLL FREE (800) 227-2600 PRIOR TO TRENCHING, GRADING, EXCAVATION, DRILLING, PIPE PUSHING, PLANTING TREES, DIGGING POST HOLES FOR FENCES, ETC.(U.S.A.) WILL SUPPLY INFORMATION OR LOCATE AND MARK ANY UNDERGROUND FACILITIES.

- LEGEND**
- DIRECTION OF FLOW
- (A) TYPE 5 CURB (4-30 C&D)
 - (B) TYPE 2 CURB & GUTTER (4-30 C&D)
 - (C) 4' WIDE VALLEY GUTTER (1 C7)
 - (D) TYPE 1 SIDEWALK (4-30 C&D)

- NOTES TO CONTRACTOR:**
- CONTRACTOR SHALL POTHOLE & VERIFY UTILITY POINTS OF CONNECTION PRIOR TO BEGINNING WORK.
 - CONTRACTOR SHALL VERIFY LOCATION AND INVERTS OF EXISTING UTILITIES PRIOR TO CONSTRUCTION AND NOTIFY ENGINEER OF ANY SUBSTANTIAL DIFFERENCE FROM DESIGN. CONNECT TO EXISTING IN CONFORMANCE WITH THE CITY/COUNTY STANDARDS.
 - AN ACCESS PERMIT IS REQUIRED PRIOR TO MAKING CONNECTION. PLEASE ALLOW 10 DAYS FOR APPROVAL.



SCALE: 1" = 20'



DATE SIGNED: _____

CAUTION: UNAUTHORIZED CHANGES AND USES

THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE FOR OR LIABLE FOR UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS. ALL CHANGES TO THE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS AND THE CITY ENGINEER.

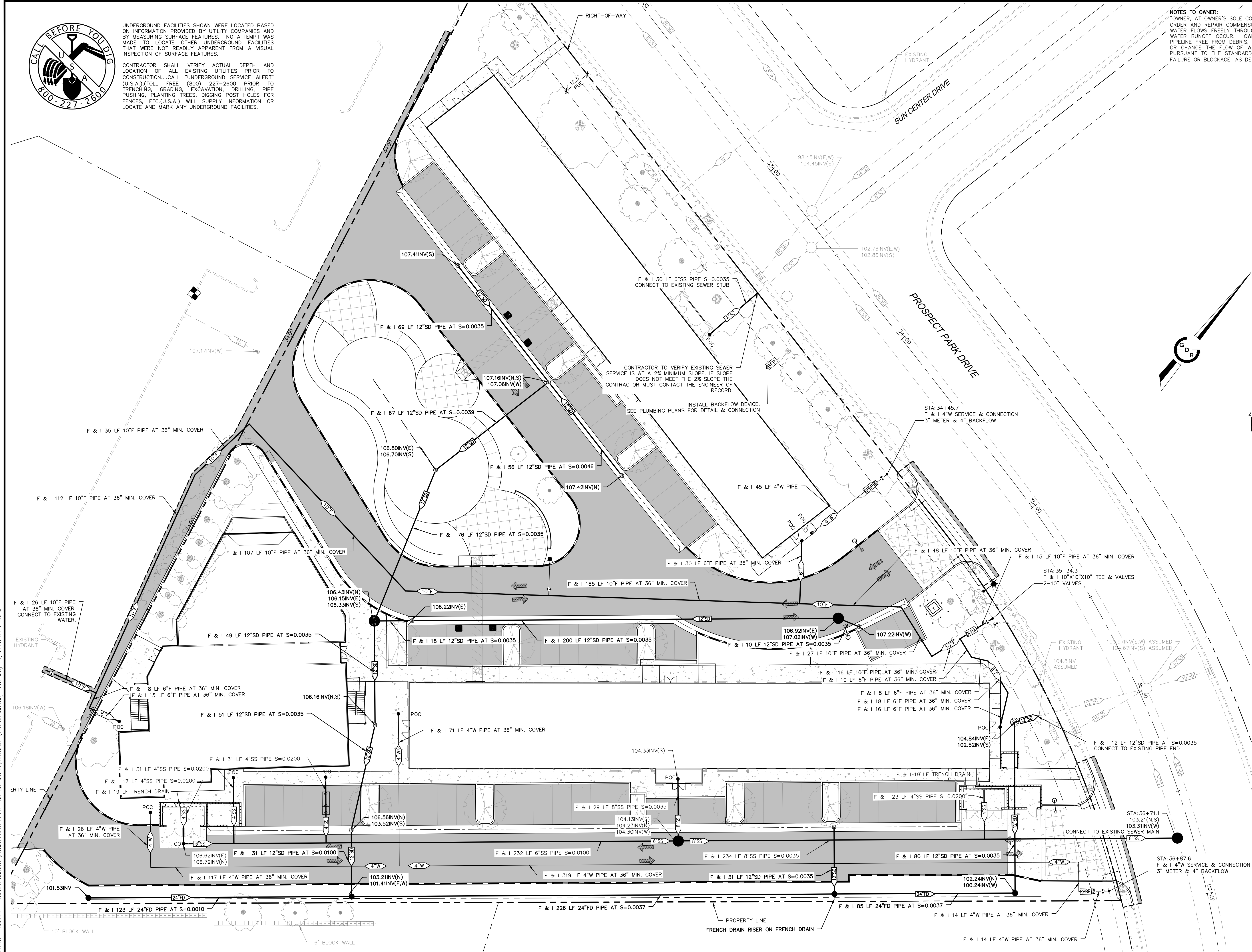
DESCRIPTION			DATE	BY
GDR ENGINEERING, INC.				
ENGINEERING/SURVEYING/PLANNING				
3525 MITCHELL ROAD, SUITE G CERCES, CA 95307				
TELEPHONE: (209) 538-3360 FAX: (209) 538-7370				
E-MAIL: GDRENGINEERING@GDRENG.COM				
2910 PROSPECT PARK DRIVE				
RANCHO CORDOVA, CA				
GRADING PLAN				
SCALE: AS SHOWN		DATE: 04/30/2020		
DWG No. 19048DSGN.dwg	LAYOUT C4-GRD			SHEET: C4 of 14
DRAWN: CP, JA				FILE No. 19048
CHECKED:				

PRELIMINARY NOT FOR CONSTRUCTION



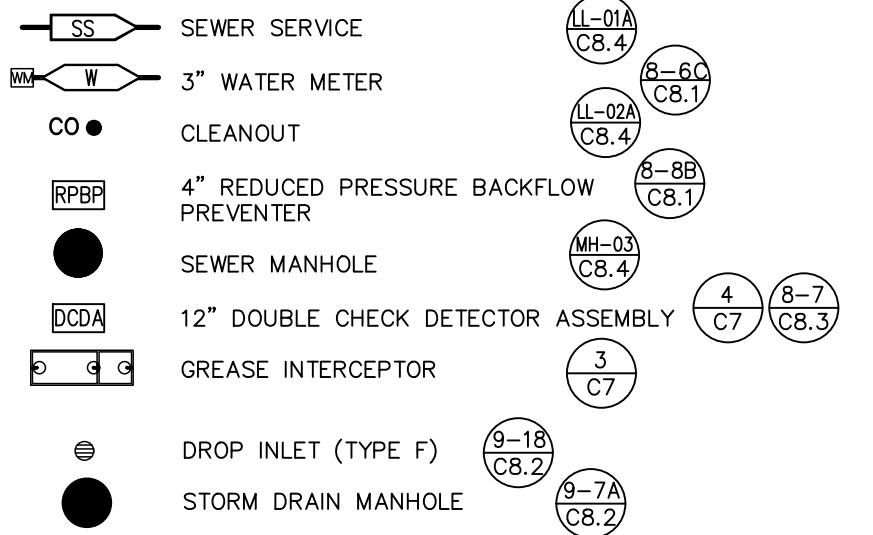
UNDERGROUND FACILITIES SHOWN WERE LOCATED BASED ON INFORMATION PROVIDED BY UTILITY COMPANIES AND BY MEASURING SURFACE FEATURES. NO ATTEMPT WAS MADE TO LOCATE OTHER UNDERGROUND FACILITIES THAT WERE NOT READILY APPARENT FROM A VISUAL INSPECTION OF SURFACE FEATURES.

CONTRACTOR SHALL VERIFY ACTUAL DEPTH AND LOCATION OF ALL EXISTING UTILITIES PRIOR TO CONSTRUCTION...CALL "UNDERGROUND SERVICE ALERT" (U.S.A.), (TOLL FREE (800) 227-2600) PRIOR TO TRENCHING, GRADING, EXCAVATION, DRILLING, PIPE PUSHING, PLANTING TREES, DIGGING POST HOLES FOR FENCES, ETC.(U.S.A.) WILL SUPPLY INFORMATION OR LOCATE AND MARK ANY UNDERGROUND FACILITIES.



NOTES TO OWNER:
OWNER, AT OWNER'S SOLE COST AND EXPENSE, SHALL MAINTAIN THE PRIVATE DRAINAGE PIPELINE IN GOOD WORKING ORDER AND REPAIR COMMENSURATE WITH THE COUNTY'S STANDARDS FOR SIMILAR DRAINAGE PIPELINES SUCH THAT WATER FLOWS FREELY THROUGH THE SYSTEM AS AND WHEN WEATHER EVENTS OR OTHER SOURCES OF SURFACE WATER RUNOFF OCCUR. OWNER SHALL AT ALL TIMES TAKE ALL NECESSARY ACTION TO KEEP THE DRAINAGE PIPELINE FREE FROM DEBRIS, TRASH, FOLIAGE AND ANY OTHER OBSTRUCTION WHICH MAY DISRUPT, ALTER, IMPEDE OR CHANGE THE FLOW OF WATER. OWNER SHALL ALSO PERFORM ANY RELOCATION OF THE DRAINAGE PIPELINE PURSUANT TO THE STANDARD SPECIFICATIONS OF THE COUNTY SHOULD RELOCATION BE NECESSARY DUE TO PIPE FAILURE OR BLOCKAGE, AS DETERMINED NECESSARY BY THE COUNTY."

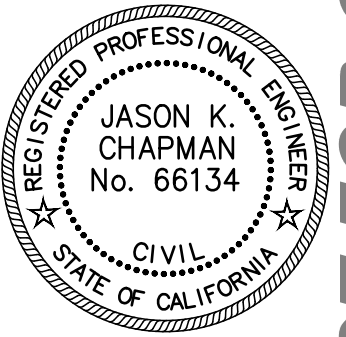
LEGEND



- NOTES TO CONTRACTOR:**
- CONTRACTOR SHALL POTHOLE & VERIFY UTILITY POINTS OF CONNECTION PRIOR TO BEGINNING WORK.
 - CONTRACTOR SHALL VERIFY LOCATION AND INVERTS OF EXISTING UTILITIES PRIOR TO CONSTRUCTION AND NOTIFY ENGINEER OF ANY SUBSTANTIAL DIFFERENCE FROM DESIGN. CONNECT TO EXISTING IN CONFORMANCE WITH THE CITY/COUNTY STANDARDS.
 - WATER LINES, CONDUITS FOR ELECTRICAL OR OTHER UTILITIES SHALL BE LOCATED SO AS TO NOT CONFLICT WITH REQUIRED TREE LOCATIONS FOR STREET AND PARKING LOTS.
 - ON CROSSINGS PROVIDE SEPARATION PER SACRAMENTO COUNTY SERVICES AGENCY 8-10 AND 8-11.
 - SEE SHEET C7.3 FOR SMFD NOTES.
 - AN ACCESS PERMIT IS REQUIRED PRIOR TO MAKING CONNECTION. PLEASE ALLOW 10 DAYS FOR APPROVAL.
 - STORM DRAIN MESSAGES TO BE INSTALLED PER COUNTY STANDARD DETAIL 11-10A & B.



SCALE: 1" = 20'



DATE SIGNED:

"NOT APPROVED FOR PRIVATE UNDERGROUND FIRE SERVICE INSTALLATION." A SEPARATE PLAN SUBMITTAL IS REQUIRED FROM THE INSTALLING CONTRACTORS. SEE THE SACRAMENTO METROPOLITAN FIRE DISTRICT NOTES."

SACRAMENTO METRO FIRE DISTRICT

APPROVED AS TO FIRE SERVICE LOCATION ONLY. MAIN SIZE DETERMINED BY SACRAMENTO SUBURBAN WATER DISTRICT

BY _____ DATE _____

PIPE SCHEDULE

DESCRIPTION	TYPE OF PIPE
STORM DRAIN	POLYVINYL CHLORIDE PIPE (PVC) ASTM D3034-DR35

CAUTION: UNAUTHORIZED CHANGES AND USES

THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE FOR OR LIABLE FOR UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS. ALL CHANGES TO THE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS AND THE CITY ENGINEER.

GDR ENGINEERING, INC.
ENGINEERING/SURVEYING/PLANNING
3525 MITCHELL ROAD, SUITE G CERCES, CA 95307
TELEPHONE: (209) 538-3360 FAX: (209) 538-7370
E-MAIL: GDRENGINEERING@GDRENG.COM

**2910 PROSPECT PARK DRIVE
RANCHO CORDOVA, CA
UTILITY PLAN**

SCALE: AS SHOWN DATE: 04/30/2020
DWG No. 19048DSGN.dwg LAYOUT C6-UT SHEET: C6 OF 14
DRAWN: GP, JA FILE NO.: 19048
CHECKED: _____

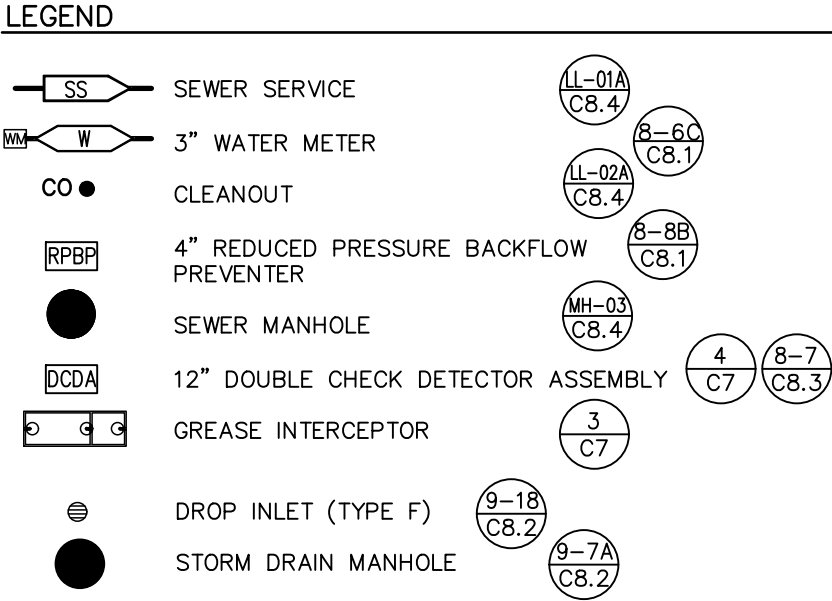
PRELIMINARY NOT FOR CONSTRUCTION



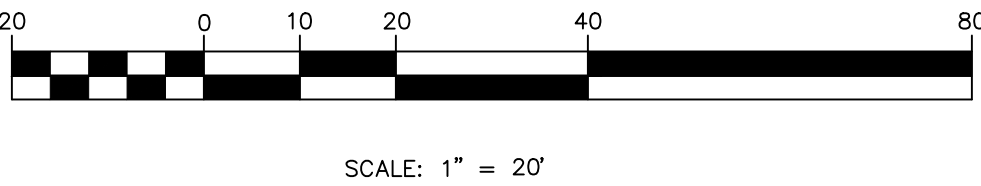
UNDERGROUND FACILITIES SHOWN WERE LOCATED BASED ON INFORMATION PROVIDED BY UTILITY COMPANIES AND BY MEASURING SURFACE FEATURES. NO ATTEMPT WAS MADE TO LOCATE OTHER UNDERGROUND FACILITIES THAT WERE NOT READILY APPARENT FROM A VISUAL INSPECTION OF SURFACE FEATURES.

CONTRACTOR SHALL VERIFY ACTUAL DEPTH AND LOCATION OF ALL EXISTING UTILITIES PRIOR TO CONSTRUCTION...CALL "UNDERGROUND SERVICE ALERT" (U.S.A.), (TOLL FREE (800) 227-2600. PRIOR TO TRENCHING, GRADING, EXCAVATION, DRILLING, PIPE PUSHING, PLANTING TREES, DIGGING POST HOLES FOR FENCES, ETC.(U.S.A.) WILL SUPPLY INFORMATION OR LOCATE AND MARK ANY UNDERGROUND FACILITIES.

NOTES TO OWNER:
OWNER, AT OWNER'S SOLE COST AND EXPENSE, SHALL MAINTAIN THE PRIVATE DRAINAGE PIPELINE IN GOOD WORKING ORDER AND REPAIR COMMENSURATE WITH THE COUNTY'S STANDARDS FOR SIMILAR DRAINAGE PIPELINES SUCH THAT WATER FLOWS FREELY THROUGH THE SYSTEM AS AND WHEN WEATHER EVENTS OR OTHER SOURCES OF SURFACE WATER RUNOFF OCCUR. OWNER SHALL AT ALL TIMES TAKE ALL NECESSARY ACTION TO KEEP THE DRAINAGE PIPELINE FREE FROM DEBRIS, TRASH, FOLIAGE AND ANY OTHER OBSTRUCTION WHICH MAY DISRUPT, ALTER, IMPEDE OR CHANGE THE FLOW OF WATER. OWNER SHALL ALSO PERFORM ANY RELOCATION OF THE DRAINAGE PIPELINE PURSUANT TO THE STANDARD SPECIFICATIONS OF THE COUNTY SHOULD RELOCATION BE NECESSARY DUE TO PIPE FAILURE OR BLOCKAGE, AS DETERMINED NECESSARY BY THE COUNTY."



- NOTES TO CONTRACTOR:**
- CONTRACTOR SHALL POTHOLE & VERIFY UTILITY POINTS OF CONNECTION PRIOR TO BEGINNING WORK.
 - CONTRACTOR SHALL VERIFY LOCATION AND INVERTS OF EXISTING UTILITIES PRIOR TO CONSTRUCTION AND NOTIFY ENGINEER OF ANY SUBSTANTIAL DIFFERENCE FROM DESIGN. CONNECT TO EXISTING IN CONFORMANCE WITH THE CITY/COUNTY STANDARDS.
 - WATER LINES, CONDUITS FOR ELECTRICAL OR OTHER UTILITIES SHALL BE LOCATED SO AS TO NOT CONFLICT WITH REQUIRED TREE LOCATIONS FOR STREET AND PARKING LOTS.
 - ON CROSSINGS PROVIDE SEPARATION PER SACRAMENTO COUNTY SERVICES AGENCY 8-10 AND 8-11.
 - SEE SHEET C7.3 FOR SMFD NOTES.
 - AN ACCESS PERMIT IS REQUIRED PRIOR TO MAKING CONNECTION. PLEASE ALLOW 10 DAYS FOR APPROVAL.



DATE SIGNED:

"NOT APPROVED FOR PRIVATE UNDERGROUND FIRE SERVICE INSTALLATION." A SEPARATE PLAN SUBMITTAL IS REQUIRED FROM THE INSTALLING CONTRACTORS. SEE THE SACRAMENTO METROPOLITAN FIRE DISTRICT NOTES."

SACRAMENTO METRO FIRE DISTRICT

APPROVED AS TO FIRE SERVICE LOCATION ONLY. MAIN SIZE DETERMINED BY SACRAMENTO SUBURBAN WATER DISTRICT

BY _____ DATE _____

PIPE SCHEDULE

DESCRIPTION	TYPE OF PIPE
STORM DRAIN	POLYVINYL CHLORIDE PIPE (PVC) ASTM D3034-DR35

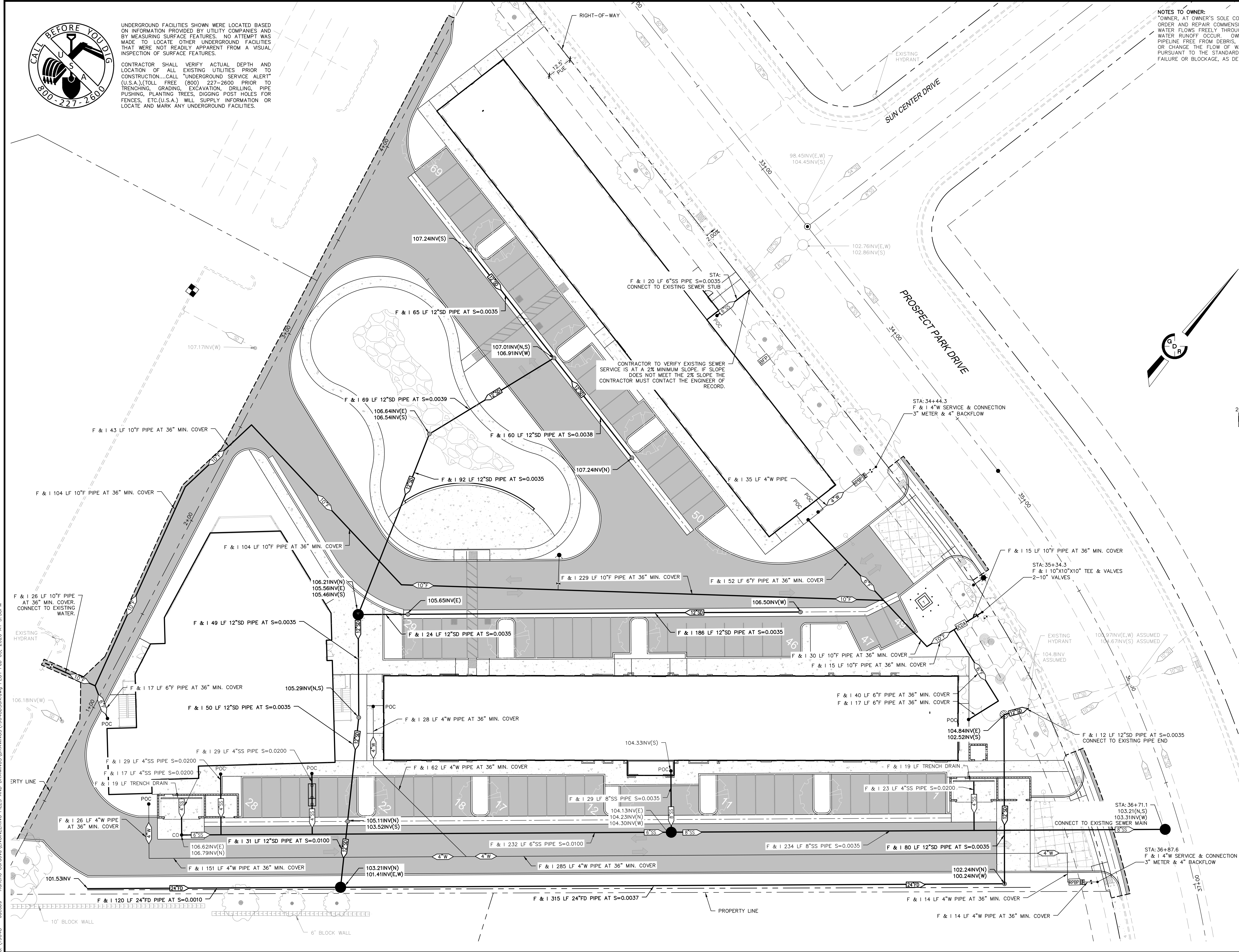
CAUTION: UNAUTHORIZED CHANGES AND USES

THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE FOR OR LIABLE FOR UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS. ALL CHANGES TO THE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS AND THE CITY ENGINEER.

GDR ENGINEERING, INC.
ENGINEERING/SURVEYING/PLANNING
3525 MITCHELL ROAD, SUITE G CERCES, CA 95307
TELEPHONE: (209) 538-3360 FAX: (209) 538-7370
E-MAIL: GDRENGINEERING@GDRENGR.COM

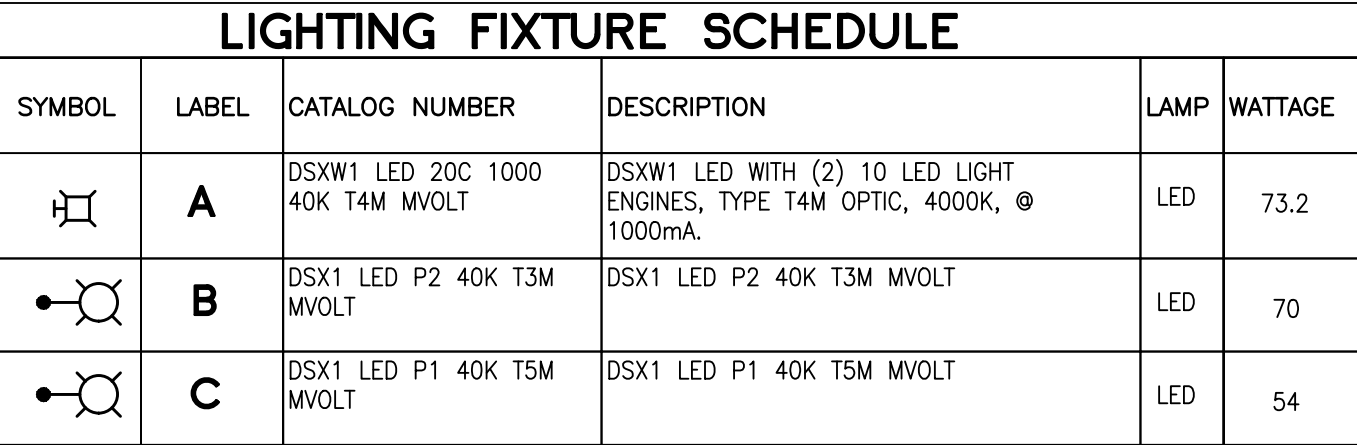
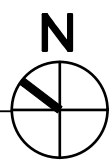
**2910 PROSPECT PARK DRIVE
RANCHO CORDOVA, CA
UTILITY PLAN**

SCALE: AS SHOWN	DATE: 02/03/2020
DWG NO. 19048DSGN.dwg	LAYOUT C6-SS&W
DRAWN: GP, JA	SHEET: C6 OF 14
CHECKED:	FILE NO. 19048



G:\19048 - Jacobs - Rancho Cordova\ENGINEERING FILES AND DRAWINGS\DRAWINGS\19048DSGN.dwg PLOT Feb 03, 2020 AT 3:58PM

PRELIMINARY NOT FOR CONSTRUCTION



ARCHITECT

CONSULTANT



PROJECT ADDRESS

CALIFORNIA
NORTHSTATE
UNIVERSITY

NEW STUDENT DORMITORY BUILDING

CLIENT

CALIFORNIA NORTHSTATE
UNIVERSITY

DATE:

MARCH 25, 2020

DRAWN

CCM

FILE:

272-19

PERMIT NO.

BY

DESCRIPTION

OVERALL SITE PLAN - PHOTOMETRICS

SHEET

E1.0

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
General Conditions					
1.	The approved entitlement is for a Conditional Use Permit and Major Design Review for a new dormitory project for an existing college campus. The project includes two dormitory buildings that will house 400 dorms, a cafeteria with an additional 16 dorms and various onsite improvements associated with the development. The site is located at along Prospect Park Drive at the intersection of Prospect Park Drive and Sun Center Drive APN 072-0600-002-0000. The project is described in the City Council staff report and Exhibit A with the conditions herein, for Project No. DD9919.	Project Description	On-Going	Planning	
2.	The Applicant shall hold harmless the City, its Council Members, officers, agents, employees, and representatives from liability for any award, damages, costs and fees incurred by the City and/or awarded to any plaintiff in an action challenging the validity of this permit or any environmental or other documentation related to approval of this permit. Applicant further agrees to provide a defense for the City in any such action.	General	On-Going	Planning	
3.	Any future alteration to the buildings, change in use, intensification of the site, or modification to the parking and landscaped area must be reviewed by the City to ensure compliance with all local, state, and federal regulations. Minor modifications that are found to be in substantial conformance with the approved plans such as colors, plant materials, or minor lot line adjustments, may be approved administratively. Major modifications shall be approved by the applicable decision making body.	General	On-Going	Planning/ Building /Public Works	
4.	Applicant/Developer shall not carry a negative account balance with the City for the processing of the project. If a negative account balance occurs, it will be the developer's responsibility to pay the balance due, in order to avoid delays in the processing of future	General	On-Going	Finance	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
	permits or recordation of maps. Please email the Finance Department at billings@cityofranchocordova.org for the status of your account with the City.				
5.	The Permit is valid for a period of three (3) years from the date of City Council approval unless an extension is granted by the Community Development Director.	Expiration	On-Going	Planning	
6.	Signage is not approved with this permit. All signage shall comply with the City of Rancho Cordova Zoning Code.	Signage	On-Going	Planning	
7.	Noise sources associated with construction, repair, remodeling, demolition, paving and/or grading of any real property must adhere to the development standards outlined within the City's Noise Element, RCMC 6.68 and RCMC 16.18.1407(F).	Construction	On-Going	Planning/ Building/Code Enforcement	
8.	Applicant shall be responsible for all damage to City streets associated with construction of the project and shall repair any damage as soon as possible.	Construction	On-Going	Public Works	
9.	The removal and replanting of landscape not listed on the approved plan set must be consistent with RCMC 23.716.080 through 23.716.090 and reviewed by the Planning Department prior to the removal. All landscape care, maintenance, and tree pruning must adhere to RCMC 23.716.100 through 23.716.110.	Landscaping	On-Going	Planning	
At Improvement Plans/Grading Permit Issuance					
10.	Applicant shall submit a pre-construction nest survey to the Planning Department for review and acceptance prior to removal of trees and/or site disturbance. The survey must be done no longer than 14 days prior to tree removal and/or site disturbance.	Species	Prior to tree removal and/or site disturbance	Planning	
11.	Number, size, and location of driveways are subject to approval by the Public Works Department.	Infrastructure	Prior to Approval of Improvement Plans	Public Works	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
12.	Applicant shall photo-document the condition of adjacent streets, sidewalks and infrastructure to the satisfaction of the Public Works Department.	Infrastructure	Prior to Approval of Improvement Plans	Public Works	
13.	Enter into a frontage agreement and bond for construction of public improvements per the approved Public Works plans to the satisfaction of the Public Works Department.	Improvement Bond	Prior to Approval of Improvement Plans	Public Works	
14.	A final landscape plan shall be submitted in conjunction with improvement plan and or building permit submittal and approved by the planning and public works departments prior to issuance of permits and/or any installation of landscape materials RCMC 23.716.020. The final landscape planting and irrigation plan shall be prepared by a registered licensed landscape architect and include the following items per RCMC 22.180.060: • Planting plan to scale that indicate slope • Irrigation Plan • Soils Test • Water Use Calculations • Irrigation Schedule • Permeability test for LID facilities' locations • Soil media specifications (LID features)	Landscaping	Prior to Approval of Improvement Plans	Public Works	
15.	Each building with sewage source shall have a separation connection to SASD's sewer system. If there is more than one building in any single parcel and the parcel is not proposed for split, then each building on that parcel must have a separate connection to a private onsite sewer line or a separate connection to the SASD public sewer line. These improvements must be shown on the plans.	Sewer	Prior to Approval of Improvement Plans	SASD	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
16.	Stormwater Quality- Post Construction The improvement plans shall incorporate all applicable post construction stormwater quality measures; including source control, treatment control, low impact development, and full capture trash control measures into the site improvement plans in conformance with the most recent version of the <i>Stormwater Quality Design Manual for the Sacramento Region</i> . The applicant shall prepare and submit a Post-Construction Stormwater Quality Control Plan that includes details and sizing calculations of all the proposed post construction stormwater quality measures. In addition, a maintenance covenant is required for ALL proposed post construction stormwater quality measures, as detailed in Appendix B of the <i>Stormwater Quality Design Manual for the Sacramento Region</i> .	Stormwater	Prior to Approval of Improvement Plans	Public Works	
17.	Stormwater Quality– During Construction: SWPPP- the applicant shall prepare a Storm Water Pollution Prevention Plan (SWPPP) to be executed through all phases of grading and project construction. These measures shall be consistent with the City's Improvement Standards and Land Grading and Erosion Control Ordinance. General Construction Permit – The project applicant shall file a Notice of Intent (NOI) to obtain coverage under the Statewide Construction Stormwater General Permit (Construction General Permit). Applicants shall comply with the terms of the Construction General Permit, the City of Rancho Cordova Municipal Code, and the City's NPDES Permit Requirements.	Stormwater	Prior to Approval of Improvement Plans	Public Works	
18.	All new structures shall be protected from the 100-year (1 percent) flood event. Certified pad elevations (certified by a registered Civil Engineer or licensed Land Surveyor) shall be set at least one and two tenths foot (1.2') above all sources of 100-year flooding (see	Stormwater	Prior to Approval of Improvement Plans	Public Works	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
	Section 9-1 of improvement standards). The overland release path must be shown on the plans and the hydraulic computation must be provided to estimate the flow depths along the overland release paths. The calculations must be in conformance with Section 9-15 Improvement Standards.				
19.	The removal of trees shall adhere to the Topography Map dated May 5, 2020 (Exhibit A of the approved Resolution). Trees shall be replaced or mitigated per Rancho Cordova Municipal Code 19.12.120. Tree replacement is one inch per one-inch ratio. In-lieu payment is \$165 per inch.	Trees	Prior to Approval of Improvement Plans	Public Works	
20.	The Stormwater Pollution Prevention Plan in place for the site shall include a contingency plan for the implementation of a process to remove fine clay sediments prior to discharge to The City of Rancho Cordova's storm drain system and/or Waters of the State (e.g., creeks, rivers) to the satisfaction of the City of Rancho Cordova. A polymer treatment system or comparable process shall be designed in the erosion and sediment control plan of the improvement plans. This system shall be implemented by qualified professionals with training and proven experience in this field. Such treatment shall be accomplished in a manner that does not pose a toxic threat to fish and other aquatic organisms in receiving waters.	Stormwater	Prior to Approval of Improvement Plans	Public Works	
21.	Provide a permanent concrete stamp, or other permanently applied message to the satisfaction of the City not including paint, which reads "No Dumping-Flows to Creek" or other approved message at each storm drain inlet	Signage	Prior to Approval of Improvement Plans	Public Works	
22.	Show the design for a fire access roadway of not less than 20-feet of unobstructed width, 13-feet, 6-inches of vertical clearance, and turning radii of 25 feet inside and 50 feet outside dimension on the improvement plans. The access roadway shall extend to within 150 feet of all portions of the exterior walls of the first story of any	Fire Access	Prior to Approval of Improvement Plans	Fire	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
	proposed building. <i>The use of turf-block or grass-crete or similar alternate road surfaces is not approved for installation in fire apparatus access roadways.</i>				
23.	Show the design for a minimum of 2 remote fire access roadways. Remote fire access roadways shall be spaced a distance apart that is no less than ½ the diagonal measurement of the overall project site.	Fire Access	Prior to Approval of Improvement Plans	Fire	
24.	Show the design for aerial apparatus access. Aerial apparatus access shall conform to Sacramento Metro Fire Districts, Fire Prevention Standard #3.	Fire Access	Prior to Approval of Improvement Plans	Fire	
25.	Show the design for an approved fire apparatus turnaround. The fire apparatus turnaround shall conform to Sacramento Metro Fire Districts, Fire Prevention Standard #3. The fire access turn-around shall be located within 50 feet of the end of the access roadway.	Fire Access	Prior to Approval of Improvement Plans	Fire	
26.	Show on the plan how Fire Lanes will be marked. Fire Lane identification shall be provided along the required fire access roadway. Fire Lane identification shall be in accordance with the Sacramento Metro Fire Districts Fire Prevention Standard #3 and the California Vehicle Code. Vehicle parking is prohibited on any street less than 28 feet in width. Vehicle parking is permitted on both sides of streets 36 feet or more in width. Roadway widths shall be measured between the gutter-line or edge of pavement on opposite sides of the road. Identification of fire apparatus access roadways may be required on private roads.	Fire Access	Prior to Approval of Improvement Plans	Fire	
27.	Provide a note on the plan that reads, "Fire apparatus access roads shall be designed and maintained to support the imposed live load of 80,000 pounds, with a maximum axle load of 31,000 pounds, and meet Public Works Standards for roadways. A report, prepared by a registered geotechnical engineer, verifying the ability of the road to bear the required minimum weight, shall be	Fire Access	Prior to Approval of Improvement Plans	Fire	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
	submitted with any plan indicating construction of roadway. Verification of constructed roadway shall be provided by a registered geotechnical engineer prior to final of the project.”				
28.	Show the location of the required fire hydrants for this project on the improvement plans. Approved fire hydrants capable of providing the required fire flow for the protection of any and all structures shall be located along the fire apparatus access roadway. The required fire hydrants shall be installed and operational prior to any construction or on-site storage of combustible materials. The minimum required fire flow for the protection of commercial developments is 1,500 gallons per minute (gpm) at a pressure of 20 pounds per square inch (psi) for a two-hour duration.				
Prior to Issuance of Building Permits					
29.	Applicant shall complete improvement plans to the satisfaction of the Public Works Department. Improvement plans shall include, but shall not be limited to: • All onsite civil improvements • Civil plan shall include an ADA access plan • Driveways and sidewalk shall be constructed per Sacramento County Improvement Standards • Utility laterals • Replacement of damaged sidewalk and curb and gutter along property frontage to the satisfaction of The Public Works Department. Sidewalk panels shall be replaced to the nearest joint • Public improvement plans shall clearly delineate all transitions to existing improvements	Improvement Plans	Prior to issuance of Building Permits	Public Works	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
	All improvements to be designed and constructed to the satisfaction of the Public Works Department. Complete installation of to satisfaction of the City prior to occupancy				
30.	Property Owner/Applicant shall participate in the provision of funding to provide transit-related services by voting to approve a special tax. The tax shall be the annual amount (with appropriate annual inflation adjustment) as established at the time of voting by the City Council. The election to provide for the tax shall be completed prior to the issuance of building permits. The property owner shall be responsible for paying all costs associated with holding the election. The tax shall be due at the time specified in the ordinance imposing the tax. In addition, the Owner of the property shall hold a deed assessment in the form of Conditions, Covenants & Restrictions against the property, or other form as shall be approved by the City, which assessment will take effect in the event the special tax described in this Condition of Approval is reduced or repealed. Contact: Elizabeth Sparkman at (916) 851-8714 as there may be a 1-2 month lead time to satisfy this condition.	Funding	Prior to issuance of Building Permits	Public Works	
31.	The Landowner shall support the annexation of the Project into the Police Services CFD and cover Landowner's fair-share costs of the CFD annexation, not to exceed \$7,000 for the Property. City agrees that the CFD will provide that on lands designated for all residential land use categories, the base year Police Special Tax shall be \$450.00 annually per residential dwelling unit, including multi-family units. The special tax imposed by the CFD will be payable on a parcel within the Property only after a building permit has been issued by City for the construction of a building on that particular parcel, and there will be no undeveloped land tax imposed by the CFD. The CFD shall further provide that on each July 1 commencing July 1, 2012, the Police Special Tax shall be escalated by the increase, if any, in the City CPI Index. However, in no event shall	Funding	Prior to issuance of Building Permits	Public Works	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
	the tax per parcel for any fiscal year be less than the amount established for the prior fiscal year. The CFD shall specify that the Police Special Tax shall commence being payable annually following the issuance of a building permit for each parcel subject to the Police Special Tax.				
32.	All trash enclosures and refuse areas shall comply with zoning code regulations and all service provider standards regarding amount, design, and access based upon the project's estimated need and waste pickup schedules. Trash enclosures should try to incorporate the same architectural treatments, materials and colors as the main building in order to properly screen them from view. The gate to the trash enclosure shall be an opaque metal gate.	Architectural	Prior to Issuance of Building Permits	Planning	
33.	Bicycle Parking shall be installed in accordance with RCMC 23.719.115. All parking shall be located near main entrances and not impede onsite automobile and pedestrian access. The final design and location will be reviewed and approved by the Planning Department.	Bicycle Parking	Prior to Issuance of Building Permits	Planning	
34.	A final landscape plan shall be submitted to the Planning Department in conjunction with building permit submittal and approved by the Planning and Public Works Departments prior to issuance of permits and/or any installation of landscape materials RCMC 23.716.020. The final landscape planting and irrigation plan shall be prepared by a registered licensed landscape architect and include the following items per RCMC 22.180.060: • Planting plan to scale that indicate slope • Irrigation Plan • Soils Test • Water Use Calculations • Irrigation Schedule	Landscaping	Prior to Issuance of Building Permits	Planning	
35.	Designer shall certify that installed landscaping conforms to City water conservation landscape requirements.	Landscape	Prior to Issuance of	Public Works	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
			Building Permit		
36.	The owner must contact Permit Services Unit at PermitServices@sacsewer.com or by phone at 916-876-6100 to determine if sewer impact fees are due. Fees are to be paid prior to issuance of building permits.	Impact Fees	Prior to Issuance of Building Permit	SASD	
37.	Provide Fire Access Agreement between all parcels connected to and served by fire access. Fire Access Agreement shall be recorded with the Public Records Office having jurisdiction.	Fire	Prior to Final Building Inspection	Fire	
38.	Provide Fire Access Roadway Maintenance Agreement (RMA) between all parcels connected to and served by the fire access roadway. The Fire Access Roadway Maintenance Agreement shall be recorded with the Public Records Office having jurisdiction. The roadway maintenance agreement shall include the following: a) Provisions for the necessary repair and maintenance of the roadway surface. b) Removal of vegetation overgrowing the roadway and infringing on the roadway clear vertical height of thirteen feet six inches (13' 6") or width of twenty feet (20') c) Provisions for the maintenance, repair, and/or replacement of NO PARKING-FIRE LANE signage or striping d) Provisions for the necessary repair and maintenance of vehicle and pedestrian access gates and opening systems	Fire	Prior to Final Building Inspection	Fire	
39.	The applicant shall meet the following: Civil Site Plans and Architectural Plans shall be submitted <u>and</u> approved prior to Final Building Permit being issued. Fire Sprinkler and Fire Alarm plans	Fire	Prior to Final Building Inspection	Fire	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
	shall be <u>submitted</u> prior to Final Building Permit being issued. Please note: The Sacramento Metro Fire District does not allow deferred submittals for Fire Sprinkler and/or Fire Alarm plans. Where a bridge or elevated surface is part of a fire apparatus access road, the bridge shall be constructed and maintained in accordance with AASHTO HB-7.				
Prior to Final inspection/Certificate of Occupancy					
40.	Approved numbers or addresses shall be placed on all new or existing buildings in such a position as to be easily read from the street or road fronting the property. The minimum size of the numbers shall not be less than six (6) inches and shall be mounted immediately adjacent to a light source and shall also contrast with their background.	Fire	Prior to Final Inspection/ Certificate of Occupancy	Fire	
41.	Upon completion of the installation of the landscaping, the designer shall certify that the landscape complies with all city water conserving landscape requirements. Certification shall be accomplished by completion of a certificate of compliance on a form approved by the director of the city public works department. Failure to submit a complete and accurate certificate of compliance will delay final approval of the project and/or discontinue water service per RCMC 22.180.090. Upon receipt of the certificate of compliance and site inspection from City staff, the landscaping performance bond will be released.	Landscaping	Prior to final Building Inspection	Public Works	
42.	Install improvements per the approved Public Works plans and to the satisfaction of the Public Works Department.	Improvements	Prior to final building inspection of the first unit	Public Works	

ITEM 11.1.
California Northstate University Dormitory
DD9900 Conditions of Approval

ATTACHMENT 7
Exhibit D to the Resolution

		<u>Category</u>	<u>Timing/ Implementation</u>	<u>Enforcement/ Monitoring</u>	<u>Verification</u> (date & Signature)
43.	Record drawings of grading and improvement plans (1 full size and 1 half size hard copy), as well as a compact disc containing said plans in AutoCAD and pdf format, and a GIS shape file, or equivalent to the satisfaction of the City Engineer shall be submitted and approved by the Public Works Department.	Drawings	Prior to final building inspection	Public Works	

ITEM 11.1.



tel: 916.455.7300 • fax: 916.244.7300
510 8th Street • Sacramento, CA 95814

May 14, 2020

SENT VIA EMAIL: (dsander@cityofranchocordova.org,
ggatewood@cityofranchocordova.org, dterry@cityofranchocordova.org,
lbudge@cityofranchocordova.org, rmegarvey@cityofranchocordova.org)

Mayor David Sander and Council Members
City of Rancho Cordova
2720 Prospect Park Drive
Rancho Cordova, California 95670

RE: California Northstate University Dormitory Project

Dear Mayor Sander and Council Members,

These comments on the California Northstate University College of Health Sciences (“CNU”) Dormitory Project (“Project”) are submitted on behalf of Goldenberg & Associates Real Estate Investments. The principal of Goldenberg & Associates, Mr. Goldenberg, has been a property owner in Rancho Cordova for over 20 years. Over the years, Mr. Goldenberg has owned and managed approximately 325,000 square feet of commercial property in Rancho Cordova, and still owns several large commercial buildings in the immediate vicinity of the Project. Activities conducted in Mr. Goldenberg’s buildings have brought hundreds of jobs to Rancho Cordova and contributed significantly to the local community and economy.

The proposed five-story Dormitory Project is not compatible with these surrounding commercial uses and changes to the area caused by the 400 room Dormitory, with only one parking space for every three occupants, would interfere with successful tenantry, leasing and operating these existing businesses and cause unanalyzed and potentially significant environmental impacts. As explained below, this project should be carefully and transparently reviewed at a time when the public and local businesses are able to consider the environmental and other effects. Furthermore, the Project cannot be approved because it is not an accessory use as defined in the City’s Zoning Code and other applicable law. Last, the Project would have several environmental impacts for which there was either no consideration in the City’s 2005 General Plan Environmental Impact Report (“EIR”), or for which there are new significant new impacts not considered in 2005.

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 2 of 15

**I. The City Should not Rush Approval of this Controversial Project
During the COVID-19 Pandemic**

The timing of the City's consideration of this controversial Dormitory Project is unacceptable and undermines participation by affected members of the public and nearby businesses. Sacramento County's latest health order, effective today, continues to direct all individuals, except those conducting essential activities, to stay home, and extends the terms of the order to continue social distancing and reducing person-to-person contact to further slow transmission of COVID-19.¹ There have been 1,077 confirmed COVID-19 cases and 43 deaths in our county. State, nation, and world-wide numbers are grimmer. We are in an unprecedented public health emergency.

This is not the time to ask the public to engage on the controversial CNU Dorm Project or to press forward on permitting processes. Governments at every level are focused on fighting the COVID-19 pandemic and the public is focused on the well-being of their families. Most office work is on hold or being conducted remotely. Many of the buildings surrounding the Project site are currently unoccupied, and neighboring businesses are likely unaware of CNU's proposed Project. Indeed, CNU itself is only conducting instruction online due to the COVID-19 pandemic.² A check on the Project site this week revealed empty streets and parking lots; those most affected by the placement of the incompatible Dormitory Project are likely completely unaware of the Project.

The options of virtual meetings are an inadequate substitute for traditional meetings where the public may be heard. Remote meeting options are most appropriate for situations where an agency must conduct its business without delay, for instance in relation to the COVID-19 crisis and other operational necessities. It is also very concerning that the City does not allow the public to verbally comment on agenda items via telephone or webcast, as many other public agencies are doing during the ongoing COVID-19 emergency. Instead, a member of the public must *physically go to City Hall* to be heard. Federal, state and county orders direct people to stay in their homes except to conduct necessary activities. In addition, even if some people are comfortable attending a public meeting at this time, many others have been specifically directed by their doctors not to go out in public for health and/or age reasons. Forcing attendance in person to make a comment in real time to decisionmakers is unconscionable and likely

¹ Order of the Health Officer of the County of Sacramento, May 1, 2020, available at: https://www.saccounty.net/COVID-19/Documents/May1_ExecutedHealthOrder_SignedNewStayathomeOrder-FINAL.pdf.

² See <http://www.cnsu.edu/>.

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 3 of 15

violates Equal Protection rights of protected classes of individuals. Thus, a decision on this Project should only occur after businesses and residents are able to move more freely about, and meaningfully participate in the City's public processes. To proceed otherwise undermines the investment of innumerable businesses in this area and would be unlawful under both the City's Zoning Code as well as the California Environmental Quality Act (Pub. Resources Code, § 21000 et seq. ["CEQA"]).

II. The Scope of the Project is Not Defined

According to the staff Report, housing "options are limited for perspective students relocating from another country" and "[l]ocating the dormitory on a parcel adjacent to the existing university, provides students with the necessary housing they need in order to be close to the campus." (Staff Report, p. 2.) It is unclear, however, how many students CNU currently enrolls or what the planned enrollment is for the future. An inquiry to CNU via telephone did not yield an answer to this seemingly simple question, though an invitation to come to the facility during business hours was extended to find out more about the school. City staff also could not answer the enrollment question. From the size of the existing facility (45,000 square feet), it seems very possible that the school currently serves far fewer than the 400 students who would reside in the new dormitory.

To the extent the Dorm Project would be part of an expansion of the number of students enrolled at the school, that should be disclosed now to avoid impermissibly piecemealing environmental review. A lead agency under CEQA may not avoid including analysis of smaller or related projects that actually comprise part of the larger project. This rule prohibiting "piecemealing" is intended to assure "that environmental considerations not become submerged by chopping a large project into many little ones, each with a potential impact on the environment, which cumulatively may have disastrous consequences." (*Burbank-Glendale-Pasadena Airport Authority v. Hensler* (1991) 233 Cal.App.3d 577, 592.) Delaying analysis and mitigation of an impact until the permitting phase of a project conflicts with CEQA's policy of integrated review (Pub. Resources Code, § 21003, subd. (a)), and such deferral is therefore impermissible. (*Banning Ranch Conservancy v. City of Newport Beach* (2017) 2 Cal.5th 918, 939-41.)

It is unclear how many students are or will be enrolled in the CNU, and whether the Dorm Project is just a part of a larger planned expansion that would have additional environmental impacts. The City must disclose the entire action proposed, and then analyze that action under CEQA. Nothing in the Staff Report or the 2005 General Plan EIR addresses this fundamental issue.

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 4 of 15

III. The Project is Not an Accessory Use and is Incompatible with the Zoning Code, Precluding Conditional Use Permit Issuance

According to the April 20, 2020 Staff Report, the City Council approved a code amendment allowing dormitory housing as an accessory use to public and private schools, subject to a conditional use permit. Staff have explained that this change was made at the request of CNU. The Project, however, is not an accessory to the existing CNU facility. (Staff Report, p. 1.) The proposed Project is five stories tall, and is substantially larger in area than the CNU school itself, located at 2910 Prospect Park Drive; the two proposed Dormitories and cafeteria total 107,822 square feet while the CNU facility is 45,000 square feet. The Project is also not on the same parcel as the existing CNU facility. In fact, the other nearby building at 2920 Prospect Park Drive, which currently conducts activities unrelated to the CNU school, is closer to the proposed dormitory building than to CNU's existing facility.

The Rancho Cordova Municipal Code ("RCMC") does not provide a definition of accessory use, which in itself is unconstitutionally vague. It is not clear what constitutes an accessory use as opposed to a primary use. However, the RCMC does offer definitions of accessory dwelling units, structures, and specific uses that all suggest the Project is incompatible with the well-established definition of accessory use.

Under RCMC section 23.1104.020, accessory dwelling units and accessory structures both must be on the same lot or parcel as the primary building. Under the same section, accessory uses for religious institutions, retail, tasting rooms, and major vehicle services all occur on the same parcel. Moreover, retail accessory uses are limited in size based on the total square footage of the primary use. These limitations are all consistent with the generally understood definition of accessory use.

Accessory use incorporates two concepts: that the use must not be the primary use of the property; and that the use must be attendant or concomitant. (*Cleveland National Forest Foundation v. County of San Diego* (2019) 37 Cal.App.5th 1021, 1047, fn. 11, citing *Lawrence v. Zoning Bd. of Appeals of North Branford* (1969) 158 Conn. 509, 554; see also Lindgren & Mattas, CEB California Land Use Practice, § 4.46 (2018) ("Accessory uses are structures or activities that are subordinate in area, extent, and purpose to the principal use; contribute to the comfort, convenience, or the necessity of the principal use; and are located on the same lot and in the same zoning district as the principal use.")). Other jurisdictions have recognized that the size of the principal and the accessory use is a relevant factor in determining whether the use is subordinate or minor. (See *Melton v. Monroe County* (1993) 622 So. 2d 481, 483 [holding that a 2,000 square foot, 300 foot long dock was not an accessory use because it was "not subordinate in area

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 5 of 15

to the principal structure”]; see also *Gallagher v. Board of Appeals Acton* (1997) 687 N.E.2d 1277,1279 [finding that an addition to an existing residential use was not an accessory because the addition was three times the size of the existing residence].)

The City’s proposal to allow dormitories as accessory use to schools, without any requirements or restrictions based on size or location, render the word “accessory” meaningless. Regardless, the Project does not in any way conform with the basic definition of accessory use, as the two dormitories and the cafeteria would be the primary and only use on the subject parcel, and are not on the same parcel as the school they are purportedly incidental to, and other unrelated buildings are closer to the proposed dormitories than the CNU school. In addition, the cumulative square footage of the Dormitories and cafeteria themselves would be substantially larger than the CNU school facility.

As the Project cannot be characterized as an accessory use, it is inconsistent with the Zoning Code and the City cannot make the necessary finding to support issuance of a Conditional Use Permit (“CUP”). (RCMC, § 23.134.070, subd. D [Approval Findings: “The project meets the requirements of the zoning code including development standards, design guidelines, and special use provisions.].) The California Supreme Court has explained that a “findings requirement serves to conduce the administrative body to draw legally relevant sub-conclusions supportive of its ultimate decision.” (*Topanga Association for a Scenic Community v. County of Los Angeles* (1974) 11 Cal.3d 506, 516 [*Topanga*].)

Further, the *Topanga* court established that “implicit in section 1094.5 is a requirement that an agency which renders the challenged decision must set forth findings to bridge the analytical gap between the raw evidence and the ultimate decision.” (*Topanga, supra*, 11 Cal.3d at 515.) Instead of providing such evidence, the City’s CUP Resolution merely restates the conclusion that “project complies with all applicable standards and guidelines included in the Rancho Cordova Municipal Code.” The agency’s failure to provide supporting evidence as to how the project is an accessory use to the existing CNU campus fails to “bridge the analytical gap between the raw evidence and ultimate decision” as required by *Topanga*. (*Ibid.*)

Likewise, the City’s CUP Resolution fails to provide evidence supporting the required finding that “The negative impacts of the proposed use on adjacent properties and on the public can be mitigated through application of other code standards or other reasonable conditions of approval.” (RCMC, § 23.134.070, subd. B.) Instead of providing evidence to support a finding that impacts on adjacent properties have been mitigated, the CUP Resolution concludes without any support that “The project would

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 6 of 15

not have any negative impacts on adjacent properties or the public.” Examples of numerous negative impacts on adjacent properties are described in this letter. Thus, the City’s CUP findings do not make the relevant sub-conclusion necessary to support the issuance of a CUP, violating *Topanga*.

IV. The City Must Conduct Environmental Review of Project-Specific Impacts Prior to Consideration of the Project

The Staff Report for the April 20, 2020 City Council meeting (“Staff Report”) contends that CEQA review is not required for the Project due to the exemption found in Public Resources Code section 21083.3 and 14 CCR (“CEQA Guidelines”) section 15183. (Staff Report, pp. 12-13.) Yet reliance on the exemption is misplaced, and environmental review of the Project is required.

Public Resources Code section 21083.3 provides for streamlined review under CEQA for projects that are consistent with development densities established by existing community plans for which an EIR has been certified. In such instances, CEQA review is limited to environmental impacts peculiar to the parcel or project that were either not addressed as significant impacts in the underlying EIR or for which substantial new information shows the impact will be more significant than previously described. (Pub. Resources Code, § 21083.3, subd. (a).)

A project will not be covered by the underlying EIR for the general plan if there is a fair argument regarding the existence of a reasonably foreseeable project-specific significant change in the environment that is peculiar to the project or its location. (*Wal-Mart Stores, Inc. v. City of Turlock* (2006) 138 Cal.App.4th 273, 288 (*Turlock*) [overruled on other grounds]; see also *Gentry v. City of Murrieta* (1995) 36 Cal.App.4th 1359, 1406, fn. 24 (*Gentry*)). Here there are both environmental impacts that were not considered in the 2005 General Plan EIR and substantial new information regarding impacts previously addressed in the General Plan EIR. Therefore, the City must prepare a new EIR in order to disclose and analyze potentially significant impacts peculiar to the Project.

A. Potentially Significant Impacts Not Addressed in the General Plan EIR

The impacts discussed below were not evaluated in the 2005 General Plan EIR but are reasonably foreseeable and peculiar to the Project.

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 7 of 15

1. Greenhouse Gas Emissions

As the Staff Report notes, lead agencies were not required to evaluate greenhouse gas (“GHG”) emissions when the General Plan and the EIR were initially prepared. (Staff Report, p. 12.) This is correct, but this does not absolve the City of its duty to evaluate this Project’s GHG emission impacts. The Staff Report relies on *Citizens for Responsible Equitable Environmental Development v. City of San Diego* (2011) 196 Cal.App.4th 515 (*CREED*) to support its continued avoidance of evaluating GHG emissions. (Staff Report, pp. 12-13.) This reliance is misplaced. In *Creed* the issue was whether an addendum to a previously prepared EIR needed to address GHG emissions based on new information. (*CREED, supra*, 196 Cal.App.4th at 530-531.) The court ruled that information regarding GHG emission impacts was in fact known at the time the EIR was approved and did not constitute new information. (*Ibid.*) Therefore, under Public Resources Code section 21166, a supplemental EIR was not required. (*Ibid.*)

Here, however, Public Resources Code section 21166 does not apply, and the validity of the General Plan EIR is not at issue. Under Public Resources Code section 21083.3 and CEQA Guidelines section 15183, the relevant inquiry now is whether the underlying EIR ever considered a potentially significant impact. The Staff Report makes clear that the 2005 General Plan EIR did not evaluate GHG emissions.

This is not a challenge to the 2005 General Plan EIR, nor is it a suggestion that subsequent review of the General Plan’s GHG emissions must be analyzed. Public Resources Code section 21083.3 and CEQA Guidelines section 15183 are clear: even if a project is consistent with a general plan, it must analyze environmental effects that were not addressed in the EIR for the general plan. The 2005 General Plan EIR did not address GHG emissions, and therefore, the City must now analyze this Project’s GHG emission impacts. To suggest otherwise would preclude GHG emission analysis for all projects consistent with the General Plan, until the General Plan is updated and a new EIR is prepared. This approach is untenable and irresponsible.

As to the substantial evidence supporting the existence of a reasonably foreseeable project-specific GHG emissions impact, the City need only consider the description of the Project itself. Project construction would include substantial truck trips, including those to move the prefabricated materials necessary for modular construction. Any vehicle used to transport construction materials would create GHG emissions. Additionally, the Project’s residents would generate additional trips over the existing use. (Staff Report, p. 12.) These vehicles would also create GHG emissions.

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 8 of 15

Similar dormitory projects from the City of Davis demonstrate that construction and operation of dormitories can have a significant GHG emission impact. (See Exhibit 1, Draft EIR for Lincoln40 Project, pp. 4.2-34 to 4.2-37, 4.2-51 to 4.2-55; Exhibit 2, Draft EIR for Nishi Gateway Project, pp. 4.7-1 to 4.7-28.) The similarities between this Project and the dormitories in Davis support a fair argument that the Project would have a significant GHG emission impact.

The Sacramento Metropolitan Air Quality Management District (“SMAQMD”) began providing guidance on GHG analysis for purposes of CEQA in 2009 and has continually updated that guidance, most recently in April 2020. (See Exhibit 3, SMAQMD CEQA Guidance, p. 6-6.) SMAQMD recommends lead agencies conduct GHG analysis and mitigation on the programmatic level but offers guidance for conducting such analysis and mitigation on the project level for those jurisdictions that do not have a reduction plan or other programmatic analysis. (*Id.* at 6-2.) SMAQMD’s guidance even provides significance thresholds for both construction and operation of land development projects. (See Exhibit 4, SMAQMD Thresholds of Significance Table.) That SMAQMD’s GHG emissions guidance contemplates application to individual construction projects further supports a fair argument that the Project would have a significant GHG emission impact.

In light of this substantial evidence supporting a fair argument that the Project would have a significant GHG emissions impact, the Project is not exempt under Public Resources Code section 21083.3 and CEQA Guidelines section 15183, and the City must conduct the necessary environmental review of the Project’s GHG impact.

2. Energy Consumption

Appendix F of the CEQA guidelines explains that: “Potentially significant energy implications of a project should be considered in an EIR [to the extent relevant and applicable to the project]. The following list of energy impact possibilities and potential conservation measures is designed to assist in the preparation of an EIR. In many instances specific items may not apply or additional items may be needed.” Appendix F discusses how energy consumption and conservation may be analyzed in the EIR. (See *Tracy First v. City of Tracy* (2009) 177 Cal.App.4th 912, 930.)

An EIR must also include a statement concerning “[m]itigation measures proposed to minimize significant effects on the environment, including, but not limited to, measures to reduce the wasteful, inefficient, and unnecessary consumption of energy.” (Pub. Resources Code, § 21100, subd. (b)(3).) The requirement to adopt energy impact mitigation measures “is substantive and not procedural in nature and was enacted for the

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 9 of 15

purpose of requiring the lead agencies to focus upon the energy problem in the preparation of the final EIR.” (*People v. County of Kern* (1976) 62 Cal.App.3d 761, 774.) Furthermore, “Energy conservation measures, as well as other appropriate mitigation measures, shall be discussed when relevant. Examples of energy conservation measures are provided in Appendix F.” (CEQA Guidelines, § 15126.4, subd. (a)(1)(C).)

Here, the 2005 General Plan only considered whether build out would require new infrastructure and did not consider energy impacts of that buildout. (See GP Draft EIR, p. 4.12-104 [“Impact 4.12.8.1: Implementation of the General Plan would substantially increase demand for electrical, natural gas, telephone and related infrastructure. This is considered a less than significant impact.”].) Yet, as explained above, since at least 2009, lead agencies are required to evaluate a project’s energy consumption. (CEQA Guidelines, Appen. F; see *Ukiah Citizens for Safety First v. City of Ukiah* (2016) 248 Cal.App.4th 256, 262-267; *California Clean Energy Committee v. City of Woodland* (2014) 225 Cal.App.4th 173, 206-211.) Because the City did not analyze energy consumption impacts in the General Plan EIR, it must now analyze the energy consumption impacts of the Project. (Pub. Resources Code, § 21083.3, subd. (a)-(b); CEQA Guidelines, § 15183, subd. (a)-(b).) The City must also propose mitigation measures for those impacts if they are significant. (Pub. Resources Code, § 21100, subd. (b)(3); see also CEQA Guidelines, § 15126.4, subd. (a)(1)(C).)

The Dormitory Project is large and would require energy to construct, as well as to operate for its useful lifetime. This is a potentially significant effect of the Project. Yet these energy demands, and means to reduce them consistent with CEQA, have not been disclosed or analyzed.

The dormitory projects in Davis illustrate how construction of a large-scale residential project could cause significant energy consumption impacts. (See Exhibit 1, Lincoln40 Draft EIR, pp. 5-5 to 5-12; Exhibit 2, Nishi Draft EIR, pp. 4.7-25 to 4.7-26.) Energy consumption, particularly during the construction phase, will always be a potentially significant impact for large-scale residential development projects. In light of this substantial evidence supporting a fair argument that the Project would have a significant energy consumption impact, the Project is not exempt under Public Resources Code section 21083.3 and CEQA Guidelines section 15183 and the City must conduct the necessary environmental review.

3. Vehicle Miles Traveled

CEQA Guidelines section 15064.3, pursuant significance for transportation impacts, effectively replacing automobile or level of service (“LOS”) delay. The City

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 10 of 15

understandably did not analyze the General Plan's VMT impacts in 2005. However, the fact that VMT analysis was not legally mandated in 2005 does not absolve the City from conducting this analysis now. Public Resources Code section 21083.3 and CEQA Guidelines 15183 therefore do not exempt the City of its duty to conduct VMT analysis.

While CEQA Guidelines section 15064.3 does not apply statewide until July 1, 2020, this does not necessarily absolve the City of its duty to analyze VMT either. Recent caselaw, *Citizens for Positive Growth & Preservation v. City of Sacramento* (2019) 43 Cal.App.5th 609, reaffirmed thatto Public Resources Code section 21099, establishes Vehicle Miles Traveled ("VMT") as the appropriate threshold of

:

In mandamus proceedings like this one, "the law to be applied is that which is current at the time of judgment in the appellate court." (*Callie v. Board of Supervisors* (1969) 1 Cal.App.3d 13, 18–19; see also *Fairbank v. City of Mill Valley* (1999) 75 Cal.App.4th 1243, 1255–1257, fn. 12 ["where no vested rights will be impaired, it is appropriate for an appellate court to apply the law in existence at the time of its decision rather than at the time an approval was issued"].)

(*Id.* at 626.) In practical terms, this language requires the City to have prepared a transportation analysis based on VMT. Any judicial determination regarding the adequacy of any analysis by the City will almost certainly occur after July 1, 2020, and thus the law in effect at that time, including CEQA Guidelines section 15064.3, will apply. The prudent choice would be for the City to conduct adequate analysis of the Project's VMT impacts prior to approval rather than risk facing a legal challenge having conducted no review at all.

The Staff Report indicates that the Project would generate a net increase of 644 daily trips, 6 A.M. peak hour trips and 86 P.M. peak hour trips. (Staff Report, p. 12.) While these numbers may be below the City's thresholds of significance for vehicle trip generation, the extent of the Project's VMT impact is readily apparent. However, the City has already recognized that the Project will cause increases in traffic. The prospect of increased traffic alone supports a fair argument that the Project could have a significant VMT impact.

The City appears to not have prepared any thresholds of significance for VMT. This cannot excuse a failure to evaluate VMT as an impact, as case law provides that "a lead agency has a duty to inform itself about available methodologies for assessing an impact." (*Berkeley Keep Jets Over the Bay Comm. v. Board of Port Comm'rs* (2001) 91

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 11 of 15

Cal.App.4th 1344, 1367.) OPR has provided and updated a Technical Advisory on Evaluating Transportation Impacts in CEQA since September 2017. In an effort to assist the City in informing itself on this issue, we attach a copy of OPR's most recent Technical Advisory, prepared in December 2018. (See Exhibit 5.)

B. New Information Regarding Impacts Previously Analyzed in the General Plan EIR

The following impacts were initially addressed in the 2005 General Plan EIR. However new information regarding the severity of the impacts have become known since 2005. Thus, the City must conduct analysis of Project-specific impacts in these areas.

1. Health Risk Assessment of Toxic Air Contaminant Emissions and Ultra-fine Particulates

The understanding of the health risks of Toxic Air Contaminants ("TAC") has evolved considerably since 2005. The late Dr. Thomas A. Cahill, professor of physics and atmospheric sciences at University of California, Davis published over 260 peer-reviewed articles and was recognized as an authority on mobile-source TAC emissions. (Exhibit 6, Cahill, Comments and Attachments on Nishi Project, pp. 2010-2012].)³ In 2018, Dr. Cahill commented extensively on myriad potential health impacts that could arise from placing a large residential project near a freeway. (Exhibit 6, Cahill, Comments and Attachments on Nishi Project, pp. 2307-2308.) This research included early heart attacks from ultra-fine particulate ("UFP")⁴ metals, increases in cancer from diesel exhaust, high rates of childhood asthma, and the rapid and permanent loss of lung function from UFPs. (Exhibit 6, Cahill, Comments and Attachments on Nishi Project, p. 2307.) Notably, Dr. Cahill developed all of his relevant research regarding the health impacts of TAC and UFP emissions after 2005. (See Exhibit 6, Cahill, Comments and Attachments on Nishi Project, pp. 2013-2434].) Not only does Dr. Cahill's research demonstrates the evolving understanding of the health impacts of TACs and UFPs from vehicle traffic (Exhibit 6, Cahill, Comments and Attachments on Nishi Project, pp. 2080-2089 [health risks of diesel particulates], 2089-2097 [health risks of UFPs], 2384

³ For ease of reference, citations to Exhibit 6 are to the bates stamp numbers provided in the lower right corner of each page. Dr. Cahill's comments and attachments were previously a part of an administrative record in a writ proceeding regarding a different project.

⁴ UFPs are particles with diameters less than 0.1 micrometers and are comprised mostly of metals. (Exhibit 6, p. AR 2620.)

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 12 of 15

[accelerating biological aging linked to prenatal exposure]) but also the sources of UFPs (Exhibit 6, Cahill, Comments and Attachments on Nishi Project, pp. 2331-2348 [research linking UFP generation to brake wear and motor oil zinc].) This is new information that was not available or known in 2005 is substantial and supports a fair argument that the Project could have more severe impacts than previously analyzed in the 2005 General Plan EIR.

The Project would not only place its residents within 500 feet of Highway 50, but it would also increase local vehicle trips. (Staff Report, p. 12.) The Project thus has the potential to exacerbate TAC and UFP emissions by adding additional vehicles to the road, a significant impact under CEQA. (*California Building Industry Association v. Bay Area Air Quality Management District* (2015) 62 Cal.4th 369, 377 (“[W]hen a proposed project risks exacerbating those environmental hazards or conditions that already exist, an agency must analyze the potential impact of such hazards on future residents or users”).) The existing conditions at the Project site already suggest a significant health risk for residents. According to Caltrans, the section of Highway 50 nearest the Project already experiences traffic delays LOS F at 204 hours of vehicle delay. (See Exhibit 7, Caltrans, Transportation Concept Report and Corridor System Management Plan for US Route 50 District 3 (2014), Table 13.) The Project would only exacerbate the existing traffic, adding additional delayed vehicles, which in turn would generate additional TAC and UFP emissions.

Not only does the City need to analyze the TAC and UFP emission impacts of the Project, it must then translate those emissions into corresponding health impacts. (*Sierra Club v. County of Fresno* (2018) 6 Cal.5th 502, 522.) As Dr. Cahill’s research demonstrates, the health impacts from those emissions could be considerable, just like with the Nishi project, which was also adjacent to a freeway. Given the substantial nature of this new information, the City must analyze the Project’s TAC and UFP emissions and conduct a health risk assessment of those emissions.

2. Noise and Resulting Health Impacts

The 2005 General Plan EIR also evaluated noise impacts, but like TACs and UFPs, the understanding of the health impact of noise has developed in the interim. Exposure to noise increases incidences of hypertension and heart ailments. (Exhibit 8, Lercher, et al., Cardiovascular Effects of Environmental Noise; Research in Austria (2011) Noise and Health Vol.13, pp. 234-250.) Even noise annoyance, which can cause its own negative health outcomes, come from lower decibel levels than previously thought. (Exhibit 9, Freitas et al., Traffic Noise Abatement: How Different Pavements, Vehicle Speeds and Traffic Densities Affect Annoyance Levels (2012) Transportation

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 13 of 15

Research Part D, Vol. 17, pp. 321-326.) These negative health impacts have been attributed to increased traffic. (Exhibit 10, Andersson & Ogren, Noise charges in road traffic: Pricing schedule based on the marginal cost principle (2011) Journal of Transportation Engineering, Vol. 137, pp. 926-933; see also Exhibit 11, Bendtsen, Highway Noise Abatement: Planning Tools and Danish Examples (Report for Caltrans by the Danish Road Institute and the University of California Pavement Research Center) (2010).) A 2018 Study quantified the health impacts of occupational noise, and found that occupational noise exposure cause hearing difficulty, hypertension and elevated cholesterol. (Exhibit 12, Kerns et al., Cardiovascular conditions, hearing difficulty, and occupational noise exposure within US industries and occupations (2018) Am. J. Ind. Med. Vol. 61., pp. 477-491.)

The Project would be surrounded almost entirely by business users and could pose an additional significant occupational noise-source for nearby workers. New information on how to measure and mitigate noise impacts has developed as well. (See Exhibit 10, Andersson & Ogren; Exhibit 11, Bendtsen; Exhibit 13, Murphy & King, Scenario analysis and noise action planning: Modelling the impact of mitigation measures on population exposure (2011) Applied Acoustics Vol. 72, pp. 487-494.) In light of this new information, the City must analyze the Project's noise impacts as well as the corresponding health impacts.

* * *

In summary, the Project is not an accessory use and the findings necessary for issuance of a CUP cannot be made. In addition, the City has not yet undertaken the environmental review necessary upon which to base approval of the Project. Public Resources Code section 21083.3 and CEQA Guidelines section 15183 were not intended to entirely insulate projects from environmental review, but rather to reduce lead agencies burden to evaluate impacts already contemplated in during development of general plans.

The 2005 General Plan EIR covered a broad range of impacts, and both the law and scientific understanding of certain environmental impacts have changed substantially. This is precisely why Public Resources Code section 21083.3 and CEQA Guidelines section 15183 require lead agencies to conduct environmental review of discrete issues that were not evaluated in a prior EIR, or that would be informed by significant new information. The City must therefore address the potentially significant impacts described in this letter on a Project-specific level in a stand-alone environmental document.

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 14 of 15

In addition, the public has not had an opportunity to review and understand the Project, as the public is under the most severe restrictions in movement that have been imposed in most people's lifetimes due to the COVID-19 pandemic. Indeed, the public is not even allowed to attend the City's meetings in person, and many members of the public have not been to their workplaces in the vicinity of the Project in weeks. For this reason alone, the City should defer consideration of the Project until restrictions on movement are lessened and the public can meaningfully participate in the City's review of CNU's proposed large-scale change of this part of the City.

Very truly yours,

SOLURI MESERVE
A Law Corporation

By:



Osha R. Meserve

ORM/mmb

cc: Darcy Goulart, Planning Manager: planningservices@cityoffranchocordova.org
Stacy Leitner, City Clerk: CityClerk@cityoffranchocordova.org
Howard Goldenberg: hgolden@me.com

Attachments:

- Exhibit 1: Excerpts from the Draft Environmental Impact Report for the Lincoln40 Project, June 2017.
- Exhibit 2: Excerpts from the Draft Environmental Impact Report for the Nishi Gateway Project, September 2015.
- Exhibit 3: Sacramento Metropolitan Air Quality Management District, CEQA Guidance, Chapter 6.
- Exhibit 4: Sacramento Metropolitan Air Quality Management District, CEQA Guidance, Chapter 2, Appendix, Thresholds of Significance.
- Exhibit 5: Office of Planning and Research, Technical Advisory on Evaluating Transportation Impacts in CEQA, December 2018.
- Exhibit 6: Dr. Thomas Cahill, Comments and Attachments on the Nishi Gateway Project,
- Exhibit 7: Caltrans, Transportation Concept Report and Corridor System Management Plan for US Route 50 District 3 (2014).

ITEM 11.1.

Mayor Sander
Council Members
May 14, 2020
Page 15 of 15

- Exhibit 8: Lercher, P., D. Botteldooren, U. Widmann, U. Uhrner, and E. Kammeringer. Cardiovascular Effects of Environmental Noise; Research in Austria (2011) Noise and Health Vol.13.
- Exhibit 9: Freitas, E., C. Mendonca, J.A. Santos, C. Murteira, J.B. Ferreira, Traffic Noise Abatement: How Different Pavements, Vehicle Speeds and Traffic Densities Affect Annoyance Levels (2012) Transportation Research Part D, Vol. 17.
- Exhibit 10: Andersson, H. and M. Ogren, Noise charges in road traffic: Pricing schedule based on the marginal cost principle (2011) Journal of Transportation Engineering, Vol. 137.
- Exhibit 11: Bendtsen, H. Highway Noise Abatement: Planning Tools and Danish Examples (Report for Caltrans by the Danish Road Institute and the University of California Pavement Research Center) (2010).
- Exhibit 12: Kern, E., E. Masterson, C. Themann, G. Calvert, Cardiovascular conditions, hearing difficulty, and occupational noise exposure within US industries and occupations (2018) Am. J. Ind. Med. Vol. 61.
- Exhibit 13: Murphy, E., E.A. King, Scenario analysis and noise action planning: Modelling the impact of mitigation measures on population exposure (2011) Applied Acoustics Vol. 72.

The above listed attachments are also available at this link:

<https://www.dropbox.com/sh/4a97lpsc8y0o3bp/AABNLajYskPpnD1RgGTi8HQya?dl=0>

ITEM 11.1.

EXHIBIT 1

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

safety, and welfare of their communities through their police powers.³⁵ While not required pursuant to CEQA, in order to address potential public health impacts, the nearby SMAQMD is currently recommending that proposed developments that could expose receptors to existing sources that emit odors and TACs be analyzed and exposure reduced as part of the lead agency's planning process instead. Similarly, the City of Davis, as lead agency, has chosen to prepare a full health risk assessment to evaluate the health risks posed to future residents as a result of the project site's proximity to ongoing railroad and freeway operations. Detailed analysis and modeling results related to DPM emissions from the nearby railroad and I-80 operations are included as Appendix D to this EIR.

The YSAQMD recommends the use of screening thresholds to assess a project's potential to create an impact through the creation of CO hotspots. A violation of the CO standard could occur if either of the following criteria is true of any street or intersection affected by the mitigated project:³⁶

- The project would reduce peak-hour level of service (LOS) on one or more streets or at one or more intersections to an unacceptable LOS (typically LOS E or F); or
- The project would increase a traffic delay by 10 or more seconds on one or more streets or at one or more intersections in the project vicinity where a peak hour LOS of F currently exists.

If either or both of the above criteria are met by the mitigated project, YSAQMD recommends performing a full CO Protocol Analysis. If the results of the CO Protocol Analysis indicate a potential impact related to CO could occur, such as in instances where a project would worsen operations at a signalized intersection operating at LOS E or LOS F, YSAQMD directs Lead Agencies to perform CO dispersion modeling analysis using a modeling program such as CALINE-4. The CALINE-4 dispersion model can estimate local CO concentrations at intersections based on traffic estimates and lane configurations. Once the CO concentrations at affected intersections are estimated, the CO concentration must then be compared to the one hour and eight hour AAQS for CO. If the local CO concentration estimated using CALINE-4 exceeds either the one or eight hour AAQS for the affected intersection, then a significant impact would result; however, if the localized CO concentrations are shown to be below the applicable AAQS, the project would not result in an impact related to localized CO concentrations.

GHG Emissions

With respect to establishing significance thresholds for GHG emissions, CEQA Guidelines Section 15064.4 states:

- (a) The determination of the significance of GHG emissions calls for a careful judgment by the lead agency consistent with the provisions in Section 15064. A lead agency

³⁵ California Constitution, Article XI, Section 7. Available at: http://leginfo.ca.gov/faces/codes_displaySection.xhtml?lawCode=CONS§ionNum=SEC.%207.&article=XI. Accessed February 2017.

³⁶ Yolo-Solano Air Quality Management District. *Handbook for Assessing and Mitigating Air Quality Impacts* [p. 21]. July 11, 2007. Available at: <http://www.ysaqmd.org/documents/CEQAHandbook2007.pdf>. Accessed April 2017.

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

- should make a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate the amount of GHG emissions resulting from a project.
- (b) A lead agency should consider the following factors, among others, when assessing the significance of impacts from GHG emissions on the environment:
- (1) The extent to which the project may increase or reduce GHG emissions as compared to the existing environmental setting;
 - (2) Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project;
 - (3) The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of GHG emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an EIR must be prepared for the project.

Thus, one threshold that is commonly used to analyze a project's GHG emissions is whether the project would conflict with or obstruct the goals, strategies, or governing regulation (Health & Safety Code, § 38500-38599) of the California Global Warming Solutions Act of 2006 (AB 32) or the GHG reduction targets in SB 32.

The YSAQMD, in their *Handbook for Assessing and Mitigating Air Quality Impacts*, acknowledges that new emissions generated by development projects could potentially conflict with existing GHG emissions reductions targets, and thus, a need for development of GHG emissions thresholds exists. However, the YSAQMD has not yet established or adopted any such thresholds. The YSAQMD is currently recommending GHG analysis consistent with the SMAQMD adopted thresholds of significance. While SMAQMD recognizes that emissions from a single project cannot be determined to substantially impact overall GHG emissions levels in the atmosphere, an emissions threshold is useful to trigger further project review and assess mitigation. As such, SMAQMD designed emissions thresholds to ensure that 90 percent of new GHG emissions related to land use projects would be reviewed and assessed for mitigation. Thus, projects exceeding SMAQMD's thresholds would constitute the vast majority of GHG emissions, and exceedance of the thresholds would allow for further project review contributing to the emissions reductions goals of AB 32, SB 32, the Scoping Plan, and relevant Executive Orders. SMAQMD has established a threshold for both construction and operational GHG emissions of 1,100 MTCO_{2e}/yr. It should be noted that the nearby Placer County Air Pollution Control District has independently adopted an operational threshold of 1,100 MTCO_{2e}/yr, for use in project GHG analysis, while the El Dorado County Air Pollution Control District similarly recommends use of SMAQMD's 1,100 MTCO_{2e}/yr threshold.

The 2008 document, *City of Davis Greenhouse Gas Emissions Inventory & Forecast Update*, includes an estimation of citywide 2010 emissions levels, which form the basis of the City's GHG

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

reduction target thresholds.³⁷ The 2010 emissions levels were then used to generate emissions reduction targets, which were adopted by the City on November 18, 2008. The emissions reductions goals provide a desired rate of reduction, which is more ambitious than AB 32 or SB 32, and includes achievement of citywide carbon neutrality by 2050. In addition to the aggressive, desired reduction targets, the City also adopted minimum reduction targets equal to the State mandated reductions levels. By adopting two reductions targets, the City created a range of acceptable emissions reductions level, where the minimum reductions target would achieve statewide reductions goals based on AB 32, while the desired reduction level would surpass the state minimum. The reductions targets adopted by the City are presented in Table 4.2-8.

Table 4.2-8 Davis GHG Reduction Targets		
Target Year	Target Range	
	State Target	City of Davis Target
2010	2000 Levels	1990 levels
2012	1998 Levels	7% below 1990 levels
2015	1995 Levels	15% below 1990 levels
2015 – 2020	Average Annual Reduction	Average of 2.6% reduction per year to achieve 80% between 1990 levels by 2040
2020	1990 Levels	28% below 1990 levels
2020 – 2040	No formal target, but must reduce an average of 2.66% per year to achieve 80% below 1990 levels by 2050	Average of 2.6% per year to achieve 80% below 1990 levels
2050	80% below 1990 levels	Carbon Neutral
<i>Source: Davis City Council. Resolution No. 08-166, Series 2008: Resolution Adopting Greenhouse Gas Reduction Targets for the City of Davis (City Operations and Community). November 18, 2008.</i>		

To ensure that new developments within the City would not impede the City's progress towards the emissions reductions targets presented in Table 4.2-8 above, the City identified carbon allowances for new developments. The carbon allowances set a maximum emissions level for the operation of new developments,³⁸ while maintaining the City's emissions reductions goals.³⁹

Based on the report prepared by Deb Niemeier (Ph.D., P.E, Director John Muir Institute of the Environment, UC Davis), staff developed Table 4.2-9 below, showing the average baseline GHG "allowance" for each Davis resident, and by extension, each Davis household. The methodology behind the summary table uses peer reviewed state wide GHG emission totals broken down to the local level and factors in regional growth assumptions and foreseeable statewide initiatives designed to reduce GHG emissions (e.g. low carbon fuel standard). Using the adopted City GHG targets (and State targets), staff has calculated the allowances for key target years. This table forms the basis for establishing GHG emissions standards for new residential development projects.⁴⁰

³⁷ City of Davis Department of Community Development and Sustainability. *City of Davis Greenhouse Gas Emissions Inventory & Forecast Update*. June 2008.

³⁸ City of Davis. *Staff Report: Adoption Davis Climate Action and Adaptation Plan*. June 2, 2010.

³⁹ Niemeier, Deb. *Carbon Development Allowances*. September 2008.

⁴⁰ City of Davis. *Staff Report: GHG Emissions Thresholds and Standards for New Residential Development*. April 21, 2009.

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

The proposed structure is anticipated to operate at a density of 5.46 persons per dwelling unit. The City's carbon allowances, presented in Table 4.2-9 below, assumes a citywide resident density of 2.5 persons per dwelling unit. Because the proposed project would be more dense than the City average, the per person carbon allowance is deemed a more appropriate threshold to use for the proposed project than the per unit allowance. The proposed project is assumed to be operational by the year 2019; therefore, the per person carbon allowance for the year 2020 would apply to the proposed project. The carbon allowance for the year 2020 requires the project to achieve emissions rates at least as low as 3.7 MTCO_{2e} per year per resident with a desired emissions level of 2.7 MTCO_{2e} per year per resident. Therefore, the proposed project would be considered to conflict with the City's GHG reduction targets and CAAP, if the project would result in operational GHG emissions in excess of 3.7 MTCO_{2e} per year per resident.

Table 4.2-9 Carbon Allowances for New Residential Developments				
Target Year Minimum/Desired	Target	Carbon Allowance ¹		
		Per Unit (MTCO _{2e} /yr)	Per Person (MTCO _{2e} /yr)	Percent Reduction Over Existing (%)
Existing/Base Year (2010)	N/A	16.5	6.6	0
2012 (Minimum)	1998 level	15.0	6.0	9
2012 (Desired)	7% below 1990	8.6	3.4	48
2020 (Minimum)	1990 level	9.25	3.7	44
2020 (Desired)	28% below 1990	6.7	2.7	59
2030 (Minimum)	28% below 1990	6.7	2.7	59
2030 (Desired)	53% below 1990	4.35	1.75	74
2040 (Minimum)	53% below 1990	4.35	1.75	74
2040 (Desired)	80% below 1990	1.85	0.75	89
2050 (Minimum)	80% below 1990	1.85	0.75	89
2050 (Desired)	Carbon Neutral	Net 0		100
Notes:				
1. Assumes 2.5 persons/dwelling unit and an annual growth rate of 1% per year				
Source: Niemeier, Deb. Carbon Development Allowances. September 2008.				

For the purposes of this analysis, the CEQA Guidelines Appendix G thresholds are utilized for the GHG significance determination, with the understanding that these general thresholds are to be understood within the context of the YSAQMD and the City of Davis. The Appendix G thresholds are as follows:

- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment;
- Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs;

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

vehicles. Thus, the proposed project would result in operational emissions below YSAQMD's thresholds, while also contributing to regional air quality emission reductions related to implementation of the MTP/SCS. Therefore, the proposed project's incremental contribution to cumulative regional air quality impacts would be ***less than cumulatively considerable***.

Mitigation Measure(s)

None required.

4.2-6 Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment. Based on the analysis below, the impact is *less than cumulatively considerable*.

An individual project's GHG emissions are at a micro-scale level relative to global emissions and effects to global climate change; however, an individual project could result in a cumulatively considerable incremental contribution to a significant cumulative macro-scale impact. As such, impacts related to emissions of GHG are inherently considered cumulative impacts.

The proposed project, in combination with other proposed and pending projects in the region would significantly contribute to the State of California GHG emissions and effects of global climate change, resulting in an overall significant cumulative impact. Implementation of the proposed project would contribute to the cumulative increase in GHG emissions that are associated with global climate change. Estimated GHG emissions attributable to future development would be primarily associated with increases of CO₂ and, to a lesser extent, other GHG pollutants, such as CH₄ and N₂O. Sources of GHG emissions include area sources, mobile sources or vehicles, utilities (electricity and propane), water usage, wastewater generation, and the generation of solid waste.

As discussed earlier in this section, although the YSAQMD has not officially adopted any thresholds of significance for GHG emissions, the YSAQMD currently recommends use of the SMAQMD's adopted GHG emissions thresholds of significance. The threshold of significance for both construction and operational GHG emissions is 1,100 MTCO₂e/yr. Therefore, if the proposed project would result in GHG emission in excess of 1,100 MTCO₂e/yr, the proposed project would be considered to generate GHG emissions that may have a significant impact on the environment.

The proposed project's short-term construction-related and long-term operational GHG emissions are described in further detail below.

Construction-Related GHG Emissions

Construction-related GHG emissions are a one-time release and are, therefore, not typically expected to generate a significant contribution to global climate change, as global climate change is inherently a cumulative effect that occurs over a long period of time and is quantified on a yearly basis. However, the proposed project's construction-related GHG

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

emissions have been estimated and compared to the applicable threshold of significance, as presented below in Table 4.2-14. Construction-related emissions were modeled using CalEEMod under the assumptions described in the Method of Analysis section above.

Table 4.2-14	
Unmitigated Construction-Related GHG Emissions	
Construction Year	Annual Emissions (MTCO₂e/yr)
2017	224.64
2018	500.60
2019	81.31
Total	806.55
Applicable Threshold of Significance	1,100
<i>Source: CalEEMod, February 2017 (see Appendix E)</i>	

As shown in Table 4.2-14, construction-related activities associated with the proposed project would result in maximum annual emissions of 500.60 MTCO₂e/yr, which would be well below the applicable threshold of significance of 1,100 MTCO₂e/yr. Additionally, the total construction GHG emissions would be 806.55 MTCO₂e/yr, which would also be below the applicable threshold of significance of 1,100 MTCO₂e/yr. Because the proposed project's maximum annual and total construction GHG emissions would be below the applicable threshold of significance, the proposed project would not be considered to generate construction-related GHG emissions that would have a significant impact on the environment.

Operational GHG Emissions

The proposed project's annual operational GHG emissions are presented in Table 4.2-15 below. Project operational emissions were modeled using CalEEMod under the assumptions described above in the Method of Analysis section above.

Table 4.2-15	
Unmitigated Operational GHG Emissions	
Emission Source	Annual GHG Emissions (MTCO₂e/yr)
Area	1.62
Energy	196.82
Mobile	503.83
Solid Waste	30.07
Water	15.84
TOTAL ANNUAL GHG EMISSIONS	748.18
Applicable Threshold of Significance	1,100
<i>Source: CalEEMod, February 2017 (see Appendix E).</i>	

It should be noted that mobile emissions have been included in the total operational emissions presented above. However, as discussed throughout this EIR, the proposed project is considered an infill project and is consistent with the MTP/SCS; therefore, the proposed project is eligible for CEQA streamlining benefits. Projects eligible for CEQA

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

streamlining do not need to analyze mobile source GHG emissions. In the case of the proposed project, mobile emissions comprise approximately 67 percent of the project's total operational emissions. Although the proposed project is eligible for CEQA streamlining, in order to provide a conservative analysis, the mobile emission related to operation of the proposed project are included in the analysis for potential impacts related to GHG emissions. As shown in Table 4.2-15, the proposed project would result in total operational GHG emissions, including mobile-related GHG emissions, of approximately 748.18 MTCO₂e/yr, which would be below the applicable threshold of significance of 1,100 MTCO₂e/yr.

Conclusion

Because the proposed project would result in construction-related and operational GHG emissions below the applicable threshold of significance of 1,100 MTCO₂e/yr, the proposed project would not be considered to generate GHG emissions, directly or indirectly, that would have a significant impact on the environment. Therefore, the proposed project's impact would be *less than cumulatively considerable*.

Mitigation Measure(s)

None required.

4.2-7 Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs. Based on the analysis below, the impact is *less than cumulatively considerable*.

Proposed projects resulting in carbon emissions equal to or less than the carbon allowances presented in Table 4.2-8 above, would not interfere with the City's GHG emissions reductions goals, and would be considered consistent with the City's CAAP. The proposed project is anticipated to be completed by the year 2019; therefore, the carbon allowance for year 2020 would apply (see Table 4.2-9). The City's carbon allowance for 2020 requires that GHG emissions from new residential development do not exceed 3.7 MTCO₂e/yr/person, with a preferred emissions level not to exceed 2.7 MTCO₂e/yr/person.

As shown in Table 4.2-15 below, the proposed project would result in annual operational GHG emissions of 748.18 MTCO₂e. With an anticipated maximum population of 708 residents, the proposed project would result in GHG emissions of approximately 1.06 MTCO₂e/yr per person (748.18 MTCO₂e/yr / 708 residents = 1.06 MTCO₂e/yr/person). Annual GHG emissions of 1.06 MTCO₂e/yr per person would be well below the required maximum allowance of 3.7 MTCO₂e/yr per person and the preferred emissions level of 2.7 MTCO₂e/yr per person for new residential developments by 2020. In fact, as shown in Table 4.2-16, the proposed project would result in emissions below the desired per person carbon allowance of 1.75 MTCO₂e/yr for developments in the year 2030.

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

Table 4.2-16				
Project GHG Emissions and Carbon Allowance (MTCO₂e/yr per person)				
Proposed Project Emissions	2020 Maximum Carbon Allowance	2020 Desired Carbon Allowance	2030 Maximum Carbon Allowance	2030 Desired Carbon Allowance
1.06	3.7	2.7	2.7	1.75
Sources: • CalEEMod, February 2017 (see Appendix E). • Niemeier, Deb. Carbon Development Allowances. September 2008.				

The City's desired allowance of 1.75 MTCO₂e/yr per person for developments in 2030 is designed to achieve a 53 percent reduction in GHG emissions from 1990 levels. Achievement of a 53 percent reduction in GHG emissions by 2030 would exceed the State's goal of reducing GHG emissions by 40 percent below the 1990 level by 2030. Therefore, the proposed project would be in compliance with the City's GHG reduction targets, which would also place the project in compliance with the State's reduction targets per SB 32.

The emission levels presented above were estimated using project-specific information, such as project energy and water efficiency measures, the project-specific vehicle trip rates, and project specific VMT. The City of Davis has approved GHG credits to be used to incentivize developments that promote alternative means of transportation and reduce single-passenger vehicle trips. For instance, housing projects with a medium or high density of residential units in proximity to employment may claim a two to five percent GHG credit, respectively, or projects within three-quarters of a mile of a transit station may claim between a one and five percent GHG credit.⁴⁹ Using the City's recommended GHG credits, the proposed project would be eligible for a minimum GHG reduction credit of seven percent.

The aforementioned GHG credits are related to increased use of alternative means of transportation, and the resultant reduction in mobile source emissions. The CalEEMod emissions modeling completed for the proposed project included project-specific traffic information, provided by Fehr and Peers, which accounted for the use of alternative means of transportation by future residents of the proposed project. Therefore, the emissions presented in Table 4.2-15 and Table 4.2-16 already account for factors such as density of land use and proximity to transit. Because such factors were already included in the quantification of mobile source GHG emissions, application of the City's GHG credits would result in a double counting of emissions reductions. Consequently, the City's GHG credits are not applied to the proposed project. Nevertheless, as presented in Table 4.2-16, the GHG emissions associated with operations of the proposed project would be below the City's applicable GHG thresholds without inclusion of the GHG credits.

⁴⁹ City of Davis. *Staff Report: Greenhouse Gas Emissions Thresholds and Standards for New Residential Development*. April 21, 2009.

ITEM 11.1.

DRAFT EIR
LINCOLN40 PROJECT
JUNE 2017

Based on the above, the proposed project would achieve the GHG emissions reductions target required by the City of Davis, and would result in GHG emissions below the per person carbon allowance for new residential developments in the year 2020 and the year 2030. Because the City's CAAP is based on achievement of the City's GHG reduction targets, the proposed project would not be considered to interfere with the City's adopted CAAP or GHG emissions targets. As such, the proposed project would not be considered to conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs, and impacts would be ***less than cumulatively considerable***.

Mitigation Measures
None Required.

ITEM 11.1.

EXHIBIT 2

4.7 GREENHOUSE GAS EMISSIONS, CLIMATE CHANGE, AND ENERGY

This section discusses greenhouse gas (GHG) emissions and energy use. Emissions of GHGs have the potential to adversely affect the environment because they contribute, on a cumulative basis, to global climate change. This issue is, therefore, addressed as a cumulative impact issue because no single project produces enough GHG to alter climate change effects, but each project has the potential to contribute GHGs that ultimately concentrate in the globe's atmosphere and, from a global perspective, contribute to this growing problem. Unlike criteria air pollutants and toxic air contaminants (TACs) that are pollutants of localized or regional concern, the location where GHG emissions are generated is less of a concern. Rather, the total amount, type, and per capita emissions of GHGs ultimately define whether GHG contributions from a project should be considered significant.

An important consideration is that, unlike many resources affected by a project, GHG emissions largely are associated with the fact that a population exists: people use energy to heat and cool their homes, for transportation, and in economic activity. Thus, it is important to consider whether a project is designed to be GHG-efficient, that is, to produce relatively few GHG emissions per unit (per resident, employee, etc.) because in large part, individual projects "shift" where and how GHGs are produced, including GHG emissions per person, rather than whether they are produced.

4.7.1 Environmental Setting

GHG EMISSIONS AND CLIMATE CHANGE

The Physical Scientific Basis

Certain gases in the earth's atmosphere, classified as greenhouse gas (GHG) emissions, play a critical role in determining the earth's surface temperature. Solar radiation enters the earth's atmosphere from space. A portion of the radiation is absorbed by the earth's surface and a smaller portion of this radiation is reflected back toward space. This absorbed radiation is then emitted from the earth as low-frequency infrared radiation. The frequencies at which bodies emit radiation are proportional to temperature. The earth has a much lower temperature than the sun; therefore, the earth emits lower frequency radiation. Most solar radiation passes through GHGs; however, infrared radiation is absorbed by these gases. As a result, radiation that otherwise would have escaped back into space is instead "trapped," resulting in a warming of the atmosphere. This phenomenon, known as the greenhouse effect, is responsible for maintaining a habitable climate on Earth. Without the greenhouse effect, Earth would not be able to support life as we know it.

Prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). Human-caused emissions of these GHGs in excess of natural ambient concentrations are believed responsible for intensifying the greenhouse effect and leading to a trend of unnatural warming of the earth's climate, known as global climate change or global warming. It is "extremely likely" that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in GHG concentrations and other anthropogenic forcings together (IPCC 2014:3, 5).

Climate change is a global problem. GHGs are global pollutants, unlike criteria air pollutants and toxic air contaminants, which are pollutants of regional and local concern. Whereas pollutants with localized air quality effects have relatively short atmospheric lifetimes (about one day), GHGs have long atmospheric lifetimes (one to several thousand years). GHGs persist in the atmosphere for long enough time periods to be dispersed around the globe. Although the exact lifetime of any particular GHG molecule is dependent on

multiple variables and cannot be pinpointed, it is understood that more CO₂ is emitted into the atmosphere than is sequestered by ocean uptake, vegetation, and other forms of sequestration. CO₂ sinks, or reservoirs, include vegetation and the ocean, which absorb CO₂ through sequestration and dissolution, respectively, two of the most common processes of CO₂ sequestration. Of the total annual human-caused CO₂ emissions, approximately 55 percent is sequestered through ocean and land uptakes every year, averaged over the last 50 years, whereas the remaining 45 percent of human-caused CO₂ emissions remains stored in the atmosphere (IPCC 2013:467).

The quantity of GHGs that it takes to ultimately result in climate change is not precisely known; suffice it to say, the quantity is enormous, and no single project alone would measurably contribute to a noticeable incremental change in the global average temperature, or to global, local, or micro climates. From the standpoint of CEQA, GHG impacts to global climate change are inherently cumulative.

Greenhouse Gas Emission Sources

Emissions of GHGs contributing to global climate change are attributable in large part to human activities associated with the transportation, industrial/manufacturing, utility, residential, commercial, and agricultural emissions sectors (ARB 2014a). In California, the transportation sector is the largest emitter of GHGs, followed by electricity generation (ARB 2014a). Emissions of CO₂ are, largely, byproducts of fossil fuel combustion. CH₄, a highly potent GHG, primarily results from off-gassing (the release of chemicals from nonmetallic substances under ambient or greater pressure conditions) and is largely associated with agricultural practices and landfills. N₂O is also largely attributable to agricultural practices and soil management. Additionally, high-GWP gases have atmospheric insulative properties that are hundred to tens of thousands of times greater than that of CO₂. HFCs, PFCs, and SF₆ are some of the most common types of high-global warming potential (GWP) gases and result from a variety of industrial processes. HFCs and PFCs are used as refrigerants and can be emitted through evaporation and leakage. SF₆ is a powerful electrical insulator used in power transmission and semiconductor manufacturing and is emitted through evaporation and leakage into the atmosphere.

EFFECTS OF CLIMATE CHANGE ON THE ENVIRONMENT

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization and the United Nations Environment Programme to provide the world with a scientific view on climate change and its potential effects. According to the IPCC global average temperature is expected to increase relative to the 1986-2005 period by 0.3–4.8 °C (0.5-8.6 °F) by the end of the 21st century (2081-2100), depending on future GHG emission scenarios (IPCC 2014:SPM-8). This temperature range represents the lower and higher bounds of five mitigation scenarios analyzed by the IPCC – two stringent scenarios, two intermediate scenarios, and a worst-case scenario. Temperatures in California are projected to increase 2.7 °F above 2000 averages by 2050 and, depending on global emission levels, 4.1–8.6 °F by 2100 (Moser et al 2012:2).

Physical conditions beyond average temperatures could be indirectly affected by the accumulation of GHG emissions. For example, changes in weather patterns resulting from increases in global average temperature are expected to result in a decreased volume of precipitation falling as snow in California and an overall reduction in snowpack in the Sierra Nevada. Based upon historical data and modeling, DWR projects that the Sierra snowpack will experience a 25 to 40 percent reduction from its historic average by 2050 (DWR 2008:4). An increase in precipitation falling as rain rather than snow also could lead to increased potential for floods because water that would normally be held in the Sierra Nevada until spring could flow into the Central Valley concurrently with winter storm events (Moser et al 2012:5). This scenario would place more pressure on California's levee/flood control system.

Another outcome of global climate change is sea level rise. Sea level rose approximately 7 inches during the last century. The National Research Council (NRCouncil), in their 2012 report on *Sea-Level Rise for the Coasts of California, Oregon, and Washington* projects that the sea level along the California coastline will

change between -1 inch (fall) to 24 inches (rise) between 2000 and 2050 and 4 to 66 inches (rise) between 2000 and the end of this century. This projection is based on projected future ice loss at the poles, steric and ocean dynamics, seismic trends affecting land subsidence, and other numerical models and extrapolations, accounting for increasing levels of uncertainty in future years (NRCouncil 2012:6).

As the existing climate throughout California changes over time, the ranges of various plant and wildlife species could shift or be reduced, depending on the favored temperature and moisture regimes of each species. In the worst cases, some species would become extinct or be extirpated from the state if suitable conditions are no longer available (Moser et al 2012:11 and 12).

Changes in precipitation patterns and increased temperatures are expected to alter the distribution and character of natural vegetation and associated moisture content of plants and soils. An increase in frequency of extreme heat events and drought are also expected. These changes are expected to lead to increased frequency and intensity of large wildfires (Moser et al 2012:11).

ENERGY

The majority of GHG emissions are the product of fuel consumed for energy use. The major users are residential and commercial buildings, industry, transportation, and electric power generators. Pacific Gas & Electric (PG&E) provides electricity and natural gas services to the majority of Northern California, including Yolo County [California Energy Commission (CEC) 2015a]. In 2012, PG&E's electricity generation sources consisted of: 36 percent natural gas, 27 percent nuclear, 17 percent hydropower, 19 percent renewable sources, and 1.0 percent from other sources (CEC 2013a). On the demand side, in 2013, Yolo County residents and non-residential energy consumers used 1.7 million gigawatt-hours (GWh) of electricity and 60 million therms of natural gas (CEC 2015b). With respect to transportation fuels, the California Energy Commission (CEC) estimates that 87 million gallons of gasoline and 33 million gallons of diesel fuel were sold in Yolo County in 2012 (CEC 2015c, 2015d). Information on alternative transportation fuels sold in the County was not available. Energy consumption within the City of Davis was not readily available. At the state level, California annually consumes 14.6 billion gallons of gasoline, 2.7 billion gallons of diesel fuel, and 1.8 billion gallons of gasoline equivalents of other alternative and miscellaneous fuels¹ (BOE 2015, CEC 2013a: 289).

A CEC staff forecast of future energy demand shows that statewide electricity consumption will grow by between 0.79 and 1.56 percent per year between 2012 and 2024; and natural gas consumption is expected to reach up to 24,092 million therms by 2025 for an annual average growth rate of up to 0.86 percent. The most recent Scoping Plan, prepared to address GHG emissions in the State, also commissioned state agencies to develop comprehensive and enforceable requirements for the State's electric and utilities to achieve near-zero GHG emissions by 2050 (ARB 2014b:45). With the onset of several transportation energy policies, such as the Low Carbon Fuel Standard and the Advanced Clean Cars program discussed in the regulatory settings below, the CEC anticipates that the state would experience a 2-billion-gallon decline in annual gasoline consumption from 2012 to 2022. However, the CEC anticipates a growing demand for diesel fuel, reflecting the recent growth in freight transport, although alternatives, such as natural gas trucks and electrification of freight lines, may provide some relief (CEC 2013b).

4.7.2 Regulatory Setting

GHG emissions and responses to global climate change are regulated by a variety of federal, state, and local laws and policies. Key regulatory and conservation planning issues applicable to the proposed project are discussed below.

¹ Gasoline and diesel consumption is based on fuel tax statistics for 2014. Other fuel estimates reflect 2013 conditions, based on the California Energy Commissions estimates.

FEDERAL**Supreme Court Ruling of Carbon Dioxide as a pollutant**

The U.S. Environmental Protection Agency (EPA) is the federal agency responsible for implementing the federal Clean Air Act (CAA) and its amendments. The Supreme Court of the United States ruled on April 2, 2007 that CO₂ is an air pollutant as defined under the CAA, and that EPA has the authority to regulate emissions of GHGs. The ruling in this case resulted in EPA taking steps to regulate GHG emissions and lent support for state and local agencies' efforts to reduce GHG emissions.

National Program to Cut Greenhouse Gas Emissions and Improve Fuel Economy for Cars and Trucks

On August 28, 2014, EPA and the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) finalized a new national program that would reduce GHG emissions and improve fuel economy for all new cars and trucks sold in the U.S. (NHTSA 2012). EPA proposed the first-ever national GHG emissions standards under the CAA, and NHTSA proposed Corporate Average Fuel Economy (CAFE) standards under the Energy Policy and Conservation Act. This proposed national program allows automobile manufacturers to build a single light-duty national fleet that satisfies all requirements under both Federal programs and the standards of California and other states. While this program will increase fuel economy to the equivalent of 54.5 mpg for cars and light-duty trucks by Model Year 2025, additional phases are being developed by NHTS and EPA that address GHG emission standards for new medium- and heavy-duty trucks (NHTSA 2014).

Energy Policy and Conservation Act

The Energy Policy and Conservation Act of 1975 sought to ensure that all vehicles sold in the U.S. would meet certain fuel economy goals. Through this Act, Congress established the first fuel economy standards for on-road motor vehicles in the U.S. Pursuant to the Act, the National Highway Traffic and Safety Administration, which is part of the U.S. Department of Transportation (USDOT), is responsible for establishing additional vehicle standards and for revising existing standards. Since 1990, the fuel economy standard for new passenger cars has been 27.5 miles per gallon (mpg). Since 1996, the fuel economy standard for new light trucks (gross vehicle weight of 8,500 pounds or less) has been 20.7 mpg. Heavy-duty vehicles (i.e., vehicles and trucks over 8,500 pounds gross vehicle weight) are not currently subject to fuel economy standards. Compliance with federal fuel economy standards is determined on the basis of each manufacturer's average fuel economy for the portion of its vehicles produced for sale in the U.S. The Corporate Average Fuel Economy (CAFE) program, administered by EPA, was created to determine vehicle manufacturers' compliance with the fuel economy standards. EPA calculates a CAFE value for each manufacturer based on city and highway fuel economy test results and vehicle sales. Based on the information generated under the CAFE program, the USDOT is authorized to assess penalties for noncompliance.

Energy Policy Act of 1992

The Energy Policy Act of 1992 (EPAct) was passed to reduce the country's dependence on foreign petroleum and improve air quality. EPAct includes several parts intended to build an inventory of alternative fuel vehicles (AFVs) in large, centrally fueled fleets in metropolitan areas. EPAct requires certain federal, state, and local government and private fleets to purchase a percentage of light duty AFVs capable of running on alternative fuels each year. In addition, financial incentives are included in EPAct. Federal tax deductions will be allowed for businesses and individuals to cover the incremental cost of AFVs. States are also required by the act to consider a variety of incentive programs to help promote AFVs.

Energy Policy Act of 2005

The Energy Policy Act of 2005 was signed into law on August 8, 2005. Generally, the act provides for renewed and expanded tax credits for electricity generated by qualified energy sources, such as landfill gas; provides bond financing, tax incentives, grants, and loan guarantees for a clean renewable energy and rural community electrification; and establishes a federal purchase requirement for renewable energy.

STATE

Executive Order S-3-05

Executive Order S-3-05, signed by Governor Arnold Schwarzenegger in 2005, proclaims that California is vulnerable to the impacts of climate change. It declares that increased temperatures could reduce the Sierra Nevada snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea levels. To combat those concerns, the Executive Order established total GHG emission targets for the State. Specifically, emissions are to be reduced to the 2000 level by 2010, the 1990 level by 2020, and to 80 percent below the 1990 level by 2050.

As described below, legislation was passed in 2006 to limit GHG emissions to 1990 levels by 2020, but no additional reductions were specifically enumerated in the legislation.

Assembly Bill 32, the California Global Warming Solutions Act of 2006

In September 2006, Governor Schwarzenegger signed the California Global Warming Solutions Act of 2006 (Assembly Bill [AB] 32). AB 32 establishes regulatory, reporting, and market mechanisms to achieve quantifiable reductions in GHG emissions and a cap on statewide GHG emissions. AB 32 requires that statewide GHG emissions be reduced to 1990 levels by 2020. AB 32 also requires that these reductions "...shall remain in effect unless otherwise amended or repealed. (b) It is the intent of the Legislature that the statewide GHG emissions limit continue in existence and be used to maintain and continue reductions in emissions of GHGs beyond 2020. (c) The (Air Resources Board) shall make recommendations to the Governor and the Legislature on how to continue reductions of GHG emissions beyond 2020." [California Health and Safety Code, Division 25.5, Part 3, Section 38551]

Assembly Bill 32 Climate Change Scoping Plan and Update

In December 2008, ARB adopted its Climate Change Scoping Plan, which contains the main strategies California will implement to achieve reduction of approximately 118 million metric tons (MMT) of CO₂-equivalent (CO₂e) emissions, or approximately 21.7 percent from the state's projected 2020 emission level of 545 MMT of CO₂e under a business-as-usual scenario (this is a reduction of 47 MMT CO₂e, or almost 10 percent, from 2008 emissions). In May 2014, ARB released and has since adopted the *First Update to the Climate Change Scoping Plan* to identify the next steps in reaching AB 32 goals and evaluate the progress that has been made between 2000 and 2012 (ARB 2014b:4 and 5). According to the update, California is on track to meet the near-term 2020 GHG limit and is well positioned to maintain and continue reductions beyond 2020 (ARB 2014b:ES-2). The update also reports the trends in GHG emissions from various emission sectors.

The update also elaborates on potential GHG reduction goals beyond 2020:

California will develop a mid-term target to frame the next suite of emission reduction measures and ensure continued progress toward scientifically based targets. This target should be consistent with the level of reduction needed [by 2050] in the developed world to stabilize warming at 2 °C (3.6 °F) [above pre-industrial levels] and align with targets and commitments elsewhere. The European Union has adopted an emissions reduction target of 40 percent below 1990 levels by 2030. The United Kingdom has committed to reduce its emissions by 50 percent below 1990 levels within the 2022–2027 timeframe, and Germany has set its own 2030 emissions target of 55 percent below 1990 levels. The United States, in support of the Copenhagen Accord, pledged emission reductions of 42 percent below 2005 levels in 2030 (which, for California, translates to 35 percent below 1990 levels).

This level of reduction is achievable in California. In fact, if California realizes the expected benefits of existing policy goals (such as 12,000 megawatts [MW] of renewable distributed generation by 2020, net zero energy homes after 2020, existing building retrofits under AB 758, and others) it could reduce emissions by 2030 to levels squarely in line with those needed in the developed world and to stay on track to reduce emissions to 80 percent below 1990 levels by 2050. Additional measures, including locally driven measures and those necessary to meet federal air quality standards in 2032, could lead to even greater emission reductions (ARB 2014b:34).

As supported by many of California's climate scientists and economists, a key next step needed to build on California's framework for climate action is to establish a mid-term statewide emission reduction target. Cumulative emissions drive climate change, and a continuum of action is needed to reduce emissions not just to stated limits in 2020 or 2050, but also every year in between (ARB 2014b:ES6).

The update summarizes sector-specific actions needed to stay on the path toward the 2050 target. While the update acknowledges certain reduction targets by others (such as in the Copenhagen Accord), it stops short of recommending a specific target for California, instead acknowledging that mid-term targets need to be set "consistent with the level of reduction needed [by 2050] in the developed world to stabilize warming at 2°C (3.6°F) [above pre-industrial levels]."

Actions are recommended for the energy sector, transportation (clean cars, expanded zero-emission vehicle program, fuels policies, etc.), land use (compliance with regional sustainability planning targets), agriculture, water use (more stringent efficiency and conservation standards, runoff capture, etc.), waste (elimination of organic material disposal, expanded recycling, use of Cap and Trade program, etc.), green building (strengthen Green Building Standards), and other sectors. Many of the actions that result in meeting targets will need to be driven by new or modified regulations.

Senate Bill 375

SB 375, signed by the Governor in September 2008, aligns regional transportation planning efforts, regional GHG emission reduction targets for cars and light duty trucks, and land use and housing allocation. SB 375 requires Metropolitan Planning Organizations (MPOs) to adopt a Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS) or Alternative Planning Strategy, showing prescribed land use allocation in each MPO's Regional Transportation Plan. ARB, in consultation with the MPOs, is to provide each affected region with reduction targets for GHGs emitted by passenger cars and light trucks in their respective regions for 2020 and 2035.

The applicable MPO in the project region is the Sacramento Area Council of Governments (SACOG), which includes Yolo County. SACOG adopted its current MTP/SCS for 2035 in 2012 (2012 MTP/SCS) and is currently working on a 2016 update to the plan (2016 MTP/SCS) to identify opportunities that can help steer the region toward the goals set forth in the 2012 MTP/SCS (SACOG 2014).

Executive Order B-30-15

On April 20, 2015 Governor Edmund G. Brown Jr. signed Executive Order B-30-15 to establish a California GHG reduction target of 40 percent below 1990 levels by 2030. The Governor's executive order aligns California's GHG reduction targets with those of leading international governments such as the 28-nation European Union which adopted the same target in October 2014. California is on track to meet or exceed the current target of reducing GHG emissions to 1990 levels by 2020, as established in the California Global Warming Solutions Act of 2006. California's new emission reduction target of 40 percent below 1990 levels by 2030 will make it possible to reach the ultimate goal of reducing emissions 80 percent below 1990 levels by 2050. This is in line with the scientifically established levels needed in the U.S. to limit global warming below 2°C, the warming threshold at which there will likely be major climate disruptions such as super droughts and rising sea levels.

Advanced Clean Cars Program

In January 2012, ARB approved the Advanced Clean Cars program which combines the control of GHG emissions and criteria air pollutants, as well as requirements for greater numbers of zero-emission vehicles, into a single package of standards for vehicle model years 2017 through 2025. The new rules strengthen the GHG standard for 2017 models and beyond. This will be achieved through existing technologies, the use of stronger and lighter materials, and more efficient drivetrains and engines. The program's zero-emission vehicle regulation requires battery, fuel cell, and/or plug-in hybrid electric vehicles to account for up to 15 percent of California's new vehicle sales by 2025. The program also includes a clean fuels outlet regulation designed to support the commercialization of zero-emission hydrogen fuel cell vehicles planned by vehicle manufacturers by 2015 by requiring increased numbers of hydrogen fueling stations throughout the state. The number of

stations will grow as vehicle manufacturers sell more fuel cell vehicles. By 2025, when the rules will be fully implemented, the statewide fleet of new cars and light trucks will emit 34 percent fewer GHG emissions and 75 percent fewer smog-forming emissions than the statewide fleet in 2016 (ARB 2011b).

Integrated Energy Policy Reports (Senate Bill 1389)

Senate Bill 1389 (Bowen, Chapter 568, Statutes of 2002) requires the CEC to prepare a biennial integrated energy policy report that contains an assessment of major energy trends and issues facing the state's electricity, natural gas, and transportation fuel sectors and provides policy recommendations to conserve resources; protect the environment; ensure reliable, secure, and diverse energy supplies; enhance the state's economy; and protect public health and safety (Public Resources Code § 25301[a]). The Energy Commission prepares these assessments and associated policy recommendations every two years, with updates in alternate years, as part of the Integrated Energy Policy Report (IEPR). Preparation of the IEPR involves close collaboration with federal, state, and local agencies and a wide variety of stakeholders in an extensive public process to identify critical energy issues and develop strategies to address those issues. (CEC 2012a.)

California Long-Term Energy Efficiency Strategic Plan

On Sept. 18, 2008, the California Public Utilities Commission (CPUC) adopted California's first Long Term Energy Efficiency Strategic Plan, presenting a single roadmap to achieve maximum energy savings across all major groups and sectors in California. This comprehensive Plan for 2009 to 2020 is the state's first integrated framework of goals and strategies for saving energy, covering government, utility, and private sector actions, and holds energy efficiency to its role as the highest priority resource in meeting California's energy needs. The plan was updated in January 2011 to include a lighting chapter.

California Building Energy Efficiency Standards

California's Building Energy Efficiency Standards (Title 24, Part 6 of the California Code of Regulations) conserve electricity and natural gas in new building construction and are administered by the CEC. Local governments enforce the standards through local building permitting and inspections. The CEC has updated these standards on a periodic basis. The new 2013 Building Energy Efficiency Standards, which take effect on January 1, 2014, are 25 percent more efficient than previous standards for residential construction and 30 percent more efficient for nonresidential construction.

Comprehensive Energy Efficiency Plan for Existing Buildings (Assembly Bill 758)

Assembly Bill 758 (Skinner, Chapter 470, Statutes 2009) requires the CEC, in collaboration with the CPUC and stakeholders, to develop a comprehensive program to achieve greater energy efficiency in the state's existing buildings.

California Renewable Energy Portfolio Standard (Senate Bill X1-2)

In 2011, Governor Brown signed SB X1-2, which requires retail sellers of electricity, including investor-owned utilities and community choice aggregators, to provide at least 33 percent of their electricity supply (portfolio) from renewable sources by 2020. The CPUC and the CEC jointly implement the statewide Renewable Portfolio Standard (RPS) program through rulemakings and monitoring the activities of electric energy utilities in the state.

California Qualifying Facility and Combined Heat and Power Program Settlement

In December 2010, the CPUC approved California's Qualifying Facility and Combined Heat and Power Program Settlement, which established a CHP framework for the state's investor-owned utilities. The settlement established a near-term target of 3,000 MW of CHP for entities under the jurisdiction of the CPUC, although this target includes not just new CHP, but capacity from renewal of contracts due to expire in the next three years. The CPUC has also adopted a settlement agreement that includes reforms to the Rule 21 interconnection process to provide a clear, predictable path to interconnection of distributed generation while maintaining the safety and reliability of the grid (CEC 2012b).

California Appliance Efficiency Regulations

California's Appliance Efficiency Regulations, enacted in 1976, requires that certain appliances meet efficiency standards. Each appliance must be tested and the results certified by the CEC in order for a product to be sold in California (CEC 2012c).

Alternative and Renewable Fuel and Vehicle Technology Program

AB 118 (Statutes of 2007) created the CEC's Alternative and Renewable Fuel and Vehicle Technology Program. The statute, subsequently amended by AB 109 (Statutes of 2008), authorizes the CEC to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies.

LOCAL

Sacramento Area Council of Governments

Pursuant to SB 375, SACOG was tasked by ARB to achieve a 7 percent per capita reduction in passenger-vehicle generated transportation emissions by 2020 and a 16 percent per capita reduction by 2035 from 2005, which ARB confirmed the region would achieve by implementing its Sustainable Communities Strategy (ARB 2013). In fact, SACOG's 2012-2035 MTP/SCS projects are estimated to exceed ARB's targets with anticipated per capita reductions of 10 percent by 2020 and 16 percent by 2035 from 2005 levels [23.0 pounds (lb) CO₂ per capita per day]. These percent reductions translate to a planned forecast of 20.8 lb CO₂ per capita per day in 2020 and 19.7 lb CO₂ per capita per day in 2035 (SACOG 2012: 177,178).

SACOG is currently working on a 2016 update to the plan (2016 MTP/SCS) to identify opportunities that can help steer the region toward the goals set forth in the 2012 MTP/SCS. The 2016 MTP/SCS will also focus on implementation challenges and commitments of the current 2012 MTP/SCS. (SACOG 2014).

Yolo-Solano Air Quality Management District

The Yolo-Solano Air Quality Management District's (YSAQMD) CEQA handbook and website currently recommends that GHG emissions and impacts to climate change be evaluated for every CEQA project (YSAQMD 2007:24-25, 2015). However, in a recent letter to the City of Davis from YSAQMD written in response to the notice of preparation for this project, YSAQMD states the following.

"Recent changes to CEQA require any CEQA analysis to address a project's impacts on global climate change. The lead agency should provide a discussion of the project's potential to produce greenhouse gas emissions (GHG) and whether these emissions would be in conflict with the GHG-reduction goals set by the State. If emissions are quantified, the lead agency should contact the District to determine the most appropriate threshold of significance for the project." (Jones, pers. comm., 2015a.)

In subsequent discussions, YSAQMD has recommended using Sacramento Metropolitan Air Quality Management District's (SMAQMD) adopted GHG thresholds and guidance, pending an update of YSAQMD's own guidance. SMAQMD considers a project as having a significant impact on the environment if construction and operational emissions exceed 1,100 MTCO₂e/year. YSAQMD recommends the use of SMAQMD threshold guidance because SMAQMD is the only adjacent air district with officially adopted thresholds and YSAQMD agrees with the methodology that was used to develop SMAQMD thresholds (Jones, pers. comm., 2015b).

City of Davis General Plan

The Energy Element of the City's General Plan (amended through January 2007) contains goals, policies, and actions that pertain to energy use (City of Davis 2007). Key policies that are applicable to the proposed project include the following:

Although the General Plan does not currently have a specific Climate Change or GHG element, it does address elements of sustainability and GHG emissions as they relate to transportation in its Transportation Element. See Chapter 4.14, Transportation and Circulation, for the list of relevant policies.

Goal ENERGY 1. Reduce per capita energy consumption in Davis.

- ▲ **Policy ENERGY 1.3** Promote the development and use of advanced energy technology and building materials in Davis.
- ▲ **Policy ENERGY 1.5** Encourage the development of energy-efficient subdivisions and buildings.

Davis Climate Action and Adaptation Plan

Adopted in 2010 by the City of Davis, the Davis Climate Action and Adaptation Plan (D-CAAP) describes actions and objectives to reach the City's GHG emission targets through the year 2050 and to prepare for climate change at the City level. The D-CAAP recommends GHG emission reduction targets and strategies for achieving those targets from both community and municipal operations within the City of Davis. The reduction target and strategies focus on actions and objectives in nine sectors: mobility, energy, land use and buildings, consumption and waste, food and agriculture, community engagement, government operations, advocacy, and climate change preparation (adaptation). The City's goals extend from reducing the City's community-wide emissions to 15 percent below 1990 levels in 2015 to achieving a community-wide carbon neutral status by 2050. These targets are based on the City's desire to exceed state-recommended targets for 2020 and 2050 adopted as part of AB32 and EO S-3-05, which were adopted at the time the D-CAAP was published in 2010, and do not include the recently adopted interim 2030 target identified in EO B-30-15. The applicable targets identified in the D-CAAP are summarized in Table 4.7-1.

With respect to adaptation, the D-CAAP includes an action to prepare an assessment of vulnerabilities to climate change associated with local resources, infrastructure, and the public health system. The D-CAAP established objectives and specific actions for 2015, and only established foundations for long-term reductions beyond 2015.

Table 4.7-1 City of Davis GHG Reduction Targets: Community and City Operations

Year	Target Range ¹		Notes	
	State	Davis ²	Minimum	Desired
2015	1995 levels	15% below 1990 levels	State does not establish target for this year; linear interpolation from 2010 target.	Consistent with initial ICLEI modeling conducted by the City.
2015 to 2020	Average annual reduction	Average of 2.6% reduction/year to achieve 80% below 1990 levels by 2040	State does not establish target for these years.	Average reduction encourages monitoring of progress and some flexibility in implementation.
2020	1990 levels	28% below 1990 levels	State target.	Average reduction encourages monitoring of progress and some flexibility in implementation.
2020-2040	No formal target, but must reduce an average of 2.66%/year to achieve 80% below 1990 levels by 2050	Average of 2.6% reduction/year to achieve 80% below 1990 levels	State does not establish target for these years ³	Reduction level adopted by the state based on climate stabilization levels of 3-5.5 degree increase in temp. Average reduction encourages monitoring of progress and some flexibility in implementation.
2050	80% below 1990 levels	Carbon neutral	State target. Reduction level adopted by the state based on climate stabilization levels of 3-5.5 degree increase in temp. Average reduction encourages monitoring of progress and some flexibility in implementation.	Combination of actions at the local, regional, national, and international levels and carbon offsets. Similar target set by the UC system, City of Berkeley, and Norway.

¹ The City of Davis anticipates that it will achieve reductions within the range of the state targets (minimum) and local targets (desired)

² Due to residency time of GHG gasses in the atmosphere, early GHG reduction is generally more beneficial for mitigation of the most severe impacts of climate change.

³ The state has recently adopted an interim target of achieving a 40 percent reduction in statewide GHG emissions by 2030 as part of Executive Order B-30-15.

GHG = Greenhouse gas

ICLEI = International Council for Local Environmental Initiatives - Local Governments for Sustainability

UC = University of California

Source: City of Davis 2010

4.7.3 Impacts and Mitigation Measures

SIGNIFICANCE CRITERIA

Greenhouse Gases

Establishment of a GHG significance threshold for a single project has been a challenge ever since this issue was first addressed in CEQA. A single land use development plan or project is not large enough to meaningfully affect climate change by itself (because climate change has resulted from many decades of cumulative global GHG emissions). In 2008, the Governor's Office of Planning and Research (OPR) issued guidance regarding this issue; that guidance stated that the adoption of appropriate significance thresholds was a matter of discretion for the lead agency. The guidance states (California Governor's Office of Planning and Research 2008, pp. 4-6):

"[T]he global nature of climate change warrants investigation of a statewide threshold of significance for GHG emissions. To this end, OPR has asked ARB technical staff to recommend a method for setting thresholds which will encourage consistency and uniformity in the CEQA analysis of GHG emissions throughout the state. Until such time as state guidance is available on thresholds of significance for GHG emissions, we recommend the following approach to your CEQA analysis."

Determine Significance

- ▲ *When assessing a project's GHG emissions, lead agencies must describe the existing environmental conditions or setting, without the project, which normally constitutes the baseline physical conditions for determining whether a project's impacts are significant.*
- ▲ *As with any environmental impact, lead agencies must determine what constitutes a significant impact. In the absence of regulatory standards for GHG emissions or other scientific data to clearly define what constitutes a "significant impact," individual lead agencies may undertake a project-by-project analysis, consistent with available guidance and current CEQA practice.*
- ▲ *The potential effects of a project may be individually limited but cumulatively considerable. Lead agencies should not dismiss a proposed project's direct and/or indirect climate change impacts without careful consideration, supported by substantial evidence. Documentation of available information and analysis should be provided for any project that may significantly contribute new GHG emissions, either individually or cumulatively, directly or indirectly (e.g., transportation impacts).*
- ▲ *Although climate change is ultimately a cumulative impact, not every individual project that emits GHGs must necessarily be found to contribute to a significant cumulative impact on the environment. CEQA authorizes reliance on previously approved plans and mitigation programs that have adequately analyzed and mitigated GHG emissions to a less than significant level as a means to avoid or substantially reduce the cumulative impact of a project.*

OPR's Guidance did not require Executive Order S-3-05 to be used as a significance threshold under CEQA. Rather, OPR recognized that, until ARB establishes a state-wide standard, selecting an appropriate threshold is within the discretion of the lead agency.

CEQA Guidelines Section 15064.4 was later added, in 2010, to address GHGs. The Guidelines state:

- (a) The determination of the significance of GHG emissions calls for a careful judgment by the lead agency consistent with the provisions in Section 15064. A lead agency should make a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate the amount of GHG emissions resulting from a project.

- (b) A lead agency should consider the following factors, among others, when assessing the significance of impacts from GHG emissions on the environment:
- (1) The extent to which the project may increase or reduce GHG emissions as compared to the existing environmental setting;
 - (2) Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project;
 - (3) The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of GHG emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an EIR must be prepared for the project.

Thus, one threshold that may be used to analyze the project's GHG emissions is whether the project would conflict with or obstruct the goals or strategies of the California Global Warming Solutions Act of 2006 (AB 32) or its governing regulation (Health & Safety Code, §§ 38500-38599). The City of Davis established a more ambitious (than AB 32) goal in its D-CAAP, which is achievement of net zero carbon emissions by 2050, along a sliding trajectory downward from 2015 targets.

Applicable Greenhouse Gas Thresholds

In accordance with Appendix G of the State CEQA Guidelines, the project would result in a potentially significant impact on climate change if it would:

- ▲ generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment; or
- ▲ conflict with any applicable plan, policy or regulation of an agency adopted for the purpose of reducing the emissions of GHGs.
- ▲ The City of Davis does not currently have formally adopted thresholds of significance for GHG emissions for land use developments. However, as the lead agency, the City has determined that consistency with the D-CAAP shall be used to determine the significance of a project within the City's jurisdiction. Thus, in line with OPR's guidance mentioned previously, Appendix G of the State CEQA Guidelines, and YSAQMD recommendations, the applicable GHG significance thresholds are as follows:
 - with respect to a significant impact on the environment, and
 - for the evaluation of short-term construction-related emissions, a project would not have a significant impact on the environment if construction emissions do not exceed 1,100 MTCO₂e/year.
- ▲ For the evaluation of operational emissions of a land development, operational emissions of a project would not have a significant impact on the environment if the project meets the following:
 - operational emissions do not exceed 1,100 MTCO₂e/year, as recommended by YSAQMD via SMAQMD guidance (Jones, pers. comm., 2015b; SMAQMD 2015); or
 - operational emissions are shown to be on a trajectory towards carbon neutrality by 2050, pursuant to the D-CAAP targets.

- ▲ Thus, even if operational emissions exceed 1,100 MTCO₂e/year, if the project can show that operational emissions can demonstrate a trajectory to emitting a net of zero GHG emissions per year by 2050, the project would be less-than-significant.
- ▲ With respect to conflicting with an applicable plan, policy, or regulation of an agency adopted for the purpose of reducing emissions of GHGs, a project would have a significant impact on climate change if the project does any of the following:
 - impedes attainment of AB 32 2020 GHG emissions reduction goal;
 - impedes attainment of statewide intermediate GHG emissions reductions goal for 2040 as set in EO B-30-15;
 - is inconsistent with regional SACOG MTP/SCS goals to reduce per capita transportation emissions by 9 percent and 16 percent by 2035 from 2005 levels; or
 - is inconsistent with or would impede attainment of City's CAAP, including targets for 2020, 2040, and 2050

These thresholds compare the project's performance to the applicable statewide, regional, and local GHG reduction plans and policies.

Energy

Based on Appendix F and G of the State CEQA Guidelines, the proposed project would result in a potentially significant impact on energy use if it would:

- ▲ require or result in the construction of new energy production, and/or transmission facilities or expansion of existing facilities, the construction of which could cause significant environmental effects;
 - impact analysis may include whether the project may result in:
 - significant adverse impacts related to project energy requirements,
 - energy use inefficiencies, and/or
 - energy intensiveness of materials by amount and fuel type for each stage of the project including construction, operations, maintenance, and/or removal.
- ▲ result in the wasteful or inefficient use of energy as a result of project construction or operation;
 - result in significant adverse impacts on local and regional energy supplies and on requirements for additional capacity,
 - result in significant adverse impacts on peak and base period demands for electricity and other forms of energy,
 - fail to comply with existing energy standards,
 - result in significant adverse impacts on energy resources, or
 - result in significant adverse impacts related to transportation energy use requirements of the project and use of transportation alternatives; or
- ▲ conflict, or create an inconsistency, with any applicable plan, policy, or regulation adopted for the purpose of avoiding or mitigating environmental effects related to energy use.

METHODS AND ASSUMPTIONS

Components of the Nishi Sustainability Implementation Plan That Could Affect Project Impacts

The following goals and objectives from the Nishi Sustainability Plans are applicable to the evaluation of GHG and energy impacts:

Goal 1: Serve as a model for low-carbon, climate-resilient development that also enhances the fiscal and equitable sustainability of the broader community.

- ▲ **Objective 1.1:** Achieve substantially lower GHG emissions per capita for both residents and employees of the District compared to baseline levels, in support of the City of Davis' and UC Davis' long-term goals to achieve carbon neutrality.
- ▲ **Objective 1.2:** Encourage innovative site and building design that encourages a healthy and interconnected natural and built environment, conserves natural resources, and promotes equitable and efficient communities.
- ▲ **Objective 1.3:** Contribute to resource conservation during construction through the use of sustainable materials and cost-effective resource conservation methods.
- ▲ **Objective 1.4:** Promote and demonstrate resiliency to the effects of climate change and other challenges through project design.

Goal 2: Strive for carbon neutral transportation through the use of innovative designs, technologies, and programs.

- ▲ **Objective 2.1:** Reduce automobile dependency and reduce vehicle trips generated within the District by 10 percent compared to original project trip generation forecasts³, working towards the communitywide goal of achieving 50 percent non-single-occupancy-vehicle (SOV) mode share for residential and commercial development by 2035.
- ▲ **Objective 2.2:** Achieve a 20 percent reduction in project-related vehicle miles traveled (VMT), compared to original project VMT forecasts.
- ▲ **Objective 2.3:** Achieve maximum connectivity and safety for pedestrians, bicyclists, and transit users.
- ▲ **Objective 2.4:** Incentivize the use of clean, energy-efficient, active (i.e., human powered), and economically sustainable means of travel.
- ▲ **Objective 2.5:** Achieve an average vehicle ridership (AVR) of 1.5 for peak period commute trips by employees of the project office uses.

Goal 3: Design and construct high-performance buildings, public lighting, and on-site renewable energy systems that work towards achieving zero net energy (ZNE) by Nishi development build-out.

- ▲ **Objective 3.1:** High-performance buildings will achieve a minimum 30 percent compliance margin relative to the 2013 Title 24 Building Energy Efficiency Standards, or equivalent. High-performance buildings will also incorporate energy consumption feedback mechanisms in order to encourage resident and employee engagement and minimize wasted energy use.
- ▲ **Objective 3.2:** Other building loads not covered by Title 24 will also be high efficiency, (i.e., 100 percent high efficiency lighting, ENERGY STAR appliances and equipment), and lighting will be adaptive where practicable.

- ▲ **Objective 3.3:** Design the Nishi development to achieve ZNE such that all site energy use is offset with renewable energy generation on an annual basis. To the extent possible, on-site generation will be used to meet this objective; however, off-site generation and purchase of renewable energy offsets will also be considered. Site energy use to be offset includes building energy use, all street and area site lighting, and other community related energy uses such as pools and community buildings. It does not include mobile sources / transportation-related energy use.

Goal 4: Maximize water and wastewater efficiency through the use of conservation, reuse and integrated landscaping and stormwater management strategies.

- ▲ **Objective 4.1:** Meet or exceed 2013 CALGreen Tier 1 water use efficiency requirements for indoor water use.
- ▲ **Objective 4.2:** Minimize use of potable water in outdoor landscaping and maximize the use of non-potable water.
- ▲ **Objective 4.3:** Work towards achieving zero net water usage through use of best management practices and innovative technologies.

Goal 5: Create synergy with other project design goals and existing community sustainability initiatives.

- ▲ **Objective 5.6:** Incorporate opportunities to educate and empower future residents and employees in the District to increase awareness of resource consumption and their carbon footprint.

Impact Assessment Methodology

As noted in Chapter 3, “Project Description,” this EIR evaluates development of the Nishi site at a project level and potential redevelopment that may occur within West Olive Drive as a result of rezoning/redesignation at a programmatic level. Impacts were assessed in accordance with YSAQMD-recommended methodologies (Jones, pers. comm., 2015a). Only CO₂, CH₄, and N₂O emissions were considered. Other GHGs were considered to be negligible. GWP factors from the IPCC Fifth Assessment Report were applied to calculate CO₂e.

Construction

Short-term construction-generated GHG emissions were calculated using the California Emissions Estimator Model (CalEEMod) Version 2013.2 computer program (SCAQMD 2013), as recommended by YSAQMD and other air districts in California. Modeling was based on project-specific information (e.g., size, construction phasing, construction seasons, area to be graded, area to be paved), where available; reasonable assumptions based on typical construction activities; and default values in CalEEMod that are based on project location and land use types. Construction GHG emissions were estimated using the same assumptions as outlined in Chapter 4.3, “Air Quality.”

Construction-generated N₂O emissions from mobile sources was not available from CalEEMod, but is planned for future versions (SCAQMD 2013). It is anticipated that N₂O emissions from construction would be minimal.

Regarding energy use (e.g., fuel use) during construction, it is assumed that only diesel fuel would be used in construction equipment and a mix of diesel and gasoline fuel would be used in on-road vehicles used to haul materials or carry workers to and from the site. Although CalEEMod was used to calculate emissions from construction activities, CalEEMod does not provide fuel estimates for construction activities. Having assumed that construction equipment only uses diesel fuel, we can estimate construction-related fuel use based on emissions estimated shown later in Table 4.7-2 using emissions factors from the Climate Registry (10.21 kg CO₂ per gallon of diesel, 8.78 kg CO₂ per gallon of gasoline) (Climate Registry 2014: Table 13:1).

Operations

Operational GHG emissions were estimated using a variety of sources and models. Project-generated GHG emissions from electricity use, on-site natural gas combustion, area sources, waste, and mobile sources were calculated.

With regard to building energy use, annual electricity and natural gas usage estimated for the project was provided by the energy technical study conducted for the City of Davis and this project by Davis Energy Group (Davis Energy Group 2015). Davis Energy Group assumed that the residential and non-residential buildings would operate at 30 percent better than 2013 Title 24 standards. The energy study also accounted for outdoor lighting, three spas, a recreational pool, and electricity-generating solar panels, in addition to the land uses identified in the project description.

Indirect GHG emissions from on-site electricity use (and generation) was calculated apart from any models by applying estimated future emission PG&E factors that would be applicable by 2022, the first estimated full build-out year of operation. It was assumed that, by 2020, 33 percent of electricity sold by PG&E would be from renewable sources, based on requirements in the state's Renewable Portfolio Standard (RPS). Although Phase 1 would be operational in 2019, operational GHG emissions are analyzed on a long-term basis starting from the full build-out year. In 2013, 23.8 percent of PG&E electricity was from renewable sources with an emission factor of 167 lb CO₂/MWh (Climate Registry 2013, CPUC 2015). CH₄ and N₂O emission factors were also adjusted to reflect the statewide RPS goal and were based on the "CAMX" region emission factors from EPA's eGrid2010 database (USEPA 2014).

CalEEMod was used to calculate annual CO₂, CH₄, and N₂O emissions from the natural gas use, area sources, indirect electricity use from on-site water demand, and waste. Projected natural gas and water usage were taken from project-specific studies conducted as part of the sustainability planning effort for the project (Davis Energy Group 2015; Cunningham Engineering 2015). Area source and waste emissions were based off of CalEEMod defaults for the project's land use types and sizes.

ARB's emissions factor model, EMFAC2014, was used to estimate annual CO₂ and CH₄ emissions from vehicle miles travelled (VMT) generated by the project, which was available from Fehr and Peers (Grandy Pers. Comm., 2015); see Section 4.14 of this EIR. Fehr and Peers estimated that the project would generate 45,200 VMT per day, not accounting for any trip reduction measures. EMFAC2014 is ARB's latest update to the EMFAC model series and takes into account effects of future policies and economic forecasts. The modeled emission factors reflect the county average vehicle mix and usage rates forecast for 2022 for Yolo County, which are assumed to be reflective of the city, absent of city-specific data. N₂O emissions were not available from EMFAC2014 and are expected to be negligible.

The loss in sequestered carbon was also estimated in CalEEMod using the vegetation module. The types and amounts of vegetation that would be removed permanently because of construction were based on information available from the project description as well as assumptions based on discussions with the City. With respect to CalEEMod's prescribed vegetative land use categories, it was assumed that the project would remove 46.9 acres of cropland and add 15.9 acres of grassland, representing planned park land; approximately 4 acres of wetland, representing the planned detention basin; and no less than 20 trees, although the actual number of trees planted as part of the project would likely be more. For the purposes of presenting a conservative analysis, any planting improvements that may occur as part of the project along the Putah Creek channel were not considered as part of this analysis. Total one-time GHG emissions from the net loss in carbon sequestration were then amortized over the operational life of the project (assumed to be 40 years for this analysis) and considered in combination with on-going operational emissions. Accounting for the loss in sequestered carbon in this way allows for the evaluation of whether ongoing operation of the proposed land uses would be efficient enough to "recoup" these one-time emissions.

ISSUES NOT EVALUATED FURTHER

All GHG and energy issues addressed in the significance criteria are evaluated below.

PROJECT-SPECIFIC IMPACTS AND MITIGATION MEASURES

Impact 4.7-1: Considerably contribute to climate change through project-generated greenhouse gas emissions during construction.*Nishi Site*

Annual GHG emissions from project construction would range from a low of 578 MT CO₂e to a high of 980 MT CO₂e over an estimated 5 year period. Peak-year construction-generated GHG emissions would not exceed YSAQMD's recommended GHG emission threshold of 1,100 MT CO₂e for construction projects. Therefore, GHG emissions from project-related construction would be not be substantial. This impact would be **less than significant**.

Construction-related activities that would generate GHGs include worker commute trips, haul trucks carrying supplies and materials to and from the West Parcel development area, and off-road construction equipment (e.g., dozers, loaders, excavators). Construction of the land uses on the Nishi site would occur over five years. Construction of Phase 1 would involve demolition of two structures on West Olive, mass grading, utilities construction, and construction of the bridge between the Nishi site and West Olive Drive in 2017 and building² and roadway construction spanning from the end of 2017 through 2019. Phase 1 would provide most of the grading and infrastructure also needed for the construction of Phase 2. It is anticipated that construction would follow the general phasing schedule outlined available in Appendix C.

Annual construction emissions are summarized in Table 4.7-2. The GHG emissions are the greatest during 2017 and 2020 because of the respective grading phases at the beginning of Phase 1 and Phase 2. Refer Chapter 4.3, "Air Quality," for additional details on the construction schedule. Refer to Appendix C for a detailed summary of the modeling assumptions, inputs, and outputs. As shown in Table 4.7-2, Annual GHG emissions from project construction would range from a low of 578 MT CO₂e to a high of 980 MT CO₂e over an estimated 5-year period.

Table 4.7-2 Annual Emissions of Greenhouse Gas Emissions Associated with Project Construction by Construction Year

Construction Year	CO ₂ e (MT/year)
2017	922
2018	980
2019	657
2020	951
2021	578
YSAQMD recommended Threshold of Significance	1,100

Notes: YSAQMD recommends using SMAQMD Thresholds of Significance for greenhouse gas emissions (Jones, pers. comm., 2015b). SMAQMD thresholds are 1,100 MT CO₂e per year. Numbers in **bold** indicate exceedances of thresholds. CO₂e are calculated using IPCC Fifth Assessment 100 year lifetime global warming potential factors.

CO₂e = carbon dioxide equivalents

MT = metric tons

YSAQMD = Yolo County Air Quality Management District

IPCC = International Panel on Climate Change

Source: Data provided by Ascent Environmental, Inc. in 2015 based on modeling using CalEEMod v. 2013.2.2

Peak-year construction-generated GHG emissions would not exceed YSAQMD's recommended GHG emission threshold of 1,100 MT CO₂e for construction projects. Therefore, GHG emissions from project-related construction would be not be substantial. This impact would be **less than significant**.

² Including paving and architectural coating phases

Mitigation Measures

No mitigation measures are required.

West Olive Drive

Construction-related activities associated with the redevelopment of parcels along West Olive Drive would result in temporary, short-term GHG emissions. However, specific construction details related to the site are not yet available and would be market dependent. Given that the project would be at least half the size of the Nishi site and would not require new infrastructure development due to existing utilities serving the site, short-term construction GHG emissions are not anticipated to exceed YSAQMD thresholds. Therefore, this impact is **less than significant**.

Construction activities associated with potential redevelopment of West Olive Drive would generate GHG emissions during the operation of construction equipment and movement of materials to and from West Olive Drive. However, based on the anticipated net increase in square footage within West Olive Drive, which would be approximately 4.5 percent of the anticipated square footage within the Nishi site, emissions associated with redevelopment would be substantially less than that of the proposed development within the Nishi site. As noted above in Table 4.7-2, GHG emissions associated with development of the Nishi site would be less than applicable annual thresholds. Construction activities associated with potential redevelopment within West Olive Drive would likely not occur until the Nishi site is built out and thus would not be considered additive with the proposed Nishi site development. Further, based on anticipated redevelopment potential within West Olive Drive, emissions are reasonably anticipated to be less than those identified above for the Nishi site and less than applicable thresholds.

*Future construction GHG emissions from the West Olive Drive redevelopment would likely have less annual emissions than Nishi and; consequently, would not exceed thresholds. Therefore, this impact is **lessthan significant**.*

Mitigation Measures

No mitigation measures are required.

Impact 4.7-2: Considerably contribute to climate change through project-generated greenhouse gas emissions during operation.***Nishi Site***

Annual GHG emissions from project operation would exceed YSAQMD-recommended emission threshold of 1,100 MT CO₂e/year. Despite the development's energy efficient design and ideal location close to major destinations in the City, such as University of California at Davis (UC Davis) and downtown Davis, there is no guarantee that future emissions generated by the development could be net zero carbon by 2050. Therefore, operation of the project has the potential to result in a substantial contribution to GHG emissions. This impact would be **potentially significant**.

Operation of the project would result in GHG emissions associated with motor vehicle trips to and from the Nishi development area; combustion of natural gas for space and water heating; consumption of electricity and water; conveyance, treatment, and discharge of wastewater; decomposition of solid waste; and use of equipment for landscaping. The removal of trees and vegetation would also result in the loss of sequestered carbon. Table 4.7-3 summarizes all the direct and indirect sources of GHG emissions associated with the Nishi project upon full buildout in 2022. The emissions estimates provided below assume the project would attain building efficiencies that are 30 percent better than 2013 CalGreen Title 24 building standards based on the results of the sustainability planning effort conducted by the City, ARB vehicle emission factors forecasted for 2022, electricity emission factors that reflect PG&E's likely attainment of the state's 33 percent renewable goal, and offsets related to electricity generation from planned solar photovoltaic panels.

As shown in Table 4.7-3, upon full buildout in 2022, total net GHG emissions associated with the operation of the project would be 12,846 MTCO₂e per year, above YSAQMD-recommended mass emissions threshold of 1,100 MTCO₂e/year. Eighty-five percent of unmitigated operational emissions, apart from offsets from solar generation, are estimated to be from mobile sources generated by the project. GHG emissions from natural gas combustion account for another 11 percent of estimated operational emissions. Also, 87 percent of annual emissions, 547 out of 647 MTCO₂e, related to on-site electricity use is anticipated to be offset by proposed on-site solar electricity generation, thus accounting for the low percentage of emissions related to electricity use. A relatively small amount of emissions are further generated by solid waste, water and wastewater treatment and conveyance, landscaping, and through carbon sequestration losses through net reductions in vegetation.

Table 4.7-3 Summary of Unmitigated Annual Greenhouse Gas Emissions Associated with Nishi-Gateway Long-Term Operation at full buildout in 2022

Emissions Source	CO ₂ e (MT/year)	Percent of Total
Mobile	10,933	85%
Natural Gas	1,404	11%
Solid Waste	415	3%
Net Electricity Use with Solar Generation	80	1%
Water and Wastewater	14	<1%
Landscaping	8	<1%
Amortized Net Lost Carbon Sequestration ¹	5	<1%
Total	12,852	100%
YSAQMD recommended Threshold of Significance	1,100	

Note: Summation may not equal totals due to rounding. Electricity, natural gas, and mobile emissions modeled separately from CalEEMod. Electricity emissions assume PG&E will attain 33 percent renewables by 2020. Water and wastewater emissions account for supply, conveyance, and treatment electricity use. Solid waste emissions account for decomposition emissions, as modeled within CalEEMod. Mobile source emissions are based on 45,200 VMT per day for 365 days per year. CO₂e are calculated using IPCC Fifth Assessment 100 year lifetime global warming potential factors.

YSAQMD recommends using SMAQMD Thresholds of Significance for greenhouse gas emissions (Jones, pers. comm., 2015b). SMAQMD thresholds are 1,100 MT CO₂e per year. Numbers in **bold** indicate exceedances of thresholds. CO₂e are calculated using IPCC Fifth Assessment 100 year lifetime global warming potential factors.

¹ Accounts for removal of 46.9 acres of cropland and an addition of 6.5 20 new trees and Per CalEEMod guidance, one-time loss in emissions is amortized over the anticipated life of the project, assumed to be 40 years.

CO₂e = carbon dioxide equivalents

MT = metric tons

CalEEMod = California Emissions Estimator Model v. 2013.2.2

IPCC = International Panel on Climate Change

Source: Data provided by Ascent Environmental, Inc. in 2015 based on modeling using CalEEMod v. 2013.2.2 and EMFAC 2014 and using data from Davis Energy Group, Cunningham Engineering, and Fehr and Peers. (Davis Energy Group 2015, Cunningham Engineering 2015, Grandy, Pers. Comm., 2015, IPCC 2013)

However, with respect to the Nishi development's trajectory toward carbon neutrality by 2050, there are three major factors involved: (1) GHG-efficient design and operation of the development, (2) facilitation of denser urban development, and (3) external changes in technology, policy, and social behavior. At the project-level, the Nishi development is designed to be as energy efficient as feasible based on its proposed level of efficiency (30 percent better than 2013 CalGreen Title 24 building standards). As mentioned, 87 percent of on-site electricity use would be offset by the proposed solar panels. Based on current mobile source emission rates, which allow for some estimation of future mobile-related GHG emissions, it is anticipated that the mobile source emissions identified above in Table 4.7-3 would reduce over time. However, as it is impossible to predict the impact of legislation and policy that has yet to come, an accurate prediction of 2050 emissions is not possible. Using current mobile emission rates, mobile source emissions are anticipated to be 9,159 MTCO₂e/year, a reduction of 16 percent compared to buildout conditions. Assuming that no other improvements/reductions would occur under 2050 conditions, annual project-related GHG emissions would be 11,078 MTCO₂e/year. Therefore, the development could still generate significant GHG emissions.

At the regional-level, the development could reduce emissions when compared to the same residential and commercial growth that could occur elsewhere in the City or region. The development is adjacent to both the UC Davis campus and downtown Davis, allowing for shorter trip lengths and greater non-motorized mode shares (e.g. biking) for UC Davis students, staff, and faculty as well as other residents that may live on the Nishi site travelling between the site, campus, and downtown Davis. In anticipation of an update to UC Davis' Long Range Development Plan, the university anticipates an enrollment growth of an additional 7,000 students between 2025 and 2030 (UC Davis 2015). Given that approximately 75 percent of UC Davis students currently live in off-campus housing, siting new housing closer to campus would allow more students to travel shorter distances to campus when compared to most other off-campus housing situations (UC Davis 2015). Also, commercial land uses sited at Nishi are aimed at businesses and research/development facilities that may have or desire to have strong ties with UC Davis and the Davis community. These land uses would be close to both UC Davis and available on-site residences for employees and generate lower VMT than similar businesses located elsewhere in Davis or outside of Davis.

At the state and global level, improvements in technology, policy, and social behavior can also influence and reduce operational emissions generated by a project. The state is currently on a pathway to achieving the Renewable Portfolio Standards goal of 33 percent renewables by 2020 (CPUC 2015). Governor recently issued an Executive Order to increase the state's energy goals to derive 50 percent of electricity from renewable sources by 2030 (Office of Governor Brown 2015). Despite these goals, the majority of the project's emissions would still be from mobile sources, especially as electricity use would be nearly offset by on-site solar electricity generation. Future mobile source are greatly dependent on changes in vehicle technology, fuels, and social behavior, which can be influenced by policies to varying degrees. Taking known future policies into account, ARB estimates that over 80 percent of future vehicles in Yolo County would still run on gasoline even with increased electric vehicle mode shares (ARB 2015a). This is assumed to also be applicable to Davis vehicle fleet, absent data that may suggest otherwise. Due to these external factors, average emissions from transportation in 2050 would mostly still generate GHG emissions, but the quantity is uncertain in light of potential changes in technology and policy over the next 35 years.

*Although the future of transportation emissions generated by the Nishi development may be uncertain, the buildings and facilities are designed to be operated as efficiently as feasible. With the variety of factors involved and without further action on the Nishi site to reduce mobile source emissions or purchase GHG emissions offsets, it is uncertain that the Nishi development could be on a trajectory to achieving net zero carbon emissions by 2050. Therefore, this impact is **potentially significant**.*

Mitigation Measures

Implement Mitigation Measure 4.14-5 (Transportation Demand Management program).

Mitigation Measure 4.7-2a: Each individual project or subdivision developed/constructed as a part of the Nishi Gateway Project shall demonstrate consistency with the D-CAAP by achieving a downward trajectory in GHG emissions, towards the City goal of zero net GHG emissions by the year 2050. The project must achieve the target in place for the year in which the application (for any development within the Nishi site) is filed.

At the City's discretion, compliance with this mitigation measure for different development activities associated with the same approval may occur at different stages in the development process depending on the nature of the project and may be based on the year that physical improvements are anticipated. GHG emissions associated with all activities must demonstrate consistency with this measure at the time of or before building permits are issued. Mitigation for buildings shall occur at the time the building permit is issued, and the amount of mitigation shall be based on the year the building permit is issued. Mitigation for other emissions from a project may occur at an earlier approval but no later than issuance of entitlements. The applicant may file and City may consider and approve a GHG mitigation plan that lays out the mitigation for different stages of development within the same subsequent project approval.

Prior to issuance of any subsequent entitlement or permit in the Nishi development, or alternatively prior to any approval taking effect, the applicant shall implement the following steps unless these steps have already been undertaken for the project through a prior approval or action:

1. Using CalEEMod or another model accepted for this purpose by the City, calculate total expected GHG emissions (all sectors) for the proposed project under two scenarios: a) 1990 emissions rates; and, b) emission rates applicable at the time of the application, taking into account applicable building standards and other adopted regulatory requirements, as well as building design, use of renewable energy, etc.
2. Calculate the difference between these two scenarios in step 1 as a percentage of the 1990 project emissions.
3. Compare the difference in emissions from step 2 to the required minimum emissions reduction schedule provided below:

Applications Filed On or Before	Minimum Required Reduction in GHG Emissions From Calculated 1990 Emissions
12/31/16	22.5
12/31/17	25.0
12/31/18	27.5
12/31/19	30.0
12/31/20	32.5
12/31/21	35.0
12/31/22	37.5
12/31/23	40.0
12/31/24	42.5
12/31/25	45.0
12/31/26	47.5
12/31/27	50.0
12/31/28	52.5
12/31/29	55.0
12/31/30	57.5... (2.5% increased reduction per year)
12/31/35	70.0... (2.5% increased reduction per year)
12/31/40	82.5... (2.5% increased reduction per year)
12/31/45	95.0... (2.5% increased reduction per year)
12/31/50	100.0

4. If the difference calculated in step 2 is greater than the required reduction in step 3, the Nishi development may “bank” this as a credit to use with later projects.
5. If the difference calculated in step 2 does not demonstrate the required reduction in step 3, applicant shall identify feasible actions to achieve the required reductions using the following priority:
 - First priority – building specific actions
 - Second priority – onsite (within Nishi site) actions
 - Third priority – community based (within Davis) actions
 - Fourth priority – pay GHG reduction fees (carbon offsets) into a qualified existing local program, if one is in place
 - Fifth priority – other demonstrated method of reducing emissions
6. Calculate, using acceptable methods, the measurable GHG reduction value of each proposed action.

7. Provide a Technical Memorandum of Compliance (TMC) documenting the following minimum items: modeling (step 1); emissions calculations (step 2); applicable reduction (step 3); chosen feasible actions to achieve required reduction (step 4); and measurable GHG reduction value of each action (step 5). The TMC and all steps of the process are subject to review and authorization by the City of Davis Department of Community Development and Sustainability.
8. Implement the authorized actions and provide evidence of this to the City of Davis Department of Community Development and Sustainability. The City upon review and acceptance of implementation, shall issue the subject entitlement, permit, or approval.

Mitigation Measure 4.7-2b: Every 5 years the Nishi development shall submit a GHG Emissions Reduction Accounting and Program Effectiveness Report for the entire innovation center. The report shall be submitted by 12/31 of each fifth year starting in 2020. First report due by 12/31/20, second report due by 12/31/25, etc., through 2050.

The report shall identify the following minimum items. Other documentation requirements may be added by the City if found to be necessary to satisfy this mitigation measure.

1. Projected annual GHG emissions for the Nishi development, total and by sector, from the project EIR
2. GHG emissions from all uses collectively operating at the Nishi development, total and by sector, at the time of reporting.
3. GHG emissions from each occupied building within the Nishi development, total and by sector.
4. Summary of prior TMCs and 5-year reports
5. Running total of Nishi development emissions reductions and reduction credits, in total and by building
6. Comprehensive data base and summary of implemented reduction actions

Significance after Mitigation

Through the implementation of Mitigation Measure 4.14-5, which requires the development and implementation of a transportation demand management program, the Nishi development could reduce VMT generated by the project by up to 20 percent from 45,200 to 36,160 daily VMT. This could reduce mobile source emissions to 8,746 MTCO_{2e} in 2022. Using ARB-forecasted vehicle emission factors, these emissions could be reduced to 7,328 MTCO_{2e} by 2050. Additional incentives for low-carbon vehicles, such as electric charging stations, could reduce emissions further by increasing the percentage of vehicles that emit lower GHG emissions per mile, but these estimates are qualitative. Implementation of Mitigation Measures 4.7-2a and 4.7-2b sets GHG reduction targets and accountability for the Nishi Development, but would not guarantee reductions that show that the development would be able to achieve the City's carbon neutral target by 2050. Therefore, this impact would be **significant and unavoidable**.

West Olive Drive

The operation of potential redevelopment of uses within West Olive Drive could increase GHG emissions compared to existing conditions depending on the type and size of land uses that could be on site as well as the type and size of land use that may be replaced. Redevelopment of West Olive Drive has the potential to increase the intensity of current land uses either by building more densely or just serving a growing population resulting in the potential for increased GHG emissions over existing conditions. Therefore, this would be a **potentially significant** impact.

The level of operation of potential redevelopment of uses within West Olive Drive could increase from existing conditions depending on the type and size of land uses that could be on-site, as well as the type and size of land uses being removed. The design of the redeveloped buildings would need to comply with the latest building codes, and overall emissions from energy use would be determined by the carbon intensity of PG&E's supplied electricity and any on-site renewable energy generation. Carbon intensities of supplied electricity is anticipated to decrease over time as the state aims to exceed the current 33 percent RPS goal by 2020. It is reasonable to assume that redevelopment within West Olive Drive would be GHG efficient compared to existing development, however the extent to which it would achieve GHG reductions in accordance with GHG reduction targets is unclear.

*Because redevelopment of West Olive Drive has the potential to increase the intensity of current land uses, either by building more densely or just serving a growing population, GHG operational emissions from the site could increase over existing conditions. Therefore, this would be a **potentially significant** impact.*

Mitigation Measures

Implement Mitigation Measures 4.14-5 (Transportation Demand Management program), 4.7-2a (GHG Reduction Targets), and 4.7-2b (GHG Reduction Accountability).

Significance after Mitigation

Through the implementation of Mitigation Measure 4.14-5, which requires the development and implementation of a transportation demand management program, the West Olive Drive redevelopment could reduce VMT generated by the on-site land uses, but the ability to which the land uses can implement the TDM measures would depend on physical, logistical, fiscal constraints determined by each redeveloped land use. Implementation of Mitigation Measures 4.7-2a and 4.7-2b sets GHG reduction targets and accountability for the Nishi Development, but would not guarantee reductions that show that the development would be able to achieve the City's carbon neutral target by 2050. Due to these uncertainties, this impact would be **significant and unavoidable**.

Impact 4.7-3: Conflict with or impede attainment of goals established in applicable climate action plans or greenhouse gas reduction plans.

Nishi Site

Operation of the Nishi development would not conflict with or impede the goals of EO B-30-15 or the D-CAAP. However, unmitigated emissions from the proposed Nishi development would exceed AB 32 2020 reduction targets compared to BAU conditions and SACOG MTP/SCS per capita targets. Thus, this impact is **potentially significant**.

AB 32 has a goal of reducing the state's GHG emissions to 21.7 percent below the projected 2020 business-as-usual (BAU) scenario by 2020. Under the BAU scenario, policies, such as energy efficiency measures renewable portfolio standards for electricity production, would not be in place. The Nishi development would create a GHG efficient land use that is consistent with the development goals of AB 32, by achieving close to net zero electricity use and reducing mobile source emissions from BAU scenarios when compared to developing elsewhere in the City or region. As mentioned previously, the project is designed to be as energy efficient as feasible, potentially achieving 30 percent lower energy use than equivalent buildings meeting the 2013 Title 24 standards, as estimated by Davis Energy Group. When compared to a BAU scenario where similar land uses on the same site would only meet 2013 Title 24 standards for building energy efficiency, the proposed Nishi development would generate 10 percent less GHG emissions than a BAU scenario, as show below in Table 4.7-4. Thus, the unmitigated emissions associated with the Nishi development would conflict with or impede the goals of AB32.

Table 4.7-4 Comparison of Unmitigated Annual Greenhouse Gas Emissions Associated with Nishi-Gateway Long-Term Operation at Full Buildout and Business as Usual Scenarios

Emissions Source	BAU	Nishi (at Full Buildout)	Percent Below BAU
Electricity with Solar Generation	946	80	92%
Natural Gas	1,956	1,404	28%
Solid Waste	415	415	0%
Water-Related Electricity Use (includes wastewater)	15	11	29%
Transportation	10,933	10,933	0%
Other (e.g. landscaping)	8	8	1%
TOTAL	14,274	12,851	10%

Note: BAU scenario is a conservative scenario in which buildings would achieve a 2013 Title 24 energy efficiency standard. The Nishi development, as planned, would reflect a 30 percent better than 2013 Title 24 standard and application of water efficient fixtures. CO₂e are calculated using IPCC Fifth Assessment 100 year lifetime global warming potential factors. Potential to increase or reduce carbon sequestration potentials is not included due to no BAU scenario for sequestration available from AB32.

Summation may not equal totals due to rounding. Electricity, natural gas, and mobile emissions modeled separately from CalEEMod. Electricity emissions assume PG&E will attain 33 percent renewables by 2020. Water and wastewater emissions account for supply, conveyance, and treatment electricity use. Solid waste emissions account for decomposition emissions, as modeled within CalEEMod. Mobile source emissions are based on 45,200 VMT per day for 365 days per year. CO₂e are calculated using IPCC Fifth Assessment 100 year lifetime global warming potential factors.

BAU = Business as Usual
CO₂e = carbon dioxide equivalents
MT = metric tons
CalEEMod = California Emissions Estimator Model v. 2013.2.2
IPCC = International Panel on Climate Change

Source: Data provided by Ascent Environmental, Inc. in 2015 based on modeling using CalEEMod v. 2013.2.2 and EMFAC 2014 and using data from Davis Energy Group, Cunningham Engineering, and Fehr and Peers. (Davis Energy Group 2015, Cunningham Engineering 2015, Grandy, pers. comm., 2015, IPCC 2013)

Through EO B-30-15, the state aims to reduce statewide emissions by 40 percent below 1990 levels by 2030, with a trajectory toward achieving 80 percent below 1990 levels by 2050. Moreover, the D-CAAP aims to exceed state goals by setting a carbon neutral target for the City to achieve by 2050. Goals 1 through 4 and their respective objectives set forth in the Nishi Sustainability Plans are designed to support the City of Davis' and UC Davis' long-term goals to achieve carbon neutrality by 2050, encourage sustainable design, and promote resource conservation. Although the Nishi development itself may not be able to achieve carbon neutrality by 2050, as discussed in Impact 4.7-3, the development would serve as a model for the rest of community in sustainable low-carbon land use development. Thus, the Nishi development would not conflict with or impede the goals of EO B-30-15 or the D-CAAP.

Pursuant to SB 375, the current SACOG 2012-2035 MTP/SCS aims to reduce per capita transportation emissions in the region by 9 percent by 2020 and 16 percent by 2035 from 2005 levels. This translates to a regional target of 20.8 lb CO₂e per capita per day by 2020 and 19.7 lb CO₂e per capita per day by 2035, or 3.4 MT CO₂e per capita by 2020 and 3.3 MT CO₂e per capita by 2035. As discussed in the Chapter 4.10 "Population and Housing", the proposed Nishi development would host 1,920 new residents and up to 854 employees, with a total service population of 2,774. Using the estimated annual mobile source GHG emissions from Table 4.7-3, 10,933 MT CO₂e per year, the Nishi development would achieve 3.9 MT CO₂e per capita per year, or 23.5 MT CO₂e, starting in the 2022 full buildout year. Thus, the Nishi development would conflict with SACOG MTP/SCS transportation emission reduction goals.

*Based on the discussion above, unmitigated emissions associated with the operation of the Nishi development would not conflict with or impede the goals of EO B-30-15, or the D-CAAP. However, unmitigated emissions from the proposed Nishi development would exceed AB 32 2020 reduction targets compared to BAU conditions and SACOG MTP/SCS per capita targets. Thus, this impact is **potentially significant**.*

Mitigation Measures

Implement Mitigation Measure 4.14-5 (Transportation Demand Management program).

Significance after Mitigation

Through the implementation of Mitigation Measure 4.14-5, which requires the development and implementation of a transportation demand management program, the project would reduce VMT generated by the project by up to 25 percent from 45,200 to 36,160 daily VMT. This would reduce mobile source emissions to 8,746 MTCO₂e in 2022 (see Table 4.7-5). This reduction would result in transportation-based emissions of 3.1 MT CO₂e per capita per year or 18.8 lb CO₂e per capita per day, meeting SACOG's 2035 regional target of 19.7 lb CO₂e per capita per day for mobile source GHG emissions. As a result, mitigated transportation-related GHG emissions would not exceed SACOG's 2020 and 2035 targets. Further, overall annual GHG emissions associated with the Nishi development and proposed mitigation would achieve a 25 percent reduction compared to the BAU scenario, which would be consistent with AB 32 2020 reduction targets. As a result, implementation of Mitigation Measure 4.14-5 would reduce this impact to **less than significant**.

Table 4.7-5 Comparison of Mitigated Annual Greenhouse Gas Emissions Associated with Nishi-Gateway Long-Term Operation at full buildout in 2022 and Business as Usual Scenarios

Emissions Source	BAU	Nishi (at Full Buildout in 2022)	Percent Savings
Electricity with Solar Generation	946	80	92%
Natural Gas	1,956	1,404	28%
Solid Waste	415	415	0%
Water-Related Electricity Use (includes wastewater)	15	11	29%
Transportation	10,933	8,746	20%
Other (e.g. landscaping)	8	8	1%
TOTAL	14,274	10,664	25%

Note: BAU scenario is a conservative scenario in which buildings would achieve a 2013 Title 24 energy efficiency standard. The Nishi development, as mitigated, would reflect a 30 percent better than 2013 Title 24 standard, application of water efficient fixtures, and 20 percent reduction in VMT, per Mitigation Measure 4.14-5 and CO₂e are calculated using IPCC Fifth Assessment 100 year lifetime global warming potential factors. Potential to increase or reduce carbon sequestration potentials is not included due to no BAU scenario for sequestration available from AB32.

Summation may not equal totals due to rounding. Electricity, natural gas, and mobile emissions modeled separately from CalEEMod. Electricity emissions assume PG&E will attain 33 percent renewables by 2020. Water and wastewater emissions account for supply, conveyance, and treatment electricity use. Solid waste emissions account for decomposition emissions, as modeled within CalEEMod. Unmitigated mobile source emissions are based on 45,200 VMT per day for 365 days per year. CO₂e are calculated using IPCC Fifth Assessment 100 year lifetime global warming potential factors.

BAU = Business as Usual
 CO₂e = carbon dioxide equivalents
 MT = metric tons
 CalEEMod = California Emissions Estimator Model v. 2013.2.2
 IPCC = International Panel on Climate Change

Source: Data provided by Ascent Environmental, Inc. in 2015 based on modeling using CalEEMod v. 2013.2.2 and EMFAC 2014 and using data from Davis Energy Group, Cunningham Engineering, and Fehr and Peers. (Davis Energy Group 2015, Cunningham Engineering 2015, Grandy, Pers. Comm., 2015, IPCC 2013)

West Olive Drive

Redevelopment of West Olive Drive has the potential to increase the intensity of current land uses, either by building more densely or serving a growing population. There is no guarantee of whether new land uses would impede or be inconsistent with AB32, EO B-15-30, SACOG MTP/SCS per capita targets, or the D-CAAP. Therefore, this impact is **potentially significant**.

The level of operation of potential redevelopment of uses within West Olive Drive could increase from existing conditions depending on the type and size of land uses that could be on site. Increased activity along West Olive Drive could contribute to increased energy demand and vehicle trips. However the design

of the redeveloped buildings would need to comply with the latest building codes, and overall emissions from energy use would be determined by the carbon intensity of PG&E's supplied electricity and any on-site renewable energy generation. Carbon intensities of supplied electricity is anticipated to decrease over time as the state aims to exceed the current 33 percent RPS goal by 2020. Average vehicle emission factors are also anticipated to decrease over time, as forecasted by ARB (ARB 2015a). Further, the anticipated redevelopment (neighborhood mixed use) would likely provide uses/services that may increase pedestrian and alternative transportation in the area, thereby further reducing VMT and transportation-related GHG emissions. It is reasonable to assume that redevelopment within West Olive Drive would be GHG efficient compared to existing development, however the extent to which it would achieve GHG reductions in accordance with GHG reduction targets is unclear.

*Redevelopment of West Olive Drive has the potential to increase the intensity of current land uses, either by building more densely or serving a growing population. There is no guarantee of whether new land uses would impede or be inconsistent with AB32, EO B-15-30, SACOG MTP/SCS per capita targets, or the D-CAAP. Therefore, this impact is **potentially significant**.*

Mitigation Measures

Implement Mitigation Measures 4.14-5 (Transportation Demand Management program), 4.7-2a (GHG Reduction Targets), and 4.7-2b (GHG Reduction Accountability).

Significance after Mitigation

Through the implementation of Mitigation Measure 4.14-5, which requires the development and implementation of a transportation demand management program, the West Olive Drive redevelopment could reduce VMT generated by the on-site land uses, but the ability to which the land uses can implement the TDM measures would depend on physical, logistical, fiscal constraints determined by each redeveloped land use. Implementation of Mitigation Measures 4.7-2a and 4.7-2b would set GHG reduction targets and accountability for the redevelopment along West Olive Drive. While dedicated GHG reduction targets would allow the redevelopment to be consistent with the goals of AB32, EO B-15-30, and the D-CAAP, it remains to be seen whether future proposed land uses along West Olive Drive would be able to apply applicable TDM measures from Mitigation Measure 4.14-5. Due to the uncertainty related to the ability of West Olive Drive redevelopment to achieve SACOG MTP/SCS per capita transportation emission targets, this impact would be **significant and unavoidable**.

Impact 4.7-4: Result in unnecessary, inefficient, and wasteful use of energy.

Nishi Site

Development of the Nishi site would increase energy demands as a result of operation of on-site uses. However, compliance with existing City code requirements, as well as efficiency design measures resulting from the sustainability planning effort completed by the City, would ensure that the project would not result in an inefficient or wasteful expenditure of energy. This would be a **less-than-significant** impact.

Appendix F of the State CEQA Guidelines requires consideration of the potentially significant energy implications of a project. CEQA requires mitigation measures to reduce "wasteful, inefficient and unnecessary" energy usage (Public Resources Code Section 21100, subdivision [b][3]). However, neither the law nor the State CEQA Guidelines establish thresholds that define wasteful, inefficient, or unnecessary use. Compliance with California's Title 24 Energy Efficiency Standards would generally promote energy efficiency of structures during operation. However, compliance with building codes does not adequately address all potential energy impacts during project construction and operation. For example, energy would be required to transport people to and from the project site.

Development of the Nishi site would result in energy use as a result of both short-term construction and long-term operational activities. Mobile energy use would include consumption of gasoline, diesel, natural gas, electricity, or other fuels to be used in motor vehicles. Stationary energy use, which would occur

predominantly during operation of the project, would include electricity and natural gas in building heating and cooling systems, lighting, appliances, or other activities within buildings or site infrastructure; as well as off-site energy use for pumping water and wastewater.

Construction activities at the project site would occur periodically for a period of approximately 5-7 years and would occur in two phases (approximately 30 months in duration each.) During construction, energy used during project construction and operation would be expended in the form of electricity, gasoline, and diesel fuel, which would be used primarily by construction equipment and haul trucks travelling to and from the project site during construction. The energy used for project construction would not require significant additional capacity or significantly increase peak or base period demands for electricity and other forms of energy. There are no unusual project characteristics that would necessitate the use of construction equipment that would be less energy efficient than those used at comparable construction sites in other parts of the State. Idling of on-site equipment during construction would be limited to no more than five minutes in accordance with YSAQMD requirements. Further, on-site construction equipment may include alternatively-fueled vehicles (such as natural gas) where feasible. Furthermore, the selected construction contractors would use the best available engineering techniques, construction and design practices, and equipment operating procedures, thereby ensuring that the wasteful consumption of fuels and use of energy would not occur. Energy efficiency is also expected for the off-site production of construction materials, based on the economic incentive for efficiency. Non-renewable energy would not be consumed in a wasteful, inefficient, or unnecessary manner when compared to other construction sites in the region.

Project operation would be typical of residential and R&D uses, requiring electricity and natural gas for lighting, climate control, and day-to-day activities. Operational energy use would also include landscape maintenance. Indirect energy use would include wastewater treatment and solid waste removal. As noted in Chapter 3, "Project Description," and Impact 4.7-3 above, the project would be required to exceed 2013 Title 24 standards for energy efficiency by 30 percent. As noted above, implementation of the California Building Efficiency Standards (Title 24, Section 6) typically achieves 25 percent greater energy efficiency than buildings constructed under previous energy efficiency standards developed in 2008 (CEC 2012a). As the project would achieve 30 percent greater efficiency than 2013 Title 24 standards, it would represent some of the most energy efficient structures built in the state to date. Further, the 2016 Title 24 standards, which will not be effective until January 1, 2017, are projected to be 28 percent more efficient than the current 2013 Title 24 standards (CEC 2015a). Therefore, compared to 2013 Title 24 standards, the project would be more efficient than building standards that have yet to take effect. Furthermore, the project would include additional on-site efficiency measures, including rooftop and surface parking lot solar panels to reduce electricity consumption and increase efficiency further. As a result, the project would be among the most efficient developments from an on-site energy perspective.

With respect to energy/fuel consumption related to vehicle usage, the project would include design measure to encourage the use of pedestrian and bicycle trails and transit opportunities, such as connection to existing facilities within the Putah Creek channel, along Richards Boulevard, and on UC Davis campus. Further, Mitigation Measure 4.14-5 would reduce project-related VMT by 20 percent through transportation demand management, thereby increasing the efficiency of fuel consumption.

*According to Appendix F of the CEQA Guidelines, the means to achieve the goal of conserving energy include decreasing overall energy consumption, decreasing reliance on natural gas and oil, and increasing reliance on renewable energy sources. While the project would increase the overall energy demand in the City of Davis, the project would reduce energy use compared to similar and existing development within UC Davis, thereby providing a relatively energy efficient community, and would encourage use of renewable energy sources and alternatives to travel by personal vehicle. As a result, the project would not result in an inefficient or wasteful consumption of energy. This impact would be **less than significant**.*

Mitigation Measures

No mitigation measures are required.

West Olive Drive

Potential redevelopment of the Nishi site would increase energy demands as a result of operation of on-site uses. However, compliance with existing City code requirements and building standards employed at the time redevelopment is proposed would ensure that the project would not result in an inefficient or wasteful expenditure of energy. This would be a **less-than-significant** impact.

Similar to what was noted above for the Nishi site, construction and operation associated with the potential redevelopment of West Olive Drive may increase energy consumption. However, compared to the Nishi site, the scale of the increase in energy consumption are anticipated to be less based on the potential level of redevelopment that could occur. Construction associated with redevelopment of West Olive Drive is anticipated to be conducted in a manner similar to that of the Nishi site, including adherence to idling limitations and the use of best available construction techniques. Operation of potential redeveloped uses within West Olive Drive would result in the replacement of older, less efficient structures with more energy efficient buildings that would be intended to dovetail with existing and proposed (Nishi) development in the area. This may result in increased trip reduction through the provision of necessary commercial uses in proximity to residents. Nonetheless, as potential redevelopment would involve the operation of more energy efficient structures, consistent with building standards required at the time of construction, than currently exist on-site, the operation of more energy efficient uses would not result in the wasteful or unnecessary use of energy.

*Because the potential redevelopment of West Olive Drive would result in the replacement of existing on-site structures with more energy efficient uses, the rezoning and redevelopment of West Olive Drive (and associated redevelopment) would not result in the wasteful, inefficient, or unnecessary use of energy resources. This would be a **less-than-significant** impact.*

Mitigation Measures

No mitigation measures are required.

Impact 4.7-5: Conflict, or create an inconsistency, with any applicable plan, policy, or regulation adopted for the purpose of avoiding or mitigating environmental effects related to greenhouse gas emissions or energy.

Nishi Site

Implementation of the project within the Nishi site would be consistent with the policies of the City of Davis General Plan related to energy and GHG emissions. This would be a **less-than-significant** impact.

The City of Davis General Plan includes policies to protect environmental resources, including energy resources and GHG emissions. The development's consistency with GHG emission policies as discussed in the General Plan's Transportation element is addressed in Impact 4.14-10. The features of the proposed development of the Nishi site and mitigation measures discussed in this document are consistent with the policies of the City of Davis General Plan as shown in Table 4.7-6.

*Development of the Nishi site as part of the project would not conflict with any local policies or ordinances protecting air quality. Impacts would be **less than significant**.*

Table 4.7-6 City of Davis General Plan Policy Consistency

Policy	Project Consistency
Policy ENERGY 1.3 Promote the development and use of advanced energy technology and building materials in Davis.	The Nishi development would be designed to exceed 2013 Title 24 building standards by 30 percent and also include on-site solar electricity generation that could offset 87 percent of on-site electricity demand. Redevelopment of West Olive Drive would involve the replacement of on-site structures with more energy efficient buildings in compliance with energy requirements employed at the time of redevelopment. As a result, the project would be consistent with this policy.
Policy ENERGY 1.5 Encourage the development of energy-efficient subdivisions and buildings.	Refer to discussion above for Policy ENERGY 1.3.

Mitigation Measures

No mitigation measures are required.

West Olive Drive

Redevelopment that could occur as a result of the redesignation/rezoning of parcels located in West Olive Drive would be consistent with the policies of the City of Davis General Plan related to energy and GHG emissions. This would be a **less-than-significant** impact.

Similar to what was discussed above, potential redevelopment of West Olive Drive would not create conflicts or result in inconsistencies with the policies of the City General Plan related to energy and GHG emissions. The redevelopment's consistency with the General Plan's Transportation element is addressed in Impact 4.14-10.

*Potential redevelopment associated with the proposed General Plan Amendment and zoning change of West Olive Drive would not conflict with any regulations established for the protection of energy. Impacts would be **less than significant**.*

Mitigation Measures

No mitigation measures are required.

ITEM 11.1.

EXHIBIT 3

6 GREENHOUSE GAS EMISSIONS

6.1 INTRODUCTION

The California Environmental Quality Act (CEQA) requires that lead agencies consider the environmental effects of projects they are considering for approval. Greenhouse gas (GHG) emissions adversely affect the environment by contributing, on a cumulative basis, to global climate change. In turn, global climate change will increase sea levels, which can inundate low-lying areas; affect rain and snow fall, leading to changes in water supply; exacerbate the intensity of storms and other extreme weather, endangering human life and infrastructure; and increasing temperatures, leading to adverse effects on public health, agriculture, habitats, and biological and other resources. Thus, GHG emissions require consideration in CEQA documents.

Climate change is a global problem. GHGs are global pollutants, unlike criteria pollutants and toxic air contaminants, which are pollutants of regional and local concern. Whereas pollutants with localized air quality effects have relatively short atmospheric lifetimes (about 1 day), GHGs have long atmospheric lifetimes (1 year to several thousand years). GHGs persist in the atmosphere for time periods long enough to cause them to be dispersed around the globe, and they cause global effects. The atmospheric concentration of GHGs determines the intensity of global warming, with current levels already leading to dangerous increases in global temperatures, accompanied by sea level rise, severe weather, and other environmental impacts. The continued increase in atmospheric GHG concentrations will only worsen the severity and intensity of climate change, locking in perhaps irrevocable environmental changes. Therefore, from the standpoint of CEQA, GHG impacts to global climate change are inherently cumulative.

Prominent GHGs of primary concern from land use development projects include carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Other GHGs such as hydrofluorocarbons (HFC), chlorofluorocarbons, and sulfur hexafluoride are of less concern because construction and operational activities associated with land use development projects are not likely to generate substantial quantities of these GHGs. HFCs are primarily used in air-conditioning and refrigeration systems and are getting increased attention with the passage of [SB 1383](#). SB 1383 requires a 40 percent reduction of HFC emissions from 2013 levels by 2030. A discussion of measures to reduce HFCs is included in the California Air Resources Board's [Short-Lived Climate Pollutant Reduction Strategy](#) (March 2017). Other pollutants being addressed by the *Short-Lived Climate Pollutant Reduction Strategy* include methane and black carbon, which can be reduced by diverting organic material from landfills, reducing residential wood burning, and reducing diesel fuel combustion.

Land use development projects typically include the following sources of GHG emissions:

- Construction activities that result in exhaust emissions of GHGs from fuel combustion for mobile heavy-duty diesel- and gasoline-powered equipment, portable auxiliary equipment, material delivery trucks, and worker commuter trips;
- Motor vehicle trips generated by the particular land use (i.e. vehicles arriving and leaving the project site), including those by residents, shoppers, workers, and vendors;
- Onsite fuel combustion for space and water heating, landscape maintenance equipment, and fireplaces/stoves; and
- Offsite emissions at utility providers associated with the project's demand for electricity, water conveyance, and wastewater processing.

Generally, the District agrees that GHG emissions are best analyzed and mitigated at the program level; however, since not all jurisdictions in Sacramento County have conducted program level GHG analyses, such as a GHG reduction plan or climate action plan, the District offers the guidance contained in this chapter for addressing the GHG emissions associated with individual development projects. Please refer to [Chapter 9, Program Level Analysis of Plans](#), for recommendations for assessing and mitigating GHG emissions-related impacts at the program level.

The guidance presented in this chapter takes into consideration the following bodies of work produced by other agencies and organizations in the state:

- California Air Pollution Control Officers Association's (CAPCOA) white paper titled [CEQA & Climate Change: Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act](#) (January 2008);
- California Air Resources Board's (ARB) [Climate Change Scoping Plan](#) (December 2008, re-approved August 24, 2011);
- ARB's [First Update to the Climate Change Scoping Plan](#) (May 2014);
- ARB's [California's 2017 Climate Change Scoping Plan, The strategy for achieving California's 2030 greenhouse gas target](#) (November 2017);
- Governor's Office of Planning and Research's (OPR) technical advisory, [CEQA and Climate Change: Addressing Climate Change through California Environmental Quality Act Review](#) (June 2008);
- The California Natural Resources Agency's [CEQA Guidelines](#);
- California Air Pollution Control Officers Association's (CAPCOA) white paper titled [Model Policies for Greenhouse Gases in General Plans](#) (June 2009); and

- California Air Pollution Control Officers Association's (CAPCOA) [Quantifying Greenhouse Gas Mitigation Measures](#) (August 2010).

In November 2008, Governor Arnold Schwarzenegger issued [Executive Order S-13-08](#) to enhance the state's management of climate impacts from sea level rise, increased temperatures, shifting precipitation, and extreme weather events. The Executive Order directs the state agencies to request that the National Academy of Sciences convene an independent panel to complete the first California Sea Level Rise Assessment Report. The agencies involved in the project include the California Resources Agency; the Department of Water Resources; the California Coastal Commission; the California Ocean Protection Council; California State Parks; and the California Energy Commission (CEC). The Executive Order directed OPR to provide state land-use planning guidance related to sea level rise and other climate change impacts. In addition, SB 379, approved in 2015, asked that local governments address their vulnerabilities to climate impacts and adaptation strategies in their general plans or their local hazard mitigation plans. **Therefore, the District recommends that lead agencies address the impacts of climate change on a proposed project and its ability to adapt to these changes in CEQA documents.** It is anticipated that guidance on addressing this issue will be provided by the state agencies identified above and not the District. OPR's [website](#) contains resources and links related to adaptation. Additional resources include [Cal-Adapt](#), the [Safeguarding California and Climate Change Adaptation Policy](#), and [California's Fourth Climate Change Assessment](#). The Sacramento Area Council of Governments (SACOG) 2016 update to the [2035 Metropolitan Transportation Plan and Sustainable Communities Strategy](#) (MTP/SCS) included a climate adaptation action plan providing an overview of climate vulnerabilities for the region and establishing strategies to help the region's transportation system adapt to climate change impacts. The [2020 MTP/SCS](#) continues to provide resiliency policies.

The District acknowledges that the warming trends associated with climate change in the Sacramento region are expected to result in more episodes of unhealthy levels of ground-level ozone which will adversely affect residents and workers of proposed projects, among other impacts. Nevertheless, the primary focus of this chapter is to provide guidance about evaluating whether the GHG emissions associated with a proposed project will be responsible for making a cumulatively considerable contribution to global climate change.

REGULATORY SETTING

In September 2006, Governor Arnold Schwarzenegger signed [Assembly Bill \(AB\) 32](#), the California Global Warming Solutions Act of 2006. AB 32 established regulatory, reporting, and market mechanisms to achieve quantifiable reductions in GHG emissions and a cap on statewide GHG emissions. AB 32 required that statewide GHG emissions be reduced to 1990 levels by 2020. AB 32 also included guidance to institute emission reductions in an economically efficient manner and conditions to ensure that businesses and consumers are not unfairly affected by the

reductions. AB 32 demonstrated California's commitment to reducing GHG emissions without intent to limit population or economic growth. On April 29, 2015, Governor Edmund Brown Jr. issued [Executive Order B-30-15](#). Executive Order B-30-15 required greenhouse gas emissions in California be reduced by 40 percent below 1990 levels by 2030, and 80 percent below 1990 levels by 2050. On September 8, 2016, Governor Brown signed Senate Bill 32 (SB 32) into law which codified the mandate to reduce GHG emissions by 40 percent below 1990 levels by 2030.

CEQA requires lead agencies to identify the potentially significant effects on the environment of projects they intend to carry out or approve, and to mitigate significant effects whenever it is feasible to do so. Although AB 32 did not amend CEQA, it identifies the myriad environmental problems in California caused by global warming ([Health and Safety Code, Section 38501\(a\)](#)).

[Senate Bill \(SB\) 97](#), enacted in 2007, amended the CEQA statute to establish that GHG emissions and their effects are a prominent environmental issue that require analysis and identification of feasible mitigation under CEQA. GHG emissions were incorporated into the CEQA Guidelines on March 18, 2010.

In June of 2008, OPR published a technical advisory entitled [CEQA and Climate Change: Addressing Climate Change through California Environmental Quality Act Review](#). OPR recommends that the lead agencies under CEQA make a good-faith effort, based on available information, to estimate the quantity of GHG emissions that will be generated by a proposed project, including the emissions associated with vehicular traffic, energy consumption, water usage, and construction activities, to determine whether the emissions have the potential to result in a cumulative impact and to mitigate the impacts where feasible. In that document, OPR acknowledged that "perhaps the most difficult part of the climate change analysis will be the determination of significance," and noted that "OPR has asked the California Air Resources Board (ARB) technical staff to recommend a method for setting thresholds which will encourage consistency and uniformity in the CEQA analysis of GHG emissions throughout the state." To date, ARB has not adopted thresholds.

In December 2008, ARB adopted its [Climate Change Scoping Plan](#) (*Scoping Plan*), which is the State's plan to achieve GHG reductions in California required by AB 32. The *Scoping Plan* includes ARB-recommended GHG reductions for each emission sector of the state's GHG inventory. The largest proposed GHG reductions recommended are from improving emission standards for light-duty vehicles, implementation of the Low-Carbon Fuel Standard, employing energy efficiency measures in buildings and appliances, the widespread development of combined heat and power systems, and applying a renewable portfolio standard for electricity production. ARB has not determined what statewide reduction in GHG emissions shall be achieved from changes in local government (municipal) operations; however, the *Scoping Plan* does state that land use planning and urban growth decisions will play an important role in the state's GHG reductions because

local governments have primary authority to plan, zone, approve, and permit how land is developed to accommodate population growth and the changing needs of their jurisdictions. ARB further acknowledges that decisions on how land is used will have large impacts on the GHG emissions that will result from the transportation, housing, industry, forestry, water, agriculture, electricity, and natural gas emission sectors. The *Scoping Plan* was re-approved by the ARB on August 24, 2011, after ARB updated its Functional Equivalent Document. ARB adopted the [First Update to the Climate Change Scoping Plan](#) on May 22, 2014. The update reports on the progress made towards meeting the 2020 GHG reduction goals; lays groundwork for longer term reduction goals; and discusses opportunities to leverage funds to drive additional GHG reductions. In December 2017, ARB adopted [California's 2017 Climate Change Scoping Plan, the strategy for achieving California's 2030 greenhouse gas target](#), setting the path towards the ultimate reduction goal of 2050.

A comprehensive discussion of regulatory actions taken by federal and state agencies related to GHG is included in the District's [Greenhouse Gas Thresholds in Sacramento County](#) document supporting updated thresholds of significance, released March 4, 2020.

Regional GHG reduction targets are aligned with regional transportation planning efforts and land use and housing allocations through SB 375, signed into law in September 2008. SB 375 requires Metropolitan Planning Organizations (MPOs) to adopt a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS), which will prescribe land use allocations in that MPO's Regional Transportation Plan (RTP). On April 19, 2012, SACOG adopted its 2035 Metropolitan Transportation Plan and associated SCS (MTP/SCS), the first plan to meet the requirements of SB 375. Updated MTP/SCSs were adopted by SACOG on February 18, 2016 and November 18, 2019.

With the passage of Senate Bill 743 in 2013, the Governor's Office of Planning and Research (OPR) amended the State CEQA Guidelines providing alternative criteria to level of service (LOS) for evaluating transportation impacts. The goal of the new criteria is to promote the reduction of GHG, the development of multimodal transportation networks, and a diversity of land uses. OPR provides [documents](#) to evaluate vehicle miles traveled (VMT) as the alternative to LOS. Local jurisdictions must implement SB 743 by July 1, 2020 or do additional transportation analysis on a project by project basis.

The 2017 Climate Change Scoping Plan notes that SB 375 efforts, if fully implemented, do not provide enough light-duty transportation sector reductions for the state to meet the 2050 GHG targets. As such, land use and transportation projects consistent with the MTP/SCS may still need additional GHG reductions to be consistent with state climate change goals. In January 2019, ARB released the [California Air Resources Board 2017 Scoping Plan-Identified VMT Reductions and Relationship to State Climate Goals](#), which provides additional information on

what level of statewide VMT reduction would promote achievement of statewide GHG emissions reduction targets.

6.2 ANALYSIS EXPECTATIONS

The District recommends that CEQA analyses addressing the potential impacts of project-generated GHG emissions include the following:

- A summary of the current state of the science with respect to GHGs and climate change. [U.S. Global Change Research Program](#), [NASA](#), [California Climate Change Assessments](#), and [OEHHA's Indicators of Climate Change in California](#) provide good resources;
- A description of the existing environmental conditions or setting, without the project, which constitutes the baseline physical conditions for determining the project's impact;
- A discussion of the existing regulatory environment pertaining to GHGs;
- Identification of the thresholds of significance applicable to the proposed project. The District provides [recommended thresholds](#), including required Best Management Practices for operational emissions, for agencies without adopted GHG reduction plans (climate action plans) or their own adopted thresholds and for projects that are inconsistent with an agency's adopted GHG reduction plan;
- A discussion of the GHG emission sources associated with the project's construction and operational activities;
- Discussion of whether the project's size qualifies it to be analyzed using the District's construction screening level for GHG emissions, discussed in Section 6.3.1;
- If the analysis cannot be completed using the District's construction screening level, a quantification of the annual mass emissions of GHGs that will be generated by project construction, and the input parameters and assumptions used to estimate these values;
- Identification of the earliest year in which operational emissions of GHGs are anticipated to commence;
- Discussion of whether the project's scope and size qualify it to be analyzed using the District's [Operational Screening Levels table](#) (which lists sizes of land uses not expected to exceed 1,100 metric tons of CO₂e per year), including implementation of required tier 1 Best Management Practices;
- If the analysis cannot be completed using the District's operational screening levels table, including implementation of required tier 1 Best

ITEM 11.1.

Management Practices, a quantification of the annual mass emissions of GHGs that will be generated by project operations, and the input parameters and assumptions used to estimate these values, including implementation of required tier 2 Best Management Practices;

- A discussion of whether project construction- and operations-related GHG emissions will exceed the established significance thresholds and the resulting determination of whether the construction and operational GHG emissions, without mitigation, will represent a cumulatively considerable contribution to the significant cumulative impact;
- A discussion of feasible construction mitigation necessary to reduce impacts and make a determination whether the mitigation will be sufficient to reduce the project's construction GHG contribution to the significant cumulative impact to a less than considerable level;
- A discussion of operational mitigation, including implementation of required tier 1 and tier 2 operational Best Management Practices (or equivalent on-site or off-site mitigation) necessary to reduce impacts and make a determination whether the mitigation will be sufficient to reduce the project's operational GHG contribution to the significant cumulative impact to a less than considerable level; and
- With state-wide GHG reduction targets established in 2030 and 2050, and carbon free electricity targeted in 2045, analysts are advised to include a discussion of how the project will be consistent with these targets.

6.3 METHODOLOGIES

The evaluation of GHG emissions considers the following questions regarding Greenhouse Gas Emissions from the Environmental Checklist Form, [Appendix G of the State CEQA Guidelines](#):

VIII.a. Will the project generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment?

VIII.b. Will the project conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs?

The State CEQA Guidelines [Section 15064.4](#) states that a lead agency must make a good faith effort, based on available information, to describe, calculate, or estimate the amount of GHG emissions resulting from a project. The guidelines give the lead agency the discretion to select the most appropriate tools based on substantial evidence. The District's recommendations on appropriate methodology and tools for analyzing GHG emissions are provided in the following sections. Additionally, the District created an [applicability flow chart](#) to assist lead agencies

and project proponents with properly evaluating operational GHG emissions, thresholds, and best management practices.

6.3.1 ASSESSING MASS EMISSIONS

LAND USE DEVELOPMENT PROJECTS

Screening

The District assumes that projects described in CEQA's categorical and statutory exemption provisions ([Articles 18 and 19 of the California Code of Regulations, Title 14](#)) will not interfere with achieving emission reductions from new projects subject to CEQA. The District also assumes that GHG emissions from residential and commercial projects that are described in the categorical exemption language appear to be relatively small from a GHG perspective and may be considered less-than-cumulatively considerable.

For projects within the District's jurisdiction not described in CEQA's categorical and statutory exemption provisions, the District has developed screening levels to help lead agencies analyze operational and construction GHG emissions. The [GHG Operational Screening Levels table](#) shows the size of development (by land use type) at which 1,100 metric tons of GHG per year would not be exceeded. If a project is less than or equal to 1,100 metric tons of GHG per year and implements the District's tier 1 operational GHG Best Management Practices (noted in Section 6.4.1), the District's operational GHG threshold of significance would not be exceeded. In addition, the District has determined that projects below the GHG Operational Screening Levels would not exceed the District's construction GHG threshold of significance if the project meets the parameters in Chapter 3, Section 3.3.1 for the construction NOx screening level.

Therefore, operational and construction emissions from projects that are smaller than the land use sizes in the Operational Screening Levels table, implement the District's tier 1 operational GHG Best Management Practices, and also meet the parameters outlined in Chapter 3, Section 3.3.1 regarding construction may be considered less-than-cumulatively considerable.

[CEQA Guidelines Section 15183.5](#) includes the provision for tiering and streamlining the analysis of GHG emissions in CEQA documents. Under this provision, lead agencies may analyze and mitigate the effects of GHG emissions at a programmatic level, such as in a general plan, a long range development plan, or a separate plan to reduce GHG emissions such as a Climate Action Plan developed by a local jurisdiction, or a sustainable communities strategy developed by the metropolitan planning organization. Later project-specific CEQA documents may tier and/or incorporate by reference that existing programmatic review if the proposed project is consistent with the applicable regional or local plan that adequately addresses GHG emissions, and that plan has been evaluated pursuant

to CEQA and has a certified or approved environmental document. More guidance on program-level GHG emissions analysis is included in [Chapter 9](#).

Pursuant to CEQA Guidelines Sections [15064\(h\)\(3\)](#) and [15130\(d\)](#), a lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project complies with the requirements in a previously adopted plan or mitigation program under specified circumstances. CEQA Guidelines Section [15183.5\(b\)\(2\)](#) provides additional detail regarding use of an adopted GHG emissions reduction plan with later projects.

Quantification of GHG Emissions

CEQA is a public disclosure law that requires lead agencies to make a good-faith, reasoned effort, based upon available information, to identify the potentially significant direct and indirect environmental impacts - including cumulative impacts - of a proposed project. The District recommends the lead agency quantify the GHG emissions anticipated to be generated by a proposed project that does not meet the requirements of a categorical or statutory exemption, that cannot show consistency with the jurisdiction's adopted climate action plan or GHG reduction plan (if applicable), or that exceeds the screening levels in the [GHG Operational Screening Levels table](#) (projects below the screening levels must also implement required tier 1 Best Management Practices to avoid quantification). Direct and indirect emissions of GHGs from the project, which include construction emissions, area- and mobile-source emissions, and indirect emissions from in-state energy production and water consumption (energy for conveyance, treatment, distribution, and wastewater treatment), must be quantified and disclosed in the CEQA document. Operational calculations must also include vehicle miles traveled per resident and per worker. The annual and total amount of a project's construction related GHG emissions and the operational GHG emissions generated per year over the lifetime of the project should be disclosed separately. The most recent version of the [California Emissions Estimator Model \(CalEEMod\)](#) is the recommended analysis tool to quantify project GHG emissions. Lead agencies should discuss the use of other analysis tools with the District prior to use.

Construction Emissions

District-recommended methodologies for quantifying construction GHG emissions include using [CalEEMod](#) for proposed land use development projects and the [Roadway Construction Emissions Model](#) for proposed projects that are linear in nature.

Please note that sources of construction-related GHG emissions only include exhaust, for which the lead agency can follow the same detailed guidance as described in [Chapter 3, Construction-Generated Criteria Air Pollutant and Precursor Emissions](#) for criteria air pollutants and precursors. CalEEMod output for construction related GHG emissions must be disclosed in the CEQA document and treated as a net increase in emissions.

For linear construction projects such as construction of a new roadway, road widening, roadway overpass, levee, or pipeline, the District recommends the use of the most current version of the Roadway Construction Emissions Model. This model is a spreadsheet-based tool that uses basic project information (e.g., total construction months, project type, total project area) to estimate a construction schedule and quantify GHG emissions from heavy-duty construction equipment, haul trucks, and worker commute trips associated with linear construction projects. Lead agencies should refer to Chapter 3 for guidance on using the Roadway Construction Emissions Model.

Operational Emissions

Operational GHG emissions from a project should be calculated and reported for the first full year of operation in annual metric tons of carbon dioxide equivalents (CO₂e). Vehicle miles traveled per resident and per worker should also be calculated for comparison to tier 2 Best Management Practices, if applicable. Direct and indirect emissions from the project must be estimated using the most current version of [CalEEMod](#) in accordance with the CalEEMod User's Guide and the District's [User Tips](#). Section 5 of the District's [Greenhouse Gas Thresholds for Sacramento County](#) describes methods to modify CalEEMod inputs for operational emissions calculations (electricity, natural gas, and trip generation rate adjustments). The District encourages the use of project-specific information whenever possible.

If project emissions exceed the District's GHG operational screening levels table, the project would then apply the District's tier 1 and tier 2 Best Management Practices to reduce GHG emissions from the project. The Best Management Practices are fully described in Section 6.4, Mitigation.

STATIONARY-SOURCE FACILITIES

An emissions unit consists of a single emission source with an identified emission point, such as a stack, at a facility. Facilities can have multiple emission units located on-site and sometimes the facility as a whole is referred to as a "stationary source." Stationary sources are typically associated with industrial processes. Examples include boilers, heaters, flares, cement plants, and other types of combustion equipment.

AB 32 required ARB to adopt regulations that require the monitoring and annual reporting of GHG emissions from the sources that "contribute the most to statewide emissions", and account for the GHG emissions from all electricity consumed in California, including transmission and distribution line losses from electricity generated within the state or "imported from outside the state." Pursuant to AB 32, ARB adopted the [Greenhouse Gas Mandatory Reporting Regulation](#) in December 2007. The regulations require certain stationary sources, including, but not limited to, cement plants, petroleum refineries, and operators, retail providers and marketers involved in electric generation within California or the import or export of electricity across California borders, to comply with

ITEM 11.1.

monitoring and reporting guidelines associated with their GHG emissions. The rule also applies to operators of other facilities in California that emit greater than or equal to 25,000 metric tons CO₂/year from stationary combustion sources.

GHG Emissions Reporting Tool

The [California Electronic Greenhouse Gas Reporting Tool](#), or Cal e-GGRT, is a web-based annual reporting tool managed by ARB. The tool facilitates tracking and reporting of annual data required under the ARB Mandatory Reporting Regulation. It provides for the assignment of reporting personnel, set-up of source inventory information, and annual reporting of emissions and other data in a manner that directly addresses the requirements of the regulation. Additional elements of the same tool provide for tracking and certification of emission reports and data verification by third-party verifiers. Reporters subject to California's [Greenhouse Gas Mandatory Reporting Regulation](#) must submit their data to ARB using Cal e-GGRT. The Reporting Tool can be used to disclose a stationary source's GHG emissions in a CEQA document.

Manual Estimation

Stationary source GHG emissions may be estimated manually. District staff should be consulted to ensure the emission factors and calculation methods are appropriate for CEQA and permitting purposes.

6.3.2 DETERMINING LEVEL OF SIGNIFICANCE

LAND USE DEVELOPMENT PROJECTS

AB 32 demonstrated California's commitment to reducing GHG emissions and the state's associated contribution to climate change, without intent to limit population or economic growth within the state. To meet AB 32 goals, California must reduce GHG emissions to 1990 levels by 2020. To meet the goals of [Executive Order B-30-15](#), California must reduce GHG emissions 40 percent below 1990 levels by 2030, and 80 percent below 1990 levels by 2050. On September 8, 2016, Governor Brown signed Senate Bill 32 (SB 32) into law which codified the mandate to reduce emissions by 40 percent below 1990 levels by 2030. The District recognizes that although there is no known level of emissions that determines if a single project will substantially impact the environment, a threshold must be set to trigger review and to assess the need for mitigation.

Lead agencies shall compare the project's estimated GHG emissions to the [District's recommended thresholds of significance](#):

- Construction phase of all project types -1,100 metric tons of CO₂e per year.
- Stationary source operational emissions - 10,000 metric tons of CO₂e per year.

- Land development project operational emissions are reviewed in the context of consistency with ARB's 2017 Climate Change Scoping Plan (which pertains to the second GHG-related question from appendix G).

If a project's emissions exceed the thresholds of significance for construction or stationary source emissions, then the project emissions may have a cumulatively considerable contribution to a significant cumulative environmental impact, answering Appendix G's first GHG-related question on whether the project would generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.

For projects that exceed the District's thresholds of significance, lead agencies shall implement all feasible mitigation to reduce GHG emissions, discussed in Section 6.4, Mitigation.

The second GHG-related question in Appendix G asks if the project will conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs. In order to answer this question, project emissions should be evaluated with respect to consistency with the following plans and policies, if applicable, that have been adopted to reduce GHG emissions:

- A jurisdiction's qualified climate action plan or GHG reduction plan.
- The Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS).
- ARB's 2017 Climate Change Scoping Plan (including State climate goals beyond 2030).

In April 2020, the District adopted an update to the land development project operational GHG threshold, which requires a project to demonstrate consistency with ARB's 2017 Climate Change Scoping Plan. The District's technical support document, [Greenhouse Gas Thresholds for Sacramento County](#), identified operational measures that should be applied to a project to demonstrate consistency. The measures target GHG emissions inventory areas where State measures did not fully achieve reductions, allowing for local supportive measures. These measures, known as tier 1 and tier 2 Best Management Practices are discussed in Section 6.4, Mitigation. The District's [applicability flow chart](#) is a good reference to ensure the required best management practices are included in the project.

Construction Emissions

Lead agencies shall estimate and report a land use development or stationary source project's construction GHG emissions for each year of construction. Lead agencies shall compare the project's annual construction GHG emissions to the District's 1,100 metric ton per year threshold of significance. If the threshold is exceeded, then the project may have a cumulatively considerable contribution to

a significant cumulative environmental impact, and all feasible mitigation is required.

Operational Emissions

Lead agencies shall estimate and report a project's annual operational GHG emissions in the first year of full operation (or if various phases, for each phase of operation) for projects that cannot screen out by comparing to the District's operational screening levels table (equivalent to 1,100 metric tons of CO₂e per year), including implementation of tier 1 Best Management Practices. If the project emissions exceed the screening level, or the project fails to implement tier 1 Best Management Practices, the project may have a cumulatively considerable contribution to a significant cumulative environmental impact, and all feasible mitigation is required. Projects exceeding the screening level, must implement tier 1 and tier 2 Best Management Practices, or provide equivalent on-site or off-site mitigation measures.

For purposes of evaluating a project's consistency with the 2045 statewide carbon neutrality goal, a project would need to eliminate natural gas completely (BMP 1) or require all pre-wiring necessary so that the buildings are ready for a future retrofit to all-electric. Additionally, for a project located in an area with relatively high vehicle miles traveled per capita (resident and worker) the project would need to provide sufficient electrical capacity that 100% of project vehicles have the potential to be zero emission vehicles. Qualitatively, the project would be required to show that it is not otherwise impeding the 2045 statewide carbon neutrality goal.

STATIONARY SOURCE FACILITIES

Lead agencies shall compare the stationary source project's annual direct operational GHG emissions to the District's 10,000 metric ton per year threshold of significance for stationary sources. If the project's annual direct GHG emissions will exceed the District's threshold of significance, then the project may have a cumulatively considerable contribution to a significant cumulative environmental impact.

Stationary source GHG emissions shall also be evaluated in the context of the applicable regulatory environment that is in place under the mandates of AB 32, SB 32, ARB's Climate Change Scoping Plan and Executive Order B-30-15.

6.4 MITIGATION

The State CEQA Guidelines [Section 15126.4\(c\)](#) requires lead agencies to consider feasible means of mitigating the significant effects of GHG emissions, supported by substantial evidence and subject to monitoring and reporting. Mitigation measures may include, but are not limited to:

1. Measures in an existing plan or mitigation program for the reduction of emissions that are required as part of the lead agency's decision;

2. Reductions in emissions resulting from a project through implementation of project features, project design, or other measures, such as those described in CEQA Guidelines [Appendix F - Energy Conservation](#);
3. Off-site measures, including offsets that are not otherwise required, to mitigate a project's emissions;
4. Measures that sequester greenhouse gases; and
5. In the case of the adoption of a plan, such as a general plan, long range development plan, or GHG reduction plan, mitigation may include the identification of specific measures that may be implemented on a project-by-project basis. Mitigation may also include the incorporation of specific measures or policies found in an adopted ordinance or regulation that reduces the cumulative effect of emissions.

GHG mitigation measures could also be included in a Climate Action Plan or similar plan-level document adopted by a lead agency.

The lead agency must impose all mitigation measures that are necessary to reduce GHG emissions to a less-than-cumulatively considerable level. CEQA does not require mitigation measures that are infeasible for specific legal, economic, technological, or other reasons. A lead agency is not responsible for wholly eliminating all GHG emissions from a project; the CEQA standard is to mitigate to a level that is "less than significant" or, in the case of cumulative impacts, less than cumulatively considerable.

For every GHG emission reduction measure included in a CEQA document, the District recommends that the text shall be as detailed as possible and shall clearly identify who is responsible for implementation, funding, monitoring, enforcement, and any required maintenance activities. The lead agency shall also explain why the measure will be effective in reducing emissions and why each measure is considered to be feasible. In the case that GHG emission reduction measures relate directly or indirectly to policies in the local jurisdiction's General Plan, the District encourages the explanation of these relationships also be included.

If, after the identification of all feasible mitigation measures, a project is still deemed to have a cumulatively considerable contribution to a significant cumulative environmental impact, the lead agency can approve a project, but must adopt a Statement of Overriding Consideration to explain why further mitigation measures are not feasible, and why approval of a project with significant unavoidable impacts is warranted.

6.4.1 REDUCING MASS EMISSIONS FROM LAND USE DEVELOPMENT PROJECTS

When a lead agency does not have a previously approved community-wide GHG Reduction Plan or Climate Action Plan from which it can tier subsequent CEQA analyses for land use development projects, the project GHG emissions exceed the

ITEM 11.1.

threshold of significance for construction emissions, and/or the project size exceeds the operational land use screening levels table, which are equivalent to 1,100 metric tons of CO₂e per year, the District recommends the project proponent include all feasible measures to reduce GHG emissions.

Construction Emissions

The District provides [Recommended Measures](#) for Reducing GHG emissions from construction activities. These measures are best management practices, and some do not produce easily quantifiable GHG emission reductions. Other options for reducing GHG emissions from construction activities include obtaining emission reduction offsets or amortizing the construction emissions along with the operational emissions prior to applying mitigation.

Lead agencies may decide to amortize the level of short-term construction emissions over the expected (long-term) operational life of a project. Operational life of a building can be estimated to be 40 years for new residential and 25 years for conventional commercial. These estimates are derived from the State of California Executive Order D-16-00 and the US Green Building Council's October 2003 report on [The Costs and Financial Benefits of Green Buildings](#). The US Green Building Council's report provides longer operational life estimates for LEED certified buildings. Other operational life estimates can be used if justification is provided.

Operational Emissions

All projects must implement tier 1 Best Management Practices to demonstrate consistency with the Climate Change Scoping Plan. After implementation of tier 1 Best Management Practices, project emissions are compared to the operational land use screening levels table (equivalent to 1,100 metric tons of CO₂e per year). If a project's operational emissions are less than or equal to 1,100 metric tons of CO₂e per year after implementation of tier 1 Best Management Practices, the project will result in a less than cumulatively considerable contribution. Tier 1 Best Management Practices (fully described in [Greenhouse Gas Thresholds for Sacramento County](#)) include:

- BMP 1 - no natural gas: projects shall be designed and constructed without natural gas infrastructure.
- BMP 2 - electric vehicle (EV) ready: projects shall meet the current CalGreen Tier 2 standards, except all EV capable spaces shall be instead EV ready.

Project's that do not implement the tier 1 Best Management Practices must conduct additional calculations to determine excess emissions and provide measures either on-site or off-site to provide equivalent mitigation. Failure to implement tier 1 Best Management Practices may also require additional

environmental review, especially if a Statement of Overriding Consideration is needed.

If project emissions exceed the land use screening levels table (equivalent to 1,100 metric tons of CO₂e per year) after implementation of tier 1 Best Management Practices, the project is required to implement tier 2 Best Management Practices (fully described in [Greenhouse Gas Thresholds for Sacramento County](#)). Tier 2 Best Management Practices consists of BMP 3 - reductions in vehicle miles traveled (VMT) that meet the following requirements (or equivalent local agency's adopted SB 743 targets):

- Residential projects must achieve a 15% reduction in VMT per resident compared to existing average VMT per capita in the county.
- Office projects must achieve a 15% reduction in VMT per worker compared to existing average VMT per capita for the county.
- Retail projects must achieve no net increase in total VMT.

If the project meets the de minimis criteria for VMT in the Office of Planning and Research's SB 743 [Technical Advisory on Evaluating Transportation Impacts in CEQA](#), document the qualifying criteria to satisfy the BMP3 requirement.

Projects that do not meet tier 2 Best Management Practices (BMP 3) are required to implement additional measures to further reduce VMT to achieve the target. The District's [Recommended Guidance for Land Use Emissions Reductions](#) (District Guidance) provides a description of the most current feasible mitigation measures to reduce a project's operational GHG emissions. The District Guidance provides detailed information on how to utilize CalEEMod to select the most appropriate mitigation measures for the project and quantify GHG mitigation measures selected. All of the measures in the District Guidance include information about the reductions that might be achieved by each measure. The measures and reductions have been substantiated through research identified by a comprehensive literature review including the California Air Pollution Control Officers Association's [Quantifying Greenhouse Gas Mitigation Measures](#) document. Lead agencies and project proponents can also research and develop additional measures, in consultation with the District, that have reductions that are both quantifiable and substantiated. Potential alternative measures include use of natural refrigerants, sequestration, installation of vehicle charging stations, solar water heaters (to reduce electricity use), or offsite mitigation, including offsets, if on-site reduction measures are not sufficient to meet reduction targets. Offsite mitigation measures are required to demonstrate with substantial evidence that the project, credit, or registry being used provides GHG offsets that are real, permanent, quantifiable, verifiable, enforceable, and additional. Alternative measures are discussed further in Section 5 of the District's [Greenhouse Gas Thresholds for Sacramento County](#).

To assist in documenting, quantifying, and monitoring the mitigation measures selected by the project proponent, the District has prescribed that the selected GHG mitigation measures be explained in the context of a project-specific GHG Reduction Plan. The GHG Reduction Plan can be a standalone document or incorporated into the environmental document. During the environmental review process, and before certification of the CEQA environmental document by the lead agency, the District independently verifies the benefits of the selected measures in the GHG Reduction Plan with a letter. The GHG Reduction Plan shall then be referenced in the CEQA document as a GHG mitigation measure, appended to the document, and referenced as a condition of approval by the lead agency.

6.4.2 REDUCING EMISSIONS FROM STATIONARY SOURCES

Mitigation measures for reducing GHG emissions from stationary-source facilities shall be developed on a case-by-case basis in consultation with the District's permitting staff. Area- and mobile-source emissions shall be mitigated in the same way as land use development projects, as discussed in Section 6.4.1. Additional offsets could be implemented, including, but not limited to, the purchase of verified emission reduction credits, to ensure that a facility's GHG emissions are reduced to a less-than-cumulatively considerable level.

ITEM 11.1.

EXHIBIT 4

ITEM 11.1.

SMAQMD Thresholds of Significance Table

All Projects Subject to CEQA		
Construction Phase		Operational Phase
Mass Emission Thresholds		
NO _x (ozone precursor)	85 pounds/day	65 pounds/day
ROG (VOC) (ozone precursor)	NONE	65 pounds/day
PM ₁₀	Zero (0). If all feasible BACT/BMPs are applied, then 80 pounds/day and 14.6 tons/year	Zero (0). If all feasible BACT/BMPs are applied, then 80 pounds/day and 14.6 tons/year
PM _{2.5}	Zero (0). If all feasible BACT/BMPs are applied, then 82 pounds/day and 15 tons/year	Zero (0). If all feasible BACT/BMPs are applied, then 82 pounds/day and 15 tons/year
Concentration Thresholds (based on the California Ambient Air Quality Standard, identical threshold for both phases of development)		
CO	20 ppm 1-hour standard (23 mg/m ³); 9 ppm 8-hour standard (10 mg/m ³)	
NO ₂	0.18 ppm 1-hour standard (339 µg/m ³); 0.03 ppm Annual Arithmetic Mean (57 µg/m ³)	
SO ₂	0.25 ppm 1-hour standard (665 µg/m ³); 0.04 ppm 24-hour standard (105 µg/m ³)	
Lead	1.5 µg/m ³ 30-day average	
Visibility Reducing Particles	Extinction coefficient of 0.23 per kilometer - visibility of ten miles or more due to particles when relative humidity is less than 70 percent	
Sulfates	25 µg/m ³ 24-hour standard	
H ₂ S	0.03 ppm (42 µg/m ³) 1-hour standard	
Vinyl Chloride	0.01 ppm (26 µg/m ³) 24-hour standard	

Land Development and Construction Projects		
Construction Phase		Operational Phase
Greenhouse Gas Emissions (GHG) Thresholds		
GHG as CO ₂ e	1,100 metric tons/year	Demonstrate consistency with the Climate Change Scoping Plan by implementing applicable Best Management Practices (BMP), or equivalent on-site or off-site mitigation.
		All projects must implement tier 1 BMPs (BMP 1 & 2): <i>BMP 1</i> - projects shall be designed and constructed without natural gas infrastructure. <i>BMP 2</i> - projects shall meet the current CalGreen Tier 2 standards, except all electric vehicle capable spaces shall instead be electric vehicle ready. Projects that exceed 1,100 metric tons/year after implementation of tier 1 BMPs must implement tier 2 BMPs (BMP 3): <i>BMP 3</i> - residential projects shall achieve a 15% reduction in vehicle miles traveled per resident and office projects shall achieve a 15% reduction in vehicle miles traveled per worker compared to existing average vehicle miles traveled for the county, and retail projects shall achieve a no net increase in total vehicle miles traveled to show consistency with SB 743.

Stationary Source Only		
Toxic Air Contaminant (TAC) Thresholds		
Cancer Risk	An incremental increase in cancer risk greater than 10 in one million at any off-site receptor.	
Non-cancer (Hazard Index)	Ground-level concentration of project-generated TACs that would result in a Hazard Index greater than 1 at any off-site receptor.	
Construction Phase		Operational Phase
Greenhouse Gas Emissions (GHG) Thresholds		
GHG as CO ₂ e	1,100 metric tons/year	10,000 metric tons/year

Notes:

The SMAQMD Board of Directors adopted air quality thresholds of significance for criteria pollutants on March 28, 2002, via resolution AQMD2002018.

A project is considered significant if emissions exceed a CAAQS or contribute substantially to an existing or projected violation of a CAAQS.

A substantial contribution is considered an emission that is equal to or greater than 5% of a CAAQS.

Revisions to the CAAQS are automatically adopted as revisions to these thresholds.

Official citation for the CAAQS: California Code of Regulations, Title 17, Section 70200, Table of Standards.

The TAC thresholds were developed as part of the SMAQMD's AB2588 program.

The SMAQMD Board of Directors has not established a threshold for mobile source or non-permitted sources of TAC, see Chapter 5.

The SMAQMD Board of Directors adopted GHG thresholds on October 23, 2014, via resolution AQMD2014-028

The SMAQMD Board of Directors rescinded the 2002 concentration based thresholds for PM₁₀ and PM_{2.5} and adopted the new mass emissions

PM₁₀ and PM_{2.5} thresholds on May 28, 2015, via resolution AQMD2015-022. BACT is best available control technology and BMPs are best management practices.

The SMAQMD Board of Directors adopted an updated land development GHG threshold, including Best Management practices on April 23, 2020, via resolution 2020-009.

ITEM 11.1.

EXHIBIT 5

TECHNICAL ADVISORY

ON EVALUATING TRANSPORTATION IMPACTS IN CEQA



December 2018

ITEM 11.1.

Contents

A. Introduction	1
B. Background	2
C. Technical Considerations in Assessing Vehicle Miles Traveled.....	4
1. Recommendations Regarding Methodology	4
D. General Principles to Guide Consideration of VMT	7
E. Recommendations Regarding Significance Thresholds	8
1. Screening Thresholds for Land Use Projects.....	12
2. Recommended Numeric Thresholds for Residential, Office, and Retail Projects.....	15
3. Recommendations Regarding Land Use Plans.....	18
4. Other Considerations	19
F. Considering the Effects of Transportation Projects on Vehicle Travel	19
1. Recommended Significance Threshold for Transportation Projects	22
2. Estimating VMT Impacts from Transportation Projects	23
G. Analyzing Other Impacts Related to Transportation	25
H. VMT Mitigation and Alternatives.....	26
Appendix 1. Considerations About Which VMT to Count	29
Appendix 2. Induced Travel: Mechanisms, Research, and Additional Assessment Approaches	32

ITEM 11.1.

A. Introduction

This technical advisory is one in a series of advisories provided by the Governor’s Office of Planning and Research (OPR) as a service to professional planners, land use officials, and CEQA practitioners. OPR issues technical assistance on issues that broadly affect the practice of land use planning and the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.). (Gov. Code, § 65040, subds. (g), (l), (m).) The purpose of this document is to provide advice and recommendations, which agencies and other entities may use at their discretion. This document does not alter lead agency discretion in preparing environmental documents subject to CEQA. This document should not be construed as legal advice.

[Senate Bill 743](#) (Steinberg, 2013), which was codified in Public Resources Code section 21099, required changes to the guidelines implementing CEQA (CEQA Guidelines) (Cal. Code Regs., Title 14, Div. 6, Ch. 3, § 15000 et seq.) regarding the analysis of transportation impacts. As one appellate court recently explained: “During the last 10 years, the Legislature has charted a course of long-term sustainability based on denser infill development, reduced reliance on individual vehicles and improved mass transit, all with the goal of reducing greenhouse gas emissions. Section 21099 is part of that strategy” (*Covina Residents for Responsible Development v. City of Covina* (2018) 21 Cal.App.5th 712, 729.) Pursuant to Section 21099, the criteria for determining the significance of transportation impacts must “promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses.” (*Id.*, subd. (b)(1); see generally, adopted CEQA Guidelines, § 15064.3, subd. (b) [Criteria for Analyzing Transportation Impacts].) To that end, in developing the criteria, OPR has proposed, and the California Natural Resources Agency (Agency) has certified and adopted, changes to the CEQA Guidelines that identify vehicle miles traveled (VMT) as the most appropriate metric to evaluate a project’s transportation impacts. With the California Natural Resources Agency’s certification and adoption of the changes to the CEQA Guidelines, automobile delay, as measured by “level of service” and other similar metrics, generally no longer constitutes a significant environmental effect under CEQA. (Pub. Resources Code, § 21099, subd. (b)(3).)

This advisory contains technical recommendations regarding assessment of VMT, thresholds of significance, and mitigation measures. Again, OPR provides this Technical Advisory as a resource for the public to use at their discretion. OPR is not enforcing or attempting to enforce any part of the recommendations contained herein. (Gov. Code, § 65035 [“It is not the intent of the Legislature to vest in the Office of Planning and Research any direct operating or regulatory powers over land use, public works, or other state, regional, or local projects or programs.”].)

This December 2018 technical advisory is an update to the advisory it published in April 2018. OPR will continue to monitor implementation of these new provisions and may update or supplement this advisory in response to new information and advancements in modeling and methods.

ITEM 11.1.

B. Background

VMT and Greenhouse Gas Emissions Reduction. Senate Bill 32 (Pavley, 2016) requires California to reduce greenhouse gas (GHG) emissions 40 percent below 1990 levels by 2030, and Executive Order B-16-12 provides a target of 80 percent below 1990 emissions levels for the transportation sector by 2050. The transportation sector has three major means of reducing GHG emissions: increasing vehicle efficiency, reducing fuel carbon content, and reducing the amount of vehicle travel. The California Air Resources Board (CARB) has provided a path forward for achieving these emissions reductions from the transportation sector in its 2016 Mobile Source Strategy. CARB determined that it will not be possible to achieve the State's 2030 and post-2030 emissions goals without reducing VMT growth. Further, in its 2018 Progress Report on California's Sustainable Communities and Climate Protection Act, CARB found that despite the State meeting its 2020 climate goals, "emissions from statewide passenger vehicle travel per capita [have been] increasing and going in the wrong direction," and "California cannot meet its [long-term] climate goals without curbing growth in single-occupancy vehicle activity."¹ CARB also found that "[w]ith emissions from the transportation sector continuing to rise despite increases in fuel efficiency and decreases in the carbon content of fuel, California will not achieve the necessary greenhouse gas emissions reductions to meet mandates for 2030 and beyond without significant changes to how communities and transportation systems are planned, funded, and built."²

Thus, to achieve the State's long-term climate goals, California needs to reduce per capita VMT. This can occur under CEQA through VMT mitigation. Half of California's GHG emissions come from the transportation sector³, therefore, reducing VMT is an effective climate strategy, which can also result in co-benefits.⁴ Furthermore, without early VMT mitigation, the state may follow a path that meets GHG targets in the early years, but finds itself poorly positioned to meet more stringent targets later. For example, in absence of VMT analysis and mitigation in CEQA, lead agencies might rely upon verifiable offsets for GHG mitigation, ignoring the longer-term climate change impacts resulting from land use development and infrastructure investment decisions. As stated in CARB's 2017 Scoping Plan:

"California's future climate strategy will require increased focus on integrated land use planning to support livable, transit-connected communities, and conservation of agricultural and other lands. Accommodating population and economic growth through travel- and energy-efficient land use provides GHG-efficient growth, reducing GHGs from both transportation and building energy use. GHGs can be further reduced at the project level through implementing energy-efficient construction and travel demand management approaches."⁵ (*Id.* at p. 102.)

¹ California Air Resources Board (Nov. 2018) *2018 Progress Report on California's Sustainable Communities and Climate Protection Act*, pp. 4, 5, available at https://ww2.arb.ca.gov/sites/default/files/2018-11/Final2018Report_SB150_112618_02_Report.pdf.

² *Id.*, p. 28.

³ See <https://ca50million.ca.gov/transportation/>

⁴ Fang et al. (2017) *Cutting Greenhouse Gas Emissions Is Only the Beginning: A Literature Review of the Co-Benefits of Reducing Vehicle Miles Traveled*.

⁵ California Air Resources Board (Nov. 2017) *California's 2017 Climate Change Scoping Plan*, p. 102, available at https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

ITEM 11.1.

In light of this, the 2017 Scoping Plan describes and quantifies VMT reductions needed to achieve our long-term GHG emissions reduction goals, and specifically points to the need for statewide deployment of the VMT metric in CEQA:

“Employing VMT as the metric of transportation impact statewide will help to ensure GHG reductions planned under SB 375 will be achieved through on-the-ground development, and will also play an important role in creating the additional GHG reductions needed beyond SB 375 across the State. Implementation of this change will rely, in part, on local land use decisions to reduce GHG emissions associated with the transportation sector, both at the project level, and in long-term plans (including general plans, climate action plans, specific plans, and transportation plans) and supporting sustainable community strategies developed under SB 375.”⁶

VMT and Other Impacts to Health and Environment. VMT mitigation also creates substantial benefits (sometimes characterized as “co-benefits” to GHG reduction) in both in the near-term and the long-term. Beyond GHG emissions, increases in VMT also impact human health and the natural environment. Human health is impacted as increases in vehicle travel lead to more vehicle crashes, poorer air quality, increases in chronic diseases associated with reduced physical activity, and worse mental health. Increases in vehicle travel also negatively affect other road users, including pedestrians, cyclists, other motorists, and many transit users. The natural environment is impacted as higher VMT leads to more collisions with wildlife and fragments habitat. Additionally, development that leads to more vehicle travel also tends to consume more energy, water, and open space (including farmland and sensitive habitat). This increase in impermeable surfaces raises the flood risk and pollutant transport into waterways.⁷

VMT and Economic Growth. While it was previously believed that VMT growth was a necessary component of economic growth, data from the past two decades shows that economic growth is possible without a concomitant increase in VMT. (Figure 1.) Recent research shows that requiring development projects to mitigate LOS may actually reduce accessibility to destinations and impede economic growth.^{8,9}

⁶ *Id.* at p. 76.

⁷ Fang et al. (2017) *Cutting Greenhouse Gas Emissions Is Only the Beginning: A Literature Review of the Co-Benefits of Reducing Vehicle Miles Traveled*, available at https://ncst.ucdavis.edu/wp-content/uploads/2017/03/NCST-VMT-Co-Benefits-White-Paper_Fang_March-2017.pdf.

⁸ Haynes et al. (Sept. 2015) *Congested Development: A Study of Traffic Delays, Access, and Economic Activity in Metropolitan Los Angeles*, available at http://www.its.ucla.edu/wp-content/uploads/sites/6/2015/11/Haynes_Congested-Development_1-Oct-2015_final.pdf.

⁹ Osman et al. (Mar. 2016) *Not So Fast: A Study of Traffic Delays, Access, and Economic Activity in the San Francisco Bay Area*, available at http://www.its.ucla.edu/wp-content/uploads/sites/6/2016/08/Taylor-Not-so-Fast-04-01-2016_final.pdf.

ITEM 11.1.

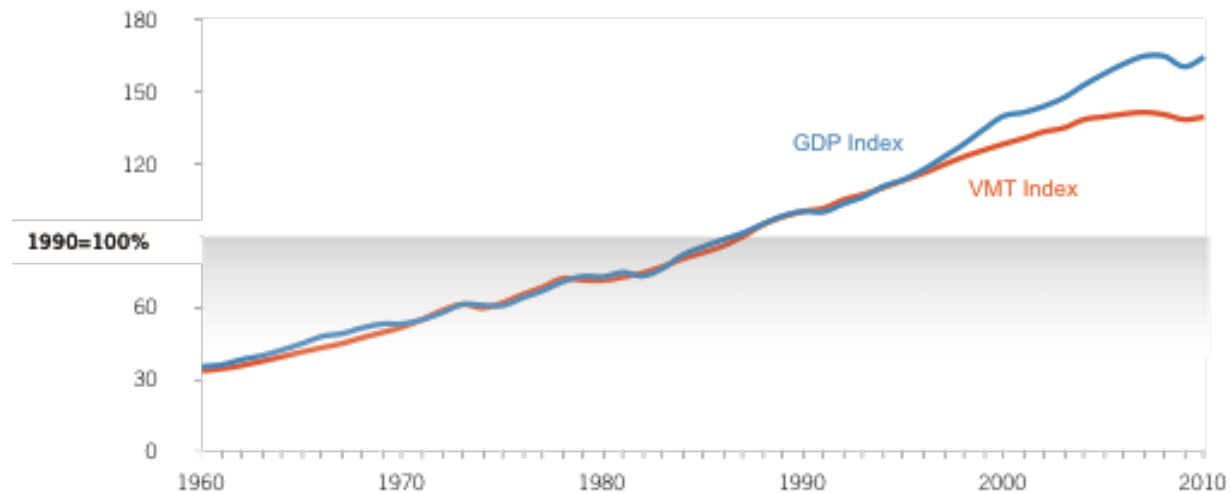


Figure 1. Kooshian and Winkelman (2011) *VMT and Gross Domestic Product (GDP), 1960-2010*.

C. Technical Considerations in Assessing Vehicle Miles Traveled

Many practitioners are familiar with accounting for VMT in connection with long-range planning, or as part of the CEQA analysis of a project's greenhouse gas emissions or energy impacts. This document provides technical information on how to assess VMT as part of a transportation impacts analysis under CEQA. Appendix 1 provides a description of which VMT to count and options on how to count it. Appendix 2 provides information on induced travel resulting from roadway capacity projects, including the mechanisms giving rise to induced travel, the research quantifying it, and information on additional approaches for assessing it.

1. Recommendations Regarding Methodology

Proposed Section 15064.3 explains that a "lead agency may use models to estimate a project's vehicle miles traveled . . ." CEQA generally defers to lead agencies on the choice of methodology to analyze impacts. (*Santa Monica Baykeeper v. City of Malibu* (2011) 193 Cal.App.4th 1538, 1546; see *Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal.3d 376, 409 ["the issue is not whether the studies are irrefutable or whether they could have been better" ... rather, the "relevant issue is only whether the studies are sufficiently credible to be considered" as part of the lead agency's overall evaluation].) This section provides suggestions to lead agencies regarding methodologies to analyze VMT associated with a project.

Vehicle Types. Proposed Section 15064.3, subdivision (a), states, "For the purposes of this section, 'vehicle miles traveled' refers to the amount and distance of automobile travel attributable to a project." Here, the term "automobile" refers to on-road passenger vehicles, specifically cars and light trucks. Heavy-duty truck VMT could be included for modeling convenience and ease of calculation (for example, where models or data provide combined auto and heavy truck VMT). For an apples-to-apples

ITEM 11.1.

comparison, vehicle types considered should be consistent across project assessment, significance thresholds, and mitigation.

Residential and Office Projects. Tour- and trip-based approaches¹⁰ offer the best methods for assessing VMT from residential/office projects and for comparing those assessments to VMT thresholds. These approaches also offer the most straightforward methods for assessing VMT reductions from mitigation measures for residential/office projects. When available, tour-based assessment is ideal because it captures travel behavior more comprehensively. But where tour-based tools or data are not available for all components of an analysis, a trip-based assessment of VMT serves as a reasonable proxy.

Models and methodologies used to calculate thresholds, estimate project VMT, and estimate VMT reduction due to mitigation should be comparable. For example:

- A tour-based assessment of project VMT should be compared to a tour-based threshold, or a trip-based assessment to a trip-based VMT threshold.
- Where a travel demand model is used to determine thresholds, the same model should also be used to provide trip lengths as part of assessing project VMT.
- Where only trip-based estimates of VMT reduction from mitigation are available, a trip-based threshold should be used, and project VMT should be assessed in a trip-based manner.

When a trip-based method is used to analyze a residential project, the focus can be on home-based trips. Similarly, when a trip-based method is used to analyze an office project, the focus can be on home-based work trips.

When tour-based models are used to analyze an office project, either employee work tour VMT or VMT from all employee tours may be attributed to the project. This is because workplace location influences overall travel. For consistency, the significance threshold should be based on the same metric: either employee work tour VMT or VMT from all employee tours.

For office projects that feature a customer component, such as a government office that serves the public, a lead agency can analyze the customer VMT component of the project using the methodology for retail development (see below).

Retail Projects. Generally, lead agencies should analyze the effects of a retail project by assessing the change in total VMT¹¹ because retail projects typically re-route travel from other retail destinations. A retail project might lead to increases or decreases in VMT, depending on previously existing retail travel patterns.

¹⁰ See Appendix 1, *Considerations About Which VMT to Count*, for a description of these approaches.

¹¹ See Appendix 1, *Considerations About Which VMT to Count*, “Assessing Change in Total VMT” section, for a description of this approach.

ITEM 11.1.

Considerations for All Projects. Lead agencies should not truncate any VMT analysis because of jurisdictional or other boundaries, for example, by failing to count the portion of a trip that falls outside the jurisdiction or by discounting the VMT from a trip that crosses a jurisdictional boundary. CEQA requires environmental analyses to reflect a “good faith effort at full disclosure.” (CEQA Guidelines, § 15151.) Thus, where methodologies exist that can estimate the full extent of vehicle travel from a project, the lead agency should apply them to do so. Where those VMT effects will grow over time, analyses should consider both a project’s short-term and long-term effects on VMT.

Combining land uses for VMT analysis is not recommended. Different land uses generate different amounts of VMT, so the outcome of such an analysis could depend more on the mix of uses than on their travel efficiency. As a result, it could be difficult or impossible for a lead agency to connect a significance threshold with an environmental policy objective (such as a target set by law), inhibiting the CEQA imperative of identifying a project’s significant impacts and providing mitigation where feasible. Combining land uses for a VMT analysis could streamline certain mixes of uses in a manner disconnected from policy objectives or environmental outcomes. Instead, OPR recommends analyzing each use separately, or simply focusing analysis on the dominant use, and comparing each result to the appropriate threshold. Recommendations for methods of analysis and thresholds are provided below. In the analysis of each use, a mixed-use project should take credit for internal capture.

Any project that includes in its geographic bounds a portion of an existing or planned Transit Priority Area (i.e., the project is within a ½ mile of an existing or planned major transit stop or an existing stop along a high quality transit corridor) may employ VMT as its primary metric of transportation impact for the entire project. (See Pub. Resources Code, § 21099, subds. (a)(7), (b)(1).)

Cumulative Impacts. A project’s cumulative impacts are based on an assessment of whether the “incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.” (Pub. Resources Code, § 21083, subd. (b)(2); see CEQA Guidelines, § 15064, subd. (h)(1).) When using an absolute VMT metric, i.e., total VMT (as recommended below for retail and transportation projects), analyzing the combined impacts for a cumulative impacts analysis may be appropriate. However, metrics such as VMT per capita or VMT per employee, i.e., metrics framed in terms of efficiency (as recommended below for use on residential and office projects), cannot be summed because they employ a denominator. A project that falls below an efficiency-based threshold that is aligned with long-term environmental goals and relevant plans would have no cumulative impact distinct from the project impact. Accordingly, a finding of a less-than-significant project impact would imply a less than significant cumulative impact, and vice versa. This is similar to the analysis typically conducted for greenhouse gas emissions, air quality impacts, and impacts that utilize plan compliance as a threshold of significance. (See *Center for Biological Diversity v. Department of Fish & Wildlife* (2015) 62 Cal.4th 204, 219, 223; CEQA Guidelines, § 15064, subd. (h)(3).)

ITEM 11.1.

D. General Principles to Guide Consideration of VMT

SB 743 directs OPR to establish specific “criteria for determining the significance of transportation impacts of projects[.]” (Pub. Resources Code, § 21099, subd. (b)(1).) In establishing this criterion, OPR was guided by the general principles contained within CEQA, the CEQA Guidelines, and applicable case law.

To assist in the determination of significance, many lead agencies rely on “thresholds of significance.” The CEQA Guidelines define a “threshold of significance” to mean “an identifiable **quantitative, qualitative¹² or performance level** of a particular environmental effect, non-compliance with which means the effect will **normally** be determined to be significant by the agency and compliance with which means the effect **normally** will be determined to be less than significant.” (CEQA Guidelines, § 15064.7, subd. (a) (emphasis added).) Lead agencies have discretion to develop and adopt their own, or rely on thresholds recommended by other agencies, “provided the decision of the lead agency to adopt such thresholds is supported by substantial evidence.” (*Id.* at subd. (c); *Save Cuyama Valley v. County of Santa Barbara* (2013) 213 Cal.App.4th 1059, 1068.) Substantial evidence means “enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached.” (*Id.* at § 15384 (emphasis added); *Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1108-1109.)

Additionally, the analysis leading to the determination of significance need not be perfect. The CEQA Guidelines describe the standard for adequacy of environmental analyses:

An EIR should be prepared with a sufficient degree of analysis to provide decision makers with information which enables them to **make a decision which intelligently takes account of environmental consequences**. An evaluation of the environmental effects of a proposed project need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is **reasonably feasible**. Disagreement among experts does not make an EIR inadequate, but the EIR should summarize the main points of disagreement among the experts. The **courts have looked not for perfection** but for **adequacy, completeness**, and a **good faith effort** at full disclosure.

(CEQA Guidelines, § 15151 (emphasis added).)

These general principles guide OPR’s recommendations regarding thresholds of significance for VMT set forth below.

¹² Generally, qualitative analyses should only be conducted when methods do not exist for undertaking a quantitative analysis.

ITEM 11.1.

E. Recommendations Regarding Significance Thresholds

As noted above, lead agencies have the discretion to set or apply their own thresholds of significance. (*Center for Biological Diversity v. California Dept. of Fish & Wildlife* (2015) 62 Cal.4th 204, 218-223 [lead agency had discretion to use compliance with AB 32's emissions goals as a significance threshold]; *Save Cuyama Valley v. County of Santa Barbara* (2013) 213 Cal.App.4th at p. 1068.) However, Section 21099 of the Public Resources Code states that the criteria for determining the significance of transportation impacts must promote: (1) reduction of greenhouse gas emissions; (2) development of multimodal transportation networks; and (3) a diversity of land uses. It further directed OPR to prepare and develop criteria for determining significance. (Pub. Resources Code, § 21099, subd. (b)(1).) This section provides OPR's suggested thresholds, as well as considerations for lead agencies that choose to adopt their own

The VMT metric can support the three statutory goals: “the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses.” (Pub. Resources Code, § 21099, subd. (b)(1), emphasis added.) However, in order for it to promote and support all three, lead agencies should select a significance threshold that aligns with state law on all three. State law concerning the development of multimodal transportation networks and diversity of land uses requires planning for and prioritizing increases in complete streets and infill development, but does not mandate a particular depth of implementation that could translate into a particular threshold of significance. Meanwhile, the State has clear quantitative targets for GHG emissions reduction set forth in law and based on scientific consensus, and the depth of VMT reduction needed to achieve those targets has been quantified. Tying VMT thresholds to GHG reduction also supports the two other statutory goals. Therefore, to ensure adequate analysis of transportation impacts, OPR recommends using quantitative VMT thresholds linked to GHG reduction targets when methods exist to do so.

Various legislative mandates and state policies establish quantitative greenhouse gas emissions reduction targets. For example:

- Assembly Bill 32 (2006) requires statewide GHG emissions reductions to 1990 levels by 2020 and continued reductions beyond 2020.
- Senate Bill 32 (2016) requires at least a 40 percent reduction in GHG emissions from 1990 levels by 2030.
- Pursuant to Senate Bill 375 (2008), the California Air Resources Board GHG emissions reduction targets for metropolitan planning organizations (MPOs) to achieve based on land use patterns and transportation systems specified in Regional Transportation Plans and Sustainable Community Strategies (RTP/SCS). Current targets for the State's largest MPOs call for a 19 percent reduction in GHG emissions from cars and light trucks from 2005 emissions levels by 2035.
- Executive Order B-30-15 (2015) sets a GHG emissions reduction target of 40 percent below 1990 levels by 2030.

ITEM 11.1.

- Executive Order S-3-05 (2005) sets a GHG emissions reduction target of 80 percent below 1990 levels by 2050.
- Executive Order B-16-12 (2012) specifies a GHG emissions reduction target of 80 percent below 1990 levels by 2050 specifically for transportation.
- Executive Order B-55-18 (2018) established an additional statewide goal of achieving carbon neutrality as soon as possible, but no later than 2045, and maintaining net negative emissions thereafter. It states, “The California Air Resources Board shall work with relevant state agencies to develop a framework for implementation and accounting that tracks progress toward this goal.”
- Senate Bill 391 requires the California Transportation Plan to support 80 percent reduction in GHGs below 1990 levels by 2050.
- The California Air Resources Board Mobile Source Strategy (2016) describes California’s strategy for containing air pollutant emissions from vehicles, and quantifies VMT growth compatible with achieving state targets.
- The California Air Resources Board’s 2017 Climate Change Scoping Plan Update: The Strategy for Achieving California’s 2030 Greenhouse Gas Target describes California’s strategy for containing GHG emissions from vehicles, and quantifies VMT growth compatible with achieving state targets.

Considering these various targets, the California Supreme Court observed:

Meeting our statewide reduction goals does not preclude all new development. Rather, the Scoping Plan ... assumes continued growth and depends on increased efficiency and conservation in land use and transportation from all Californians.

(*Center for Biological Diversity v. California Dept. of Fish & Wildlife, supra*, 62 Cal.4th at p. 220.) Indeed, the Court noted that when a lead agency uses consistency with climate goals as a way to determine significance, particularly for long-term projects, the lead agency must consider the project’s effect on meeting long-term reduction goals. (*Ibid.*) And more recently, the Supreme Court stated that “CEQA requires public agencies . . . to ensure that such analysis stay in step with evolving scientific knowledge and state regulatory schemes.” (*Cleveland National Forest Foundation v. San Diego Assn. of Governments* (2017) 3 Cal.5th 497, 504.)

Meeting the targets described above will require substantial reductions in existing VMT per capita to curb GHG emissions and other pollutants. But targets for overall GHG emissions reduction do not translate directly into VMT thresholds for individual projects for many reasons, including:

- Some, but not all, of the emissions reductions needed to achieve those targets could be accomplished by other measures, including increased vehicle efficiency and decreased fuel carbon content. The CARB’s *First Update to the Climate Change Scoping Plan* explains:

ITEM 11.1.

“Achieving California’s long-term criteria pollutant and GHG emissions goals will require four strategies to be employed: (1) improve vehicle efficiency and develop zero emission technologies, (2) reduce the carbon content of fuels and provide market support to get these lower-carbon fuels into the marketplace, (3) **plan and build communities to reduce vehicular GHG emissions and provide more transportation options, and (4) improve the efficiency and throughput of existing transportation systems.**”¹³ CARB’s *2018 Progress Report on California’s Sustainable Communities and Climate Protection Act* states on page 28 that “California cannot meet its climate goals without curbing growth in single-occupancy vehicle activity.” In other words, vehicle efficiency and better fuels are necessary, but insufficient, to address the GHG emissions from the transportation system. Land use patterns and transportation options also will need to change to support reductions in vehicle travel/VMT.

- New land use projects alone will not sufficiently reduce per-capita VMT to achieve those targets, nor are they expected to be the sole source of VMT reduction.
- Interactions between land use projects, and also between land use and transportation projects, existing and future, together affect VMT.
- Because location within the region is the most important determinant of VMT, in some cases, streamlining CEQA review of projects in travel efficient locations may be the most effective means of reducing VMT.
- When assessing climate impacts of some types of land use projects, use of an efficiency metric (e.g., per capita, per employee) may provide a better measure of impact than an absolute numeric threshold. (*Center for Biological Diversity, supra.*)

Public Resources Code section 21099 directs OPR to propose criteria for determining the significance of transportation impacts. In this Technical Advisory, OPR provides its recommendations to assist lead agencies in selecting a significance threshold that may be appropriate for their particular projects. While OPR’s Technical Advisory is not binding on public agencies, CEQA allows lead agencies to “consider thresholds of significance . . . recommended by other public agencies, provided the decision to adopt those thresholds is supported by substantial evidence.” (CEQA Guidelines, § 15064.7, subd. (c).) Based on OPR’s extensive review of the applicable research, and in light of an assessment by the California Air Resources Board quantifying the need for VMT reduction in order to meet the State’s long-term climate goals, **OPR recommends that a per capita or per employee VMT that is fifteen percent below that of existing development may be a reasonable threshold.**

Fifteen percent reductions in VMT are achievable at the project level in a variety of place types.¹⁴

Moreover, a fifteen percent reduction is consistent with SB 743’s direction to OPR to select a threshold that will help the State achieve its climate goals. As described above, section 21099 states that the

¹³ California Air Resources Board (May 2014) *First Update to the Climate Change Scoping Plan*, p. 46 (emphasis added).

¹⁴ CAPCOA (2010) *Quantifying Greenhouse Gas Mitigation Measures*, p. 55, available at <http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf>.

ITEM 11.1.

criteria for determining significance must “promote the reduction in greenhouse gas emissions.” In its document *California Air Resources Board 2017 Scoping Plan-Identified VMT Reductions and Relationship to State Climate Goals*¹⁵, CARB assesses VMT reduction per capita consistent with its evidence-based modeling scenario that would achieve State climate goals of 40 percent GHG emissions reduction from 1990 levels by 2030 and 80 percent GHG emissions reduction levels from 1990 by 2050. Applying California Department of Finance population forecasts, CARB finds per-capita light-duty vehicle travel would need to be approximately 16.8 percent lower than existing, and overall per-capita vehicle travel would need to be approximately 14.3 percent lower than existing levels under that scenario. Below these levels, a project could be considered low VMT and would, on that metric, be consistent with 2017 Scoping Plan Update assumptions that achieve climate state climate goals.

CARB finds per capita vehicle travel would need to be kept below what today’s policies and plans would achieve.

CARB’s assessment is based on data in the 2017 Scoping Plan Update and 2016 Mobile Source Strategy. In those documents, CARB previously examined the relationship between VMT and the state’s GHG emissions reduction targets. The Scoping Plan finds:

“While the State can do more to accelerate and incentivize these local decisions, local actions that reduce VMT are also necessary to meet transportation sector-specific goals and achieve the 2030 target under SB 32. Through developing the Scoping Plan, CARB staff is more convinced than ever that, in addition to achieving GHG reductions from cleaner fuels and vehicles, California must also reduce VMT. Stronger SB 375 GHG reduction targets will enable the State to make significant progress toward needed reductions, but alone will not provide the VMT growth reductions needed; there is a gap between what SB 375 can provide and what is needed to meet the State’s 2030 and 2050 goals.”¹⁶

Note that, at present, consistency with RTP/SCSs does not necessarily lead to a less-than-significant VMT impact.¹⁷ As the Final 2017 Scoping Plan Update states,

VMT reductions are necessary to achieve the 2030 target and must be part of any strategy evaluated in this Plan. Stronger SB 375 GHG reduction targets will enable the State to make significant progress toward this goal, but alone will not provide all of the VMT growth reductions that will be needed. There is a gap between what SB 375 can provide and what is needed to meet the State’s 2030 and 2050 goals.”¹⁸

¹⁵ California Air Resources Board (Jan. 2019) *California Air Resources Board 2017 Scoping Plan-Identified VMT Reductions and Relationship to State Climate Goals*, available at <https://ww2.arb.ca.gov/resources/documents/carb-2017-scoping-plan-identified-vmt-reductions-and-relationship-state-climate>.

¹⁶ California Air Resources Board (Nov. 2017) *California’s 2017 Climate Change Scoping Plan*, p. 101.

¹⁷ California Air Resources Board (Feb. 2018) *Updated Final Staff Report: Proposed Update to the SB 375 Greenhouse Gas Emission Reduction Targets*, Figure 3, p. 35, available at https://www.arb.ca.gov/cc/sb375/sb375_target_update_final_staff_report_feb2018.pdf.

¹⁸ California Air Resources Board (Nov. 2017) *California’s 2017 Climate Change Scoping Plan*, p. 75.

ITEM 11.1.

Also, in order to capture the full effects of induced travel resulting from roadway capacity projects, an RTP/SCS would need to include an assessment of land use effects of those projects, and the effects of those land uses on VMT. (See section titled “*Estimating VMT Impacts from Transportation Projects*” below.) RTP/SCSs typically model VMT using a collaboratively-developed land use “vision” for the region’s land use, rather than studying the effects on land use of the proposed transportation investments.

In summary, achieving 15 percent lower per capita (residential) or per employee (office) VMT than existing development is both generally achievable and is supported by evidence that connects this level of reduction to the State’s emissions goals.

1. Screening Thresholds for Land Use Projects

Many agencies use “screening thresholds” to quickly identify when a project should be expected to cause a less-than-significant impact without conducting a detailed study. (See e.g., CEQA Guidelines, §§ 15063(c)(3)(C), 15128, and Appendix G.) As explained below, this technical advisory suggests that lead agencies may screen out VMT impacts using project size, maps, transit availability, and provision of affordable housing.

Screening Threshold for Small Projects

Many local agencies have developed screening thresholds to indicate when detailed analysis is needed. Absent substantial evidence indicating that a project would generate a potentially significant level of VMT, or inconsistency with a Sustainable Communities Strategy (SCS) or general plan, projects that generate or attract fewer than 110 trips per day¹⁹ generally may be assumed to cause a less-than-significant transportation impact.

Map-Based Screening for Residential and Office Projects

Residential and office projects that locate in areas with low VMT, and that incorporate similar features (i.e., density, mix of uses, transit accessibility), will tend to exhibit similarly low VMT. Maps created with VMT data, for example from a travel survey or a travel demand model, can illustrate areas that are

¹⁹ CEQA provides a categorical exemption for existing facilities, including additions to existing structures of up to 10,000 square feet, so long as the project is in an area where public infrastructure is available to allow for maximum planned development and the project is not in an environmentally sensitive area. (CEQA Guidelines, § 15301, subd. (e)(2).) Typical project types for which trip generation increases relatively linearly with building footprint (i.e., general office building, single tenant office building, office park, and business park) generate or attract an additional 110-124 trips per 10,000 square feet. Therefore, absent substantial evidence otherwise, it is reasonable to conclude that the addition of 110 or fewer trips could be considered not to lead to a significant impact.

ITEM 11.1.

currently below threshold VMT (see recommendations below). Because new development in such locations would likely result in a similar level of VMT, such maps can be used to screen out residential and office projects from needing to prepare a detailed VMT analysis.

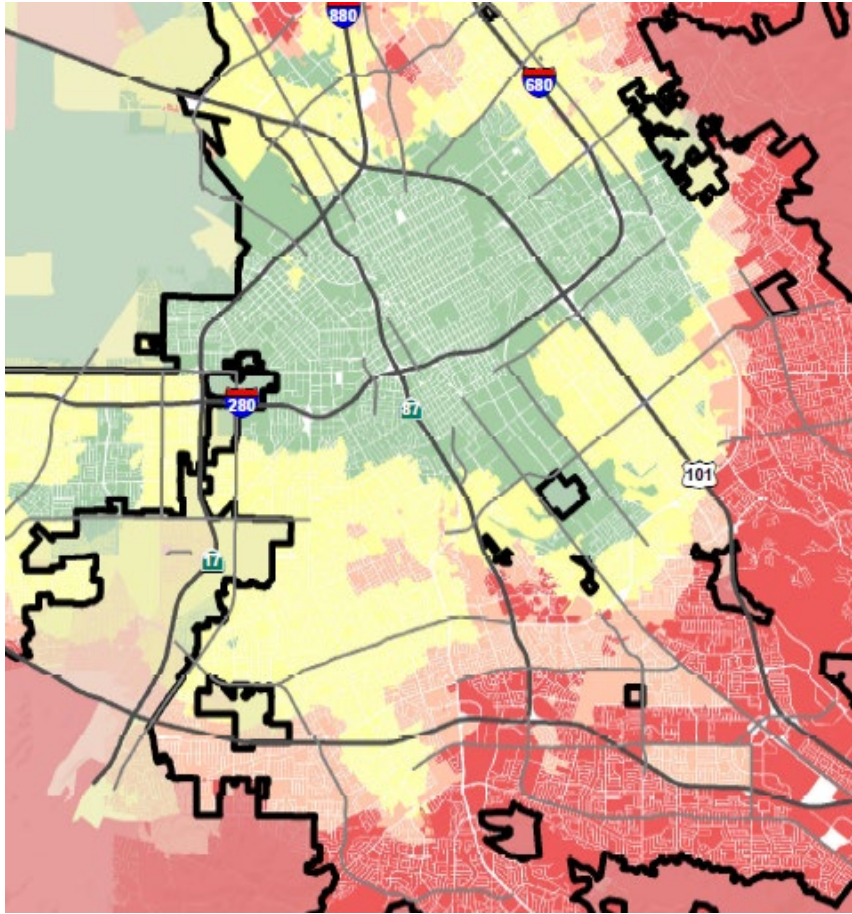


Figure 2. Example map of household VMT that could be used to delineate areas eligible to receive streamlining for VMT analysis. (Source: City of San José, Department of Transportation, draft output of City Transportation Model.)

Presumption of Less Than Significant Impact Near Transit Stations

Proposed CEQA Guideline Section 15064.3, subdivision (b)(1), states that lead agencies generally should presume that certain projects (including residential, retail, and office projects, as well as projects that are a mix of these uses) proposed within ½ mile of an existing major transit stop²⁰ or an existing stop

²⁰ Pub. Resources Code, § 21064.3 (“‘Major transit stop’ means a site containing an existing rail transit station, a ferry terminal served by either a bus or rail transit service, or the intersection of two or more major bus routes with a frequency of service interval of 15 minutes or less during the morning and afternoon peak commute periods.”).

ITEM 11.1.

along a high quality transit corridor²¹ will have a less-than-significant impact on VMT. This presumption would not apply, however, if project-specific or location-specific information indicates that the project will still generate significant levels of VMT. For example, the presumption might not be appropriate if the project:

- Has a Floor Area Ratio (FAR) of less than 0.75
- Includes more parking for use by residents, customers, or employees of the project than required by the jurisdiction (if the jurisdiction requires the project to supply parking)
- Is inconsistent with the applicable Sustainable Communities Strategy (as determined by the lead agency, with input from the Metropolitan Planning Organization)
- Replaces affordable residential units with a smaller number of moderate- or high-income residential units

A project or plan near transit which replaces affordable residential units²² with a smaller number of moderate- or high-income residential units may increase overall VMT because the increase in VMT of displaced residents could overwhelm the improvements in travel efficiency enjoyed by new residents.²³

If any of these exceptions to the presumption might apply, the lead agency should conduct a detailed VMT analysis to determine whether the project would exceed VMT thresholds (see below).

Presumption of Less Than Significant Impact for Affordable Residential Development

Adding affordable housing to infill locations generally improves jobs-housing match, in turn shortening commutes and reducing VMT.^{24,25} Further, "... low-wage workers in particular would be more likely to choose a residential location close to their workplace, if one is available."²⁶ In areas where existing jobs-housing match is closer to optimal, low income housing nevertheless generates less VMT than market-

²¹ Pub. Resources Code, § 21155 ("For purposes of this section, a high-quality transit corridor means a corridor with fixed route bus service with service intervals no longer than 15 minutes during peak commute hours.").

²² Including naturally-occurring affordable residential units.

²³ Chapple et al. (2017) *Developing a New Methodology for Analyzing Potential Displacement*, Chapter 4, pp. 159-160, available at <https://www.arb.ca.gov/research/apr/past/13-310.pdf>.

²⁴ Karner and Benner (2016) *The convergence of social equity and environmental sustainability: Jobs-housing fit and commute distance* ("[P]olicies that advance a more equitable distribution of jobs and housing by linking the affordability of locally available housing with local wage levels are likely to be associated with reduced commuting distances").

²⁵ Karner and Benner (2015) *Low-wage jobs-housing fit: identifying locations of affordable housing shortages*.

²⁶ Karner and Benner (2015) *Low-wage jobs-housing fit: identifying locations of affordable housing shortages*.

ITEM 11.1.

rate housing.^{27,28} Therefore, a project consisting of a high percentage of affordable housing may be a basis for the lead agency to find a less-than-significant impact on VMT. Evidence supports a presumption of less than significant impact for a 100 percent affordable residential development (or the residential component of a mixed-use development) in infill locations. Lead agencies may develop their own presumption of less than significant impact for residential projects (or residential portions of mixed use projects) containing a particular amount of affordable housing, based on local circumstances and evidence. Furthermore, a project which includes any affordable residential units may factor the effect of the affordability on VMT into the assessment of VMT generated by those units.

2. Recommended Numeric Thresholds for Residential, Office, and Retail Projects

Recommended threshold for residential projects: A proposed project exceeding a level of 15 percent below existing VMT per capita may indicate a significant transportation impact. Existing VMT per capita may be measured as regional VMT per capita or as city VMT per capita. Proposed development referencing a threshold based on city VMT per capita (rather than regional VMT per capita) should not cumulatively exceed the number of units specified in the SCS for that city, and should be consistent with the SCS.

Residential development that would generate vehicle travel that is 15 or more percent below the existing residential VMT per capita, measured against the region or city, may indicate a less-than-significant transportation impact. In MPO areas, development measured against city VMT per capita (rather than regional VMT per capita) should not cumulatively exceed the population or number of units specified in the SCS for that city because greater-than-planned amounts of development in areas above the region-based threshold would undermine the VMT containment needed to achieve regional targets under SB 375.

For residential projects in unincorporated county areas, the local agency can compare a residential project's VMT to (1) the region's VMT per capita, or (2) the aggregate population-weighted VMT per capita of all cities in the region. In MPO areas, development in unincorporated areas measured against aggregate city VMT per capita (rather than regional VMT per capita) should not cumulatively exceed the population or number of units specified in the SCS for that city because greater-than-planned amounts of development in areas above the regional threshold would undermine achievement of regional targets under SB 375.

²⁷ Chapple et al. (2017) *Developing a New Methodology for Analyzing Potential Displacement*, available at <https://www.arb.ca.gov/research/apr/past/13-310.pdf>.

²⁸ CAPCOA (2010) *Quantifying Greenhouse Gas Mitigation Measures*, pp. 176-178, available at <http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf>.

ITEM 11.1.

These thresholds can be applied to either household (i.e., tour-based) VMT or home-based (i.e., trip-based) VMT assessments.²⁹ It is critical, however, that the agency be consistent in its VMT measurement approach throughout the analysis to maintain an “apples-to-apples” comparison. For example, if the agency uses a home-based VMT for the threshold, it should also be use home-based VMT for calculating project VMT and VMT reduction due to mitigation measures.

Recommended threshold for office projects: A proposed project exceeding a level of 15 percent below existing regional VMT per employee may indicate a significant transportation impact.

Office projects that would generate vehicle travel exceeding 15 percent below existing VMT per employee for the region may indicate a significant transportation impact. In cases where the region is substantially larger than the geography over which most workers would be expected to live, it might be appropriate to refer to a smaller geography, such as the county, that includes the area over which nearly all workers would be expected to live.

Office VMT screening maps can be developed using tour-based data, considering either total employee VMT or employee work tour VMT. Similarly, tour-based analysis of office project VMT could consider either total employee VMT or employee work tour VMT. Where tour-based information is unavailable for threshold determination, project assessment, or assessment of mitigation, home-based work trip VMT should be used throughout all steps of the analysis to maintain an “apples-to-apples” comparison.

Recommended threshold for retail projects: A net increase in total VMT may indicate a significant transportation impact.

Because new retail development typically redistributes shopping trips rather than creating new trips,³⁰ estimating the total change in VMT (i.e., the difference in total VMT in the area affected with and without the project) is the best way to analyze a retail project’s transportation impacts.

By adding retail opportunities into the urban fabric and thereby improving retail destination proximity, local-serving retail development tends to shorten trips and reduce VMT. Thus, lead agencies generally may presume such development creates a less-than-significant transportation impact. Regional-serving retail development, on the other hand, which can lead to substitution of longer trips for shorter ones, may tend to have a significant impact. Where such development decreases VMT, lead agencies should consider the impact to be less-than-significant.

Many cities and counties define local-serving and regional-serving retail in their zoning codes. Lead agencies may refer to those local definitions when available, but should also consider any project-

²⁹ See Appendix 1 for a description of these approaches.

³⁰ Lovejoy, et al. (2013) *Measuring the impacts of local land-use policies on vehicle miles of travel: The case of the first big-box store in Davis, California*, *The Journal of Transport and Land Use*.

ITEM 11.1.

specific information, such as market studies or economic impacts analyses that might bear on customers' travel behavior. Because lead agencies will best understand their own communities and the likely travel behaviors of future project users, they are likely in the best position to decide when a project will likely be local-serving. Generally, however, retail development including stores larger than 50,000 square feet might be considered regional-serving, and so lead agencies should undertake an analysis to determine whether the project might increase or decrease VMT.

Mixed-Use Projects

Lead agencies can evaluate each component of a mixed-use project independently and apply the significance threshold for each project type included (e.g., residential and retail). Alternatively, a lead agency may consider only the project's dominant use. In the analysis of each use, a project should take credit for internal capture. Combining different land uses and applying one threshold to those land uses may result in an inaccurate impact assessment.

Other Project Types

Of land use projects, residential, office, and retail projects tend to have the greatest influence on VMT. For that reason, OPR recommends the quantified thresholds described above for purposes of analysis and mitigation. Lead agencies, using more location-specific information, may develop their own more specific thresholds, which may include other land use types. In developing thresholds for other project types, or thresholds different from those recommended here, lead agencies should consider the purposes described in section 21099 of the Public Resources Code and regulations in the CEQA Guidelines on the development of thresholds of significance (e.g., CEQA Guidelines, § 15064.7).

Strategies and projects that decrease local VMT but increase total VMT should be avoided. Agencies should consider whether their actions encourage development in a less travel-efficient location by limiting development in travel-efficient locations.

Redevelopment Projects

Where a project replaces existing VMT-generating land uses, if the replacement leads to a net overall decrease in VMT, the project would lead to a less-than-significant transportation impact. If the project leads to a net overall increase in VMT, then the thresholds described above should apply.

As described above, a project or plan near transit which replaces affordable³¹ residential units with a smaller number of moderate- or high-income residential units may increase overall VMT, because

³¹ Including naturally-occurring affordable residential units.

ITEM 11.1.

displaced residents' VMT may increase.³² A lead agency should analyze VMT for such a project even if it otherwise would have been presumed less than significant. The assessment should incorporate an estimate of the aggregate VMT increase experienced by displaced residents. That additional VMT should be included in the numerator of the VMT per capita assessed for the project.

If a residential or office project leads to a net increase in VMT, then the project's VMT per capita (residential) or per employee (office) should be compared to thresholds recommended above. Per capita and per employee VMT are efficiency metrics, and, as such, apply only to the existing project without regard to the VMT generated by the previously existing land use.

If the project leads to a net increase in provision of locally-serving retail, transportation impacts from the retail portion of the development should be presumed to be less than significant. If the project consists of regionally-serving retail, and increases overall VMT compared to with existing uses, then the project would lead to a significant transportation impact.

RTP/SCS Consistency (All Land Use Projects)

Section 15125, subdivision (d), of the CEQA Guidelines provides that lead agencies should analyze impacts resulting from inconsistencies with regional plans, including regional transportation plans. For this reason, if a project is inconsistent with the Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS), the lead agency should evaluate whether that inconsistency indicates a significant impact on transportation. For example, a development may be inconsistent with an RTP/SCS if the development is outside the footprint of development or within an area specified as open space as shown in the SCS.

3. Recommendations Regarding Land Use Plans

As with projects, agencies should analyze VMT outcomes of land use plans across the full area over which the plan may substantively affect travel patterns, including beyond the boundary of the plan or jurisdiction's geography. And as with projects, VMT should be counted in full rather than split between origin and destination. (Emissions inventories have sometimes split cross-boundary trips in order to sum to a regional total, but CEQA requires accounting for the full impact without truncation or discounting). Analysis of specific plans may employ the same thresholds described above for projects. A general plan, area plan, or community plan may have a significant impact on transportation if proposed new residential, office, or retail land uses would in aggregate exceed the respective thresholds recommended above. Where the lead agency tiers from a general plan EIR pursuant to CEQA Guidelines sections 15152 and 15166, the lead agency generally focuses on the environmental impacts that are specific to the later project and were not analyzed as significant impacts in the prior EIR. (Pub. Resources Code, § 21068.5; Guidelines, § 15152, subd. (a).) Thus, in analyzing the later project, the lead agency

³² Chapple et al. (2017) *Developing a New Methodology for Analyzing Potential Displacement*, Chapter 4, pp. 159-160, available at <https://www.arb.ca.gov/research/apr/past/13-310.pdf>.

ITEM 11.1.

would focus on the VMT impacts that were not adequately addressed in the prior EIR. In the tiered document, the lead agency should continue to apply the thresholds recommended above.

Thresholds for plans in non-MPO areas may be determined on a case-by-case basis.

4. Other Considerations

Rural Projects Outside of MPOs

In rural areas of non-MPO counties (i.e., areas not near established or incorporated cities or towns), fewer options may be available for reducing VMT, and significance thresholds may be best determined on a case-by-case basis. Note, however, that clustered small towns and small town main streets may have substantial VMT benefits compared to isolated rural development, similar to the transit oriented development described above.

Impacts to Transit

Because criteria for determining the significance of transportation impacts must promote “the development of multimodal transportation networks” pursuant to Public Resources Code section 21099, subd. (b)(1), lead agencies should consider project impacts to transit systems and bicycle and pedestrian networks. For example, a project that blocks access to a transit stop or blocks a transit route itself may interfere with transit functions. Lead agencies should consult with transit agencies as early as possible in the development process, particularly for projects that are located within one half mile of transit stops.

When evaluating impacts to multimodal transportation networks, lead agencies generally should not treat the addition of new transit users as an adverse impact. An infill development may add riders to transit systems and the additional boarding and alighting may slow transit vehicles, but it also adds destinations, improving proximity and accessibility. Such development also improves regional vehicle flow by adding less vehicle travel onto the regional network.

Increased demand throughout a region may, however, cause a cumulative impact by requiring new or additional transit infrastructure. Such impacts may be adequately addressed through a fee program that fairly allocates the cost of improvements not just to projects that happen to locate near transit, but rather across a region to all projects that impose burdens on the entire transportation system, since transit can broadly improve the function of the transportation system.

F. Considering the Effects of Transportation Projects on Vehicle Travel

Many transportation projects change travel patterns. A transportation project which leads to additional vehicle travel on the roadway network, commonly referred to as “induced vehicle travel,” would need to quantify the amount of additional vehicle travel in order to assess air quality impacts, greenhouse gas emissions impacts, energy impacts, and noise impacts. Transportation projects also are required to

ITEM 11.1.

examine induced growth impacts under CEQA. (See generally, Pub. Resources Code, §§ 21065 [defining “project” under CEQA as an activity as causing either a direct or reasonably foreseeable indirect physical change], 21065.3 [defining “project-specific effect” to mean all direct or indirect environmental effects], 21100, subd. (b) [required contents of an EIR].) For any project that increases vehicle travel, explicit assessment and quantitative reporting of the amount of additional vehicle travel should not be omitted from the document; such information may be useful and necessary for a full understanding of a project’s environmental impacts. (See Pub. Resources Code, §§ 21000, 21001, 21001.1, 21002, 21002.1 [discussing the policies of CEQA].) A lead agency that uses the VMT metric to assess the transportation impacts of a transportation project may simply report that change in VMT as the impact. When the lead agency uses another metric to analyze the transportation impacts of a roadway project, changes in amount of vehicle travel added to the roadway network should still be analyzed and reported.³³

While CEQA does not require perfection, it is important to make a reasonably accurate estimate of transportation projects’ effects on vehicle travel in order to make reasonably accurate estimates of GHG emissions, air quality emissions, energy impacts, and noise impacts. (See, e.g., *California Clean Energy Com. v. City of Woodland* (2014) 225 Cal.App.4th 173, 210 [EIR failed to consider project’s transportation energy impacts]; *Ukiah Citizens for Safety First v. City of Ukiah* (2016) 248 Cal.App.4th 256, 266.) Appendix 2 describes in detail the causes of induced vehicle travel, the robust empirical evidence of induced vehicle travel, and how models and research can be used in conjunction to quantitatively assess induced vehicle travel with reasonable accuracy.

If a project would likely lead to a measurable and substantial increase in vehicle travel, the lead agency should conduct an analysis assessing the amount of vehicle travel the project will induce. Project types that would likely lead to a measurable and substantial increase in vehicle travel generally include:

- Addition of through lanes on existing or new highways, including general purpose lanes, HOV lanes, peak period lanes, auxiliary lanes, or lanes through grade-separated interchanges

Projects that would not likely lead to a substantial or measurable increase in vehicle travel, and therefore generally should not require an induced travel analysis, include:

- Rehabilitation, maintenance, replacement, safety, and repair projects designed to improve the condition of existing transportation assets (e.g., highways; roadways; bridges; culverts; Transportation Management System field elements such as cameras, message signs, detection, or signals; tunnels; transit systems; and assets that serve bicycle and pedestrian facilities) and that do not add additional motor vehicle capacity
- Roadside safety devices or hardware installation such as median barriers and guardrails

³³ See, e.g., California Department of Transportation (2006) *Guidance for Preparers of Growth-related, Indirect Impact Analyses*, available at http://www.dot.ca.gov/ser/Growth-related/IndirectImpactAnalysis/GRI_guidance06May_files/gri_guidance.pdf.

ITEM 11.1.

- Roadway shoulder enhancements to provide “breakdown space,” dedicated space for use only by transit vehicles, to provide bicycle access, or to otherwise improve safety, but which will not be used as automobile vehicle travel lanes
- Addition of an auxiliary lane of less than one mile in length designed to improve roadway safety
- Installation, removal, or reconfiguration of traffic lanes that are not for through traffic, such as left, right, and U-turn pockets, two-way left turn lanes, or emergency breakdown lanes that are not utilized as through lanes
- Addition of roadway capacity on local or collector streets provided the project also substantially improves conditions for pedestrians, cyclists, and, if applicable, transit
- Conversion of existing general purpose lanes (including ramps) to managed lanes or transit lanes, or changing lane management in a manner that would not substantially increase vehicle travel
- Addition of a new lane that is permanently restricted to use only by transit vehicles
- Reduction in number of through lanes
- Grade separation to separate vehicles from rail, transit, pedestrians or bicycles, or to replace a lane in order to separate preferential vehicles (e.g., HOV, HOT, or trucks) from general vehicles
- Installation, removal, or reconfiguration of traffic control devices, including Transit Signal Priority (TSP) features
- Installation of traffic metering systems, detection systems, cameras, changeable message signs and other electronics designed to optimize vehicle, bicycle, or pedestrian flow
- Timing of signals to optimize vehicle, bicycle, or pedestrian flow
- Installation of roundabouts or traffic circles
- Installation or reconfiguration of traffic calming devices
- Adoption of or increase in tolls
- Addition of tolled lanes, where tolls are sufficient to mitigate VMT increase
- Initiation of new transit service
- Conversion of streets from one-way to two-way operation with no net increase in number of traffic lanes
- Removal or relocation of off-street or on-street parking spaces
- Adoption or modification of on-street parking or loading restrictions (including meters, time limits, accessible spaces, and preferential/reserved parking permit programs)
- Addition of traffic wayfinding signage
- Rehabilitation and maintenance projects that do not add motor vehicle capacity
- Addition of new or enhanced bike or pedestrian facilities on existing streets/highways or within existing public rights-of-way
- Addition of Class I bike paths, trails, multi-use paths, or other off-road facilities that serve non-motorized travel
- Installation of publicly available alternative fuel/charging infrastructure
- Addition of passing lanes, truck climbing lanes, or truck brake-check lanes in rural areas that do not increase overall vehicle capacity along the corridor

ITEM 11.1.

1. Recommended Significance Threshold for Transportation Projects

As noted in Section 15064.3 of the CEQA Guidelines, lead agencies for roadway capacity projects have discretion, consistent with CEQA and planning requirements, to choose which metric to use to evaluate transportation impacts. This section recommends considerations for evaluating impacts using vehicle miles traveled. Lead agencies have discretion to choose a threshold of significance for transportation projects as they do for other types of projects. As explained above, Public Resources Code section 21099, subdivision (b)(1), provides that criteria for determining the significance of transportation impacts must promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses. (*Id.*; see generally, adopted CEQA Guidelines, § 15064.3, subd. (b) [Criteria for Analyzing Transportation Impacts].) With those goals in mind, OPR prepared and the Agency adopted an appropriate transportation metric.

Whether adopting a threshold of significance, or evaluating transportation impacts on a case-by-case basis, a lead agency should ensure that the analysis addresses:

- Direct, indirect and cumulative effects of the transportation project (CEQA Guidelines, § 15064, subds. (d), (h))
- Near-term and long-term effects of the transportation project (CEQA Guidelines, §§ 15063, subd. (a)(1), 15126.2, subd. (a))
- The transportation project's consistency with state greenhouse gas reduction goals (Pub. Resources Code, § 21099)³⁴
- The impact of the transportation project on the development of multimodal transportation networks (Pub. Resources Code, § 21099)
- The impact of the transportation project on the development of a diversity of land uses (Pub. Resources Code, § 21099)

The CARB Scoping Plan and the CARB Mobile Source Strategy delineate VMT levels required to achieve legally mandated GHG emissions reduction targets. A lead agency should develop a project-level threshold based on those VMT levels, and may apply the following approach:

1. Propose a fair-share allocation of those budgets to their jurisdiction (e.g., by population);

³⁴ The California Air Resources Board has ascertained the limits of VMT growth compatible with California containing greenhouse gas emissions to levels research shows would allow for climate stabilization. (See [The 2017 Climate Change Scoping Plan: The Strategy for Achieving California's 2030 Greenhouse Gas Target](#) (p. 78, p. 101); [Mobile Source Strategy](#) (p. 37).) CARB's [Updated Final Staff Report on Proposed Update to the SB 375 Greenhouse Gas Emission Reduction Targets](#) illustrates that the current Regional Transportation Plans and Sustainable Communities Strategies will fall short of achieving the necessary on-road transportation-related GHG emissions reductions called for in the 2017 Scoping Plan (Figure 3, p. 35). Accordingly, OPR recommends not basing GHG emissions or transportation impact analysis for a transportation project solely on consistency with an RTP/SCS.

ITEM 11.1.

2. Determine the amount of VMT growth likely to result from background population growth, and subtract that from their “budget”;
3. Allocate their jurisdiction’s share between their various VMT-increasing transportation projects, using whatever criteria the lead agency prefers.

2. Estimating VMT Impacts from Transportation Projects

CEQA requires analysis of a project’s potential growth-inducing impacts. (Pub. Resources Code, § 21100, subd. (b)(5); CEQA Guidelines, § 15126.2, subd. (d).) Many agencies are familiar with the analysis of growth inducing impacts associated with water, sewer, and other infrastructure. This technical advisory addresses growth that may be expected from roadway expansion projects.

Because a roadway expansion project can induce substantial VMT, incorporating quantitative estimates of induced VMT is critical to calculating both transportation and other impacts of these projects. Induced travel also has the potential to reduce or eliminate congestion relief benefits. An accurate estimate of induced travel is needed to accurately weigh costs and benefits of a highway capacity expansion project.

The effect of a transportation project on vehicle travel should be estimated using the “change in total VMT” method described in *Appendix 1*. This means that an assessment of total VMT without the project and an assessment with the project should be made; the difference between the two is the amount of VMT attributable to the project. The assessment should cover the full area in which driving patterns are expected to change. As with other types of projects, the VMT estimation should not be truncated at a modeling or jurisdictional boundary for convenience of analysis when travel behavior is substantially affected beyond that boundary.

Transit and Active Transportation Projects

Transit and active transportation projects generally reduce VMT and therefore are presumed to cause a less-than-significant impact on transportation. This presumption may apply to all passenger rail projects, bus and bus rapid transit projects, and bicycle and pedestrian infrastructure projects. Streamlining transit and active transportation projects aligns with each of the three statutory goals contained in SB 743 by reducing GHG emissions, increasing multimodal transportation networks, and facilitating mixed use development.

Roadway Projects

Reducing roadway capacity (for example, by removing or repurposing motor vehicle travel lanes) will generally reduce VMT and therefore is presumed to cause a less-than-significant impact on transportation. Generally, no transportation analysis is needed for such projects.

ITEM 11.1.

Building new roadways, adding roadway capacity in congested areas, or adding roadway capacity to areas where congestion is expected in the future, typically induces additional vehicle travel. For the types of projects previously indicated as likely to lead to additional vehicle travel, an estimate should be made of the change in vehicle travel resulting from the project.

For projects that increase roadway capacity, lead agencies can evaluate induced travel quantitatively by applying the results of existing studies that examine the magnitude of the increase of VMT resulting from a given increase in lane miles. These studies estimate the percent change in VMT for every percent change in miles to the roadway system (i.e., “elasticity”).³⁵ Given that lead agencies have discretion in choosing their methodology, and the studies on induced travel reveal a range of elasticities, lead agencies may appropriately apply professional judgment in studying the transportation effects of a particular project. The most recent major study, estimates an elasticity of 1.0, meaning that every percent change in lane miles results in a one percent increase in VMT.³⁶

To estimate VMT impacts from roadway expansion projects:

1. Determine the total lane-miles over an area that fully captures travel behavior changes resulting from the project (generally the region, but for projects affecting interregional travel look at all affected regions).
2. Determine the percent change in total lane miles that will result from the project.
3. Determine the total existing VMT over that same area.
4. Multiply the percent increase in lane miles by the existing VMT, and then multiply that by the elasticity from the induced travel literature:

$$[\% \text{ increase in lane miles}] \times [\text{existing VMT}] \times [\text{elasticity}] = [\text{VMT resulting from the project}]$$

A National Center for Sustainable Transportation tool can be used to apply this method:

<https://ncst.ucdavis.edu/research/tools>

This method would not be suitable for rural (non-MPO) locations in the state which are neither congested nor projected to become congested. It also may not be suitable for a new road that provides new connectivity across a barrier (e.g., a bridge across a river) if it would be expected to substantially

³⁵ See U.C. Davis, Institute for Transportation Studies (Oct. 2015) *Increasing Highway Capacity Unlikely to Relieve Traffic Congestion*; Boarnet and Handy (Sept. 2014) *Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions*, California Air Resources Board Policy Brief, available at https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf.

³⁶ See Duranton and Turner (2011) *The Fundamental Law of Road Congestion: Evidence from US cities*, available at <http://www.nber.org/papers/w15376>.

ITEM 11.1.

shorten existing trips. If it is likely to be substantial, the trips-shortening effect should be examined explicitly.

The effects of roadway capacity on vehicle travel can also be applied at a programmatic level. For example, in a regional planning process the lead agency can use that program-level analysis to streamline later project-level analysis. (See CEQA Guidelines, § 15168.) A program-level analysis of VMT should include effects of the program on land use patterns, and the VMT that results from those land use effects. In order for a program-level document to adequately analyze potential induced demand from a project or program of roadway capacity expansion, lead agencies cannot assume a fixed land use pattern (i.e., a land use pattern that does not vary in response to the provision of roadway capacity). A proper analysis should account for land use investment and development pattern changes that react in a reasonable manner to changes in accessibility created by transportation infrastructure investments (whether at the project or program level).

Mitigation and Alternatives

Induced VMT has the potential to reduce or eliminate congestion relief benefits, increase VMT, and increase other environmental impacts that result from vehicle travel.³⁷ If those effects are significant, the lead agency will need to consider mitigation or alternatives. In the context of increased travel that is induced by capacity increases, appropriate mitigation and alternatives that a lead agency might consider include the following:

- Tolling new lanes to encourage carpools and fund transit improvements
- Converting existing general purpose lanes to HOV or HOT lanes
- Implementing or funding off-site travel demand management
- Implementing Intelligent Transportation Systems (ITS) strategies to improve passenger throughput on existing lanes

Tolling and other management strategies can have the additional benefit of preventing congestion and maintaining free-flow conditions, conferring substantial benefits to road users as discussed above.

G. Analyzing Other Impacts Related to Transportation

While requiring a change in the methodology of assessing transportation impacts, Public Resources Code section 21099 notes that this change “does not relieve a public agency of the requirement to analyze a project’s potentially significant transportation impacts related to air quality, noise, safety, or any other impact associated with transportation.” OPR expects that lead agencies will continue to

³⁷ See National Center for Sustainable Transportation (Oct. 2015) *Increasing Highway Capacity Unlikely to Relieve Traffic Congestion*, available at http://www.dot.ca.gov/newtech/researchreports/reports/2015/10-12-2015-NCST_Brief_InducedTravel_CS6_v3.pdf; see Duranton and Turner (2011) *The Fundamental Law of Road Congestion: Evidence from US cities*, available at <http://www.nber.org/papers/w15376>.

ITEM 11.1.

address mobile source emissions in the air quality and noise sections of an environmental document and the corresponding studies that support the analysis in those sections. Lead agencies should continue to address environmental impacts of a proposed project pursuant to CEQA's requirements, using a format that is appropriate for their particular project.

Because safety concerns result from many different factors, they are best addressed at a programmatic level (i.e., in a general plan or regional transportation plan) in cooperation with local governments, metropolitan planning organizations, and, where the state highway system is involved, the California Department of Transportation. In most cases, such an analysis would not be appropriate on a project-by-project basis. Increases in traffic volumes at a particular location resulting from a project typically cannot be estimated with sufficient accuracy or precision to provide useful information for an analysis of safety concerns. Moreover, an array of factors affect travel demand (e.g., strength of the local economy, price of gasoline), causing substantial additional uncertainty. Appendix B of OPR's [General Plan Guidelines](#) summarizes research which could be used to guide a programmatic analysis under CEQA. Lead agencies should note that automobile congestion or delay does not constitute a significant environmental impact (Pub. Resources Code, §21099(b)(2)), and safety should not be used as a proxy for road capacity.

H. VMT Mitigation and Alternatives

When a lead agency identifies a significant impact, it must identify feasible mitigation measures that could avoid or substantially reduce that impact. (Pub. Resources Code, § 21002.1, subd. (a).) Additionally, CEQA requires that an environmental impact report identify feasible alternatives that could avoid or substantially reduce a project's significant environmental impacts.

Indeed, the California Court of Appeal recently held that a long-term regional transportation plan was deficient for failing to discuss an alternative which could significantly reduce total vehicle miles traveled. In *Cleveland National Forest Foundation v. San Diego Association of Governments, et al.* (2017) 17 Cal.App.5th 413, the court found that omission "inexplicable" given the lead agency's "acknowledgment in its Climate Action Strategy that the state's efforts to reduce greenhouse gas emissions from on-road transportation will not succeed if the amount of driving, or vehicle miles traveled, is not significantly reduced." (*Cleveland National Forest Foundation, supra*, 17 Cal.App.5th at p. 436.) Additionally, the court noted that the project alternatives focused primarily on congestion relief even though "the [regional] transportation plan is a long-term and congestion relief is not necessarily an effective long-term strategy." (*Id.* at p. 437.) The court concluded its discussion of the alternatives analysis by stating: "Given the acknowledged long-term drawbacks of congestion relief alternatives, there is not substantial evidence to support the EIR's exclusion of an alternative focused primarily on significantly reducing vehicle trips." (*Ibid.*)

Several examples of potential mitigation measures and alternatives to reduce VMT are described below. However, the selection of particular mitigation measures and alternatives are left to the discretion of

ITEM 11.1.

the lead agency, and mitigation measures may vary, depending on the proposed project and significant impacts, if any. Further, OPR expects that agencies will continue to innovate and find new ways to reduce vehicular travel.

Potential measures to reduce vehicle miles traveled include, but are not limited to:

- Improve or increase access to transit.
- Increase access to common goods and services, such as groceries, schools, and daycare.
- Incorporate affordable housing into the project.
- Incorporate neighborhood electric vehicle network.
- Orient the project toward transit, bicycle and pedestrian facilities.
- Improve pedestrian or bicycle networks, or transit service.
- Provide traffic calming.
- Provide bicycle parking.
- Limit or eliminate parking supply.
- Unbundle parking costs.
- Provide parking cash-out programs.
- Implement roadway pricing.
- Implement or provide access to a commute reduction program.
- Provide car-sharing, bike sharing, and ride-sharing programs.
- Provide transit passes.
- Shifting single occupancy vehicle trips to carpooling or vanpooling, for example providing ride-matching services.
- Providing telework options.
- Providing incentives or subsidies that increase the use of modes other than single-occupancy vehicle.
- Providing on-site amenities at places of work, such as priority parking for carpools and vanpools, secure bike parking, and showers and locker rooms.
- Providing employee transportation coordinators at employment sites.
- Providing a guaranteed ride home service to users of non-auto modes.

Notably, because VMT is largely a regional impact, regional VMT-reduction programs may be an appropriate form of mitigation. In lieu fees have been found to be valid mitigation where there is both a commitment to pay fees and evidence that mitigation will actually occur. (*Save Our Peninsula Committee v. Monterey County Bd. of Supervisors* (2001) 87 Cal.App.4th 99, 140-141; *Gentry v. City of Murrieta* (1995) 36 Cal.App.4th 1359; *Kings County Farm Bureau v. City of Hanford* (1990) 221 Cal.App.3d 692, 727–728.) Fee programs are particularly useful to address cumulative impacts. (CEQA Guidelines, § 15130, subd. (a)(3) [a “project’s incremental contribution is less than cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact”].) The mitigation program must undergo CEQA evaluation, either on the program as a whole, or the in-lieu fees or other mitigation must be evaluated

ITEM 11.1.

on a project-specific basis. (*California Native Plant Society v. County of El Dorado* (2009) 170 Cal.App.4th 1026.) That CEQA evaluation could be part of a larger program, such as a regional transportation plan, analyzed in a Program EIR. (CEQA Guidelines, § 15168.)

Examples of project alternatives that may reduce vehicle miles traveled include, but are not limited to:

- Locate the project in an area of the region that already exhibits low VMT.
- Locate the project near transit.
- Increase project density.
- Increase the mix of uses within the project or within the project's surroundings.
- Increase connectivity and/or intersection density on the project site.
- Deploy management strategies (e.g., pricing, vehicle occupancy requirements) on roadways or roadway lanes.

ITEM 11.1.

Appendix 1. Considerations About Which VMT to Count

Consistent with the obligation to make a good faith effort to disclose the environmental consequences of a project, lead agencies have discretion to choose the most appropriate methodology to evaluate project impacts.³⁸ A lead agency can evaluate a project's effect on VMT in numerous ways. The purpose of this document is to provide technical considerations in determining which methodology may be most useful for various project types.

Background on Estimating Vehicle Miles Traveled

Before discussing specific methodological recommendations, this section provides a brief overview of modeling and counting VMT, including some key terminology.

Here is an illustrative example of some methods of estimating vehicle miles traveled. Consider the following hypothetical travel day (all by automobile):

1. Residence to Coffee Shop
2. Coffee Shop to Work
3. Work to Sandwich Shop
4. Sandwich Shop to Work
5. Work to Residence
6. Residence to Store
7. Store to Residence

Trip-based assessment of a project's effect on travel behavior counts VMT from individual trips to and from the project. It is the most basic, and traditionally the most common, method of counting VMT. A trip-based VMT assessment of the residence in the above example would consider segments 1, 5, 6 and 7. For residential projects, the sum of home-based trips is called *home-based* VMT.

A *tour-based* assessment counts the entire home-back-to-home tour that includes the project. A tour-based VMT assessment of the residence in the above example would consider segments 1, 2, 3, 4, and 5 in one tour, and 6 and 7 in a second tour. A tour-based assessment of the workplace would include segments 1, 2, 3, 4, and 5. Together, all tours comprise *household* VMT.

³⁸ The California Supreme Court has explained that when an agency has prepared an environmental impact report:

[T]he issue is not whether the [lead agency's] studies are irrefutable or whether they could have been better. The relevant issue is only whether the studies are sufficiently credible to be considered as part of the total evidence that supports the [lead agency's] finding[.]

(*Laurel Heights Improvement Assn. v. Regents of the University of California* (1988) 47 Cal.3d 376, 409; see also *Eureka Citizens for Responsible Gov't v. City of Eureka* (2007) 147 Cal.App.4th 357, 372.)

ITEM 11.1.

Both trip- and tour-based assessments can be used as measures of transportation efficiency, using denominators such as per capita, per employee, or per person-trip.

Trip- and Tour-based Assessment of VMT

As illustrated above, a tour-based assessment of VMT is a more complete characterization of a project's effect on VMT. In many cases, a project affects travel behavior beyond the first destination. The location and characteristics of the home and workplace will often be the main drivers of VMT. For example, a residential or office development located near high quality transit will likely lead to some commute trips utilizing transit, affecting mode choice on the rest of the tour.

Characteristics of an office project can also affect an employee's VMT beyond the work tour. For example, a workplace located at the urban periphery, far from transit, can require an employee to own a car, which in turn affects the entirety of an employee's travel behavior and VMT. For this reason, when estimating the effect of an office development on VMT, it may be appropriate to consider total employee VMT if data and tools, such as tour-based models, are available. This is consistent with CEQA's requirement to evaluate both direct and *indirect* effects of a project. (See CEQA Guidelines, § 15064, subd. (d)(2).)

Assessing Change in Total VMT

A third method, estimating the *change in total VMT* with and without the project, can evaluate whether a project is likely to divert existing trips, and what the effect of those diversions will be on total VMT. This method answers the question, "What is the net effect of the project on area VMT?" As an illustration, assessing the total change in VMT for a grocery store built in a food desert that diverts trips from more distant stores could reveal a net VMT reduction. The analysis should address the full area over which the project affects travel behavior, even if the effect on travel behavior crosses political boundaries.

Using Models to Estimate VMT

Travel demand models, sketch models, spreadsheet models, research, and data can all be used to calculate and estimate VMT (see Appendix F of the [preliminary discussion draft](#)). To the extent possible, lead agencies should choose models that have sensitivity to features of the project that affect VMT. Those tools and resources can also assist in establishing thresholds of significance and estimating VMT reduction attributable to mitigation measures and project alternatives. When using models and tools for those various purposes, agencies should use comparable data and methods, in order to set up an "apples-to-apples" comparison between thresholds, VMT estimates, and VMT mitigation estimates.

Models can work together. For example, agencies can use travel demand models or survey data to estimate existing trip lengths and input those into sketch models such as CalEEMod to achieve more

ITEM 11.1.

accurate results. Whenever possible, agencies should input localized trip lengths into a sketch model to tailor the analysis to the project location. However, in doing so, agencies should be careful to avoid double counting if the sketch model includes other inputs or toggles that are proxies for trip length (e.g., distance to city center). Generally, if an agency changes any sketch model defaults, it should record and report those changes for transparency of analysis. Again, trip length data should come from the same source as data used to calculate thresholds to be sure of an “apples-to-apples” comparison.

Additional background information regarding travel demand models is available in the California Transportation Commission’s [“2010 Regional Transportation Plan Guidelines,”](#) beginning at page 35.

ITEM 11.1.

Appendix 2. Induced Travel: Mechanisms, Research, and Additional Assessment Approaches

Induced travel occurs where roadway capacity is expanded in an area of present or projected future congestion. The effect typically manifests over several years. Lower travel times make the modified facility more attractive to travelers, resulting in the following trip-making changes:

- **Longer trips.** The ability to travel a long distance in a shorter time increases the attractiveness of destinations that are farther away, increasing trip length and vehicle travel.
- **Changes in mode choice.** When transportation investments are devoted to reducing automobile travel time, travelers tend to shift toward automobile use from other modes, which increases vehicle travel.
- **Route changes.** Faster travel times on a route attract more drivers to that route from other routes, which can increase or decrease vehicle travel depending on whether it shortens or lengthens trips.
- **Newly generated trips.** Increasing travel speeds can induce additional trips, which increases vehicle travel. For example, an individual who previously telecommuted or purchased goods on the internet might choose to accomplish those tasks via automobile trips as a result of increased speeds.
- **Land Use Changes.** Faster travel times along a corridor lead to land development farther along that corridor; that new development generates and attracts longer trips, which increases vehicle travel. Over several years, this induced growth component of induced vehicle travel can be substantial, making it critical to include in analyses.

Each of these effects has implications for the total amount of vehicle travel. These effects operate over different time scales. For example, changes in mode choice might occur immediately, while land use changes typically take a few years or longer. CEQA requires lead agencies to analyze both short-term and long-term effects.

Evidence of Induced Vehicle Travel. A large number of peer reviewed studies³⁹ have demonstrated a causal link between highway capacity increases and VMT increases. Many provide quantitative estimates of the magnitude of the induced VMT phenomenon. Collectively, they provide high quality evidence of the existence and magnitude of the induced travel effect.

³⁹ See, e.g., Boarnet and Handy (Sept. 2014) Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions, California Air Resources Board Policy Brief, available at https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf; National Center for Sustainable Transportation (Oct. 2015) *Increasing Highway Capacity Unlikely to Relieve Traffic Congestion*, available at http://www.dot.ca.gov/research/researchreports/reports/2015/10-12-2015-NCST_Brief_InducedTravel_CS6_v3.pdf.

ITEM 11.1.

Most of these studies express the amount of induced vehicle travel as an “elasticity,” which is a multiplier that describes the additional vehicle travel resulting from an additional lane mile of roadway capacity added. For example, an elasticity of 0.6 would signify an 0.6 percent increase in vehicle travel for every 1.0 percent increase in lane miles. Many of these studies distinguish “short run elasticity” (increase in vehicle travel in the first few years) from “long run elasticity” (increase in vehicle travel beyond the first few years). Long run elasticity is larger than short run elasticity, because as time passes, more of the components of induced vehicle travel materialize. Generally, short run elasticity can be thought of as excluding the effects of land use change, while long run elasticity includes them. Most studies find a long run elasticity between 0.6 and just over 1.0,⁴⁰ meaning that every increase in lanes miles of one percent leads to an increase in vehicle travel of 0.6 to 1.0 percent. The most recent major study finds the elasticity of vehicle travel by lanes miles added to be 1.03; in other words, each percent increase in lane miles results in a 1.03 percent increase in vehicle travel.⁴¹ (An elasticity greater than 1.0 can occur because new lanes induce vehicle travel that spills beyond the project location.) In CEQA analysis, the long-run elasticity should be used, as it captures the full effect of the project rather than just the early-stage effect.

Quantifying Induced Vehicle Travel Using Models. Lead agencies can generally achieve the most accurate assessment of induced vehicle travel resulting from roadway capacity increasing projects by applying elasticities from the academic literature, because those estimates include vehicle travel resulting from induced land use. If a lead agency chooses to use a travel demand model, additional analysis would be needed to account for induced land use. This section describes some approaches to undertaking that additional analysis.

Proper use of a travel demand model can capture the following components of induced VMT:

- Trip length (generally increases VMT)
- Mode shift (generally shifts from other modes toward automobile use, increasing VMT)
- Route changes (can act to increase or decrease VMT)
- Newly generated trips (generally increases VMT)
 - Note that not all travel demand models have sensitivity to this factor, so an off-model estimate may be necessary if this effect could be substantial.

However, estimating long-run induced VMT also requires an estimate of the project’s effects on land use. This component of the analysis is important because it has the potential to be a large component of

⁴⁰ See Boarnet and Handy (Sept. 2014) [Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions](https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf), California Air Resources Board Policy Brief, p. 2, available at https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf.

⁴¹ Duranton and Turner (2011) *The Fundamental Law of Road Congestion: Evidence from US cities*, available at <http://www.nber.org/papers/w15376>.

ITEM 11.1.

the overall induced travel effect. Options for estimating and incorporating the VMT effects that are caused by the subsequent land use changes include:

1. *Employ an expert panel.* An expert panel could assess changes to land use development that would likely result from the project. This assessment could then be analyzed by the travel demand model to assess effects on vehicle travel. Induced vehicle travel assessed via this approach should be verified using elasticities found in the academic literature.
2. *Adjust model results to align with the empirical research.* If the travel demand model analysis is performed without incorporating projected land use changes resulting from the project, the assessed vehicle travel should be adjusted upward to account for those land use changes. The assessed VMT after adjustment should fall within the range found in the academic literature.
3. *Employ a land use model, running it iteratively with a travel demand model.* A land use model can be used to estimate the land use effects of a roadway capacity increase, and the traffic patterns that result from the land use change can then be fed back into the travel demand model. The land use model and travel demand model can be iterated to produce an accurate result.

A project which provides new connectivity across a barrier, such as a new bridge across a river, may provide a shortened path between existing origins and destinations, thereby shortening existing trips. In rare cases, this trip-shortening effect might be substantial enough to reduce the amount of vehicle travel resulting from the project below the range found in the elasticities in the academic literature, or even lead a net reduction in vehicle travel overall. In such cases, the trip-shortening effect could be examined explicitly.

Whenever employing a travel demand model to assess induced vehicle travel, any limitation or known lack of sensitivity in the analysis that might cause substantial errors in the VMT estimate (for example, model insensitivity to one of the components of induced VMT described above) should be disclosed and characterized, and a description should be provided on how it could influence the analysis results. A discussion of the potential error or bias should be carried into analyses that rely on the VMT analysis, such as greenhouse gas emissions, air quality, energy, and noise.

ITEM 11.1.

EXHIBIT 6

ITEM 11.1.

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

DELTA GROUP,
Department of Physics

Address :
Physics Dept. Room 301,
One Shields Ave
Davis, CA 95616

(530) 574 5478; (530) 756 6146

tacahill@ucdavis.edu<http://delta.ucdavis.edu>

(Detection and Evaluation of Long-range Transport of Aerosols)

Submission for the Davis City Council, Tuesday Feb 6, 2018

Published air quality and health data, up to date models and site specific factors unique to Nishi support the conclusion that air quality at the Nishi site is unsuitable for residential use. Absent actual data from the site showing that there is no significant hazard, that conclusion must stand.

So what would it cost to get such data? \$30,000. That is about all it would cost for a study that would provide data to quantify the model predictions and provide solid data on the health threats of truck and train diesel and ultra-fine metal pollution at Nishi

I made a similar offer 3 years ago, and 2 weeks of data for ultra-fine diesel were taken at the end of Olive Drive, but there was no way to make measurement on the Nishi site itself and no time for analysis of metals before the June vote. Still, it was a component of the Davis EIR finding showing "...significant and unavoidable" (4.3-33) ..." air quality impacts based on existing state and federal air quality regulations.

If the developers had been considering a new Nishi with residential use, they could have come to me anytime in the past 2 years and I would have leant them about \$50,000 worth of equipment, just returned from the US EPA ultra-fine studies in Detroit, suggested trained personnel, and facilitated access to the UC Davis S-XRF facility at Stanford Linear Accelerator. But that was not done, and here we again have to make decisions based on fatally limited on-site data but scary models.

In the last 2 years, things have changed, and not for the better. Traffic continues to rise 4%/year on I-80, with a recent uptick, with more congestion and braking upwind of Nishi. Two more of my studies have been published, including one on an elevated section of I-5 at 35th Ave in Sacramento, downwind of massive vegetation. It showed that at the Nishi residential distances 600 to 1,300 feet, even after their proposed tree barrier had matured, the pollution would be 89% of what it was at the edge of the freeway – essentially no dilution. Several more studies on neo natal impacts have appeared, making pregnancy at Nishi a dire prospect, and a major UCLA study reported on Dec 30 in the LA Times confirms in some detail the information I provided 2 years ago, notably the far downwind transport of ultra-fine particles and the health impacts of freeways. Finally, from my EPA Detroit work, it appears that the developer and the city can get

ITEM 11.1.

the minimal essential information for about \$30,000, plus a temporary power line to the center of Nishi, and access to UC Davis hardware, analysis capabilities and expertise.

I request the developer and the council to put this whole project on hold to allow the developers to finish the studies they started, with 5 weeks in winter, 5 weeks in summer, diesel and ultra-fine metals, and from the results have the scientifically validated data necessary to allow rational judgements be made on potential residential use.

Thomas A. Cahill,
Professor of Physics and Atmospheric Sciences,
University of California, Davis
My CV is attached and at <http://physics.ucdavis.edu/people/faculty>

ITEM 11.1.

Thomas A. Cahill

One Shields Avenue
Physics Department
Davis, CA 95616

Office: 301 Physics Building
Phone: +1 (530) 756-6146
Email: tacahill@ucdavis.edu
Personal Website: <http://delta.ucdavis.edu/>

Research Interests:

Professor Tom Cahill joined the faculty at UC Davis in 1967, coming from a NATO Fellowship in France 1966-1967. In France, he was studying inner stellar nuclear processes, including the first measurement and phase shift analysis of polarized non-identical spin $\frac{1}{2}$ nucleons, protons on He3. The work continued and expanded into few nucleon and neutron physics at Davis 1967 – 1976, with about 35 publications.

Beginning in 1970, Professor Cahill began applying nuclear and atomic techniques for environmental problems, especially in air pollution. He founded the Crocker Nuclear Laboratory Air Quality group and became Director of the Institute of Ecology, 1972-1976. His work was instrumental in the removal of lead from gasoline and introduction of the catalytic converter, the reduction of sulfur in fuel, and the new air basin for Lake Tahoe with more stringent environmental limits. In 1977, he designed and initiated for the US EPA the first measurements of atmospheric aerosols and visibility at national parks, which in 20 years expanded into the national IMPROVE network which he ran until 1997. In this regard, he repeatedly became involved in Congressional testimony and EPA hearings to demand controls on polluters throughout the west. These programs also resulted in roughly 70 publications.

In 1980, he became Director of the Crocker Nuclear Laboratory, and started a new program in analysis of ancient documents, the Crocker Historical and Archaeological Projects (CHAPs). This resulted in pioneering analyses of the Gutenberg Bible, Dead Sea Scrolls, and the Vinland Map, among others. CHAPS had projects with about 2 dozen faculty associates, resulting in 25 publications, many fellowships for his colleagues and a key role in establish a nuclear laboratory to do this work at the Louvre Museum, Paris.

After officially retiring in 1994, Prof. Cahill formed the DELTA Group (Detection and Evaluation of Long-range Transport of Aerosols) to study aerosol impacts on global climate. This program had major NSF programs in Asia and the Arctic, including the

ITEM 11.1.

continuing aerosol sampling program under NSF Polar Programs on the Greenland Ice Cap, recently extended to 2021. This work has resulted in numerous grants and about 25 publications.

Prof Cahill continues to be involved in the health impacts of aerosols most notably during unique work on the threat of aerosols from the World Trade Center, railroads, and freeways. Working with local NGOs, he has been instrumental in a number of California laws in the past decade. Three of his papers on the health impacts of ultra-fine metals were chosen to be part of a EPA – sponsored special issue of Aerosol Science and Technology. Much of his work since 1997 has been based on his modification of x-ray beam lines at based at the Lawrence Berkeley Laboratory Advanced Light Source and the Stanford Synchrotron Radiation Lightsource. This work has resulted in over 50 publications in this area since retirement, including one in Science Magazine.

Professor Cahill's most unusual achievement is that for the 30 or so Ph.D. students mentored in his career, he was major professor and advisor in 6 separate departments – mostly in Physics, but including Chemistry, Geology, Ecology, Atmospheric Sciences, and Geography.

Since retirement in 1994, he has also published 5 science fiction novels and a major book on air pollution, "I can breathe clearly, now. Protecting yourself from air pollution" (12/2016)

Research Areas

He has presently an NSF grant for aerosols and climate at the Greenland Summit site (until 2021), he is consultant to the CA Department of Justice on the \$176 million lead clean up of the Exide recycling plant in Los Angeles, and is a global spokesperson for IKEA corporation.

Career History

- Ph.D., UCLA 1965
- Adjunct Professor, UCLA 1965 – 1966
- NATO Fellow, Centre de'Etudes Nuclearies, Saclay France, 1966-1967
- Assistant Professor, University of California Davis, 1967-1972
- Associate Professor, University of California Davis 1972-1976
- Director, Institute of Ecology, UC Davis 1972 - 1975
- Professor, University of California Davis 1976 – 1994
- Co-Director, Crocker Historical and Archaeological Programs, 1978 - 1994

ITEM 11.1.

- Director, Crocker Nuclear Laboratory 1980 - 1989
- Professor, Atmospheric Sciences 1992 – 1994
- Visiting Professor and Fellow, U. Kyoto, Japan, 1992
- Professor, Emeritus, Physics and Atmospheric Sciences 1994 – present
- Founder and Head, UC Davis DELTA Group, (Detection and Evaluation of Long-range Transport of Aerosols 1997 - present
- Appointed by the Speaker of the Assembly to the California Inspection and Maintenance Review Committee 2006- 2011

Honors

- National Defense Fellow, UCLA, 1959- 1962
- NATO Fellow, France, 1966-1967
- OAS Fellow, Chile, 1968
- Outstanding Educator of America, 1973
- U. Kyoto Research Fellow, 1992
- UC Davis Public Service Award 1994
- American Lung Association Outstanding Scientist Volunteer, 2002
- Who's Who in the World 2003-present
- Appointed by the Speaker of the Assembly to the California Inspection and Maintenance Review Committee 2006- present
- UC Davis Distinguished Emeritus Professor Award 2013-2014

ITEM 11.1.

1

2

3

4

5

6

I can breathe clearly, now.

Protecting yourself from air pollution

7

Thomas A. Cahill

8

Professor of Physics and Atmospheric Sciences

9

10

11

Picture of Daisy, a young girl in colorful dress, holding a bunch of wilting flowers. In the

12

background a smoggy city.

ITEM 11.1.

Dedications

13

14

15 To my enormously supportive and darling wife, Ginny, and our long-suffering children
16 who have spent far too many vacations sitting in hot cars as I tried to repair field equipment. The
17 only good news is that most sites were “to die for” scenic.

18 I also want to dedicate this book to my many hundreds of research students, mostly
19 undergraduate. They usually did most of the work and often had the best ideas.

20 Finally, I want to also dedicate this book to Jeff March and Marti Childs, fantastic editors,
21 who went far beyond what publishers normally do to clean up my fractured text and make the
22 book far more accessible to the non-expert.

23

24

Preface

This is a book about a serious topic with life-or-death implications. In its 20 chapters, it exposes and explores problems associated with soil and air contamination using complex scientific data that my colleagues and I produced through meticulous measurements and analysis. While I have lightened up the narrative with frequently humorous stories about the hurdles I had to surmount in obtaining air and mineral samples and jousting with stubborn opponents, this book distills just about everything I have learned during more than five decades as a research physicist and atmospheric scientist.

I have tried to give you, the reader, the reality behind air quality impacts devoid of the watered-down and often misleading statements disseminated by government agencies, environmental groups and the popular press. So if you don't understand all of it, or even most of it, do not despair! I have added ***Nerd Alerts!*** To help you navigate troubled waters. Even if you don't grasp all of the scientific methods and "nitty-gritty" chemical analysis details that each chapter of the book presents, you will still derive plenty of useful "take-away" information from the "How can I protect myself" segments scattered throughout the book. For those of you who seek even more detailed information than this book contains, the references in many of the chapters include links to numerous authoritative online resources.

Although I have conducted scientific research throughout the world, most of the data presented in this book is derived from sampling in California, because this is where I completed my educational training and engaged in my academic career. California has a long history of contamination, especially in photochemical smog and visibility reduction from various sources, and my research findings have global applicability.

I first want to emphasize that in everything I have done, I have had wonderful support personnel, many of whom were students at the University of California, Davis. I have recognized them as coauthors, and in many cases first author, in my publications. I also acknowledge the contributions of my adversaries, who in many cases pushed me to do my best work to rebut their opposition, if they had any hint of merit in them. Many were feeble excuses for logic.

ITEM 11.1.

Consumer product disclaimer:

The author discloses that the statements made in this book may lead to outrage and denial, including from well-meaning but poorly informed environmental groups, public agencies frozen in past times (often by inappropriate regulations), and inveterate polluters and well-funded professional environmental scofflaws (viz., global climate deniers).

So, read this book at your own risk. Whenever possible, I back up my opinions with the peer-reviewed literature, but there are a few examples when such are lacking. I make these instances clear. In any case, I cannot be held liable for any physical and mental trauma you may incur from my opinions. I should know, because on many occasions, my opinions caused vigorous albeit unsuccessful efforts to shut me up. I was told by the UC Davis chancellor himself that my revelations prompted many calls for him to fire me (he assured me that he wasn't seriously tempted).

Gratuitous Advice: You'll be wasting your money on this book, though, if you are a current cigarette or cigar smoker. You have problems beyond any help I can propose.

ITEM 11.1.

74 **Tales from the Field**

75 In 1970, impelled by both my concerns about air pollution (after all, I lived 9 years in Los
 76 Angles and went to school a UCLA), and an effort to make enough money to save our basic
 77 nuclear physics program from going belly up, I staggered out from the hallowed halls of
 78 academia into the rough and tumble world of air pollution research. For air pollution studies, you
 79 have to go where the problem occurs, and be “flexible” in how you use your resources (and
 80 sometimes those of others) to get the right answer. And if you get an answer that is both right
 81 and important, there is often a price to pay. On three occasions (Ronald Regan governor, Ronald
 82 Reagan, president, and Georg W. Bush), powerful men and their minions attempted to shut down
 83 my research program. In each of these cases, the efforts to suppress my findings pushed me to
 84 do even more and better work, and these became some of the high points of my career

85 **Tales from the field: Los Angeles freeways**

86 Disaster! What had I done? Below me the six westbound lanes of the Santa Monica
 87 freeway in Los Angeles, which in 1973 was the most heavily traveled road in the world, had
 88 come to a complete stop. As far as I could see, it had turned into a mammoth parking lot, right in
 89 the height of rush hour. And it was all my fault. I and my UC Davis students were investigating
 90 highway air pollution, under the auspices of the California Air Resources Board. We had placed
 91 an air sampler on the middle of a pedestrian bridge across the freeway, but to access it, I had to
 92 climb up onto the top of a wire cage that had been built to prevent pedestrians from falling off or
 93 dropping rocks etc. on the cars below. Traffic had come to a screeching halt as drivers thought I
 94 was planning to jump. Supposedly the jam went all the way back to downtown Los Angeles, and
 95 it was hours before the jam cleared.

96 With that embarrassing episode behind us, our sampling and analysis showed that the
 97 amount of freeway-derived lead in the air in nearby residential neighborhoods was far greater
 98 than prior estimates had predicted. This report was quietly shelved in Sacramento, but word of it
 99 leaked out. Subsequent newspaper headlines reported that the ARB was suppressing dangerous
 100 lead levels – which resulted in cancelation of all ARB funding for my research. Chapter 11 (Get
 101 the Lead Out) presents more details, and tells how I exacted revenge.

102 ***Shut down Tom – attempt No. 1***

ITEM 11.1.

103 **Ronald Reagan, Governor, 1973**

104 My offense? Lead from cars in California houses.

105 Details: Chapter 11, Get the Lead Out!

106 **Tales from the field: Mount St. Helens**

107 “Well, we’re going, aren’t we?” So said my darling wife, Ginny, a second-year law student
108 in the School of Law at the University of California, Davis, when I confronted her outside a
109 classroom that day in late March 1980. Ginny and I had met at UCLA, she as a Woodrow Wilson
110 Fellow in French, I as a nuclear astrophysicist – disciplines about as remote from one another as
111 one can get. Mount St. Helens, which had been dormant for 100 years, had begun oozing
112 magma, and a series of earthquakes began fracturing a pressure dome that was distorting the
113 northern face of the mountain. Ginny had classes to finish and was facing final exams, but all
114 this was jettisoned for a chance to see a volcano erupt. So she grabbed her law books, I grabbed
115 the kids Cathy (then 12) and Tommy (10), and commandeered four aerosol samplers that might,
116 or might not, still be on the Air Resources Board inventory. I had no time to ask anyone, in any
117 case. We headed north in the blue station wagon to the home of my sister Lisa in St. Helens,
118 Oregon, across the Columbia River from the mountain. You could see the top of the volcano and
119 occasional puffs of ash, and Ginny set up to study on that deck. The kids and I drove around the
120 base of the volcano, setting up air samplers as the ground shook and ash intermittently drifted
121 down on us.

122 Because each air sampling unit could operate by itself for about five weeks, we then
123 headed home and waited, ready to re-start the samplers if the volcano did nothing. The mountain
124 blew up on May18, 1980, about a week before I was scheduled to change filters. Two of my
125 samplers were buried under the ash and rock avalanche and never found (sorry, ARB!); one that
126 was upwind measured nothing; but one got the edge of the mammoth eruption and saw for the
127 first time chlorine in sea salt from the subducting oceanic plate. On to *Science* magazine with
128 that discovery! Not surprisingly, both of the kids are now tenured professors and prominent
129 research scientists in environmental areas.

130

131

ITEM 11.1.

Tales from the field: Mono Lake

“Say, Tom, some Mono Lake data was in your Owens Lake Final Report?” Thus mused Mary Nichols, Chair of the California Air Resources Board, implying that the California Air Resources Board (ARB) had paid me to evaluate Owens, not Mono. Was I going rogue? Owens (dry) Lake in the southern end of Owens valley is usually the single worst source of coarse blowing dust in the United States. I had a small grant from the ARB to find the reasons for the dust. But to get to Owens from Davis, I took highway 395 past Mono Lake – just east of Yosemite National Park and home to more than 100,000 shore birds that breed there each year. Just as the Los Angeles Department of Water and Power (LADWP, the agency that gives arrogance a bad name) had dried up Owens Lake circa 1925, the agency was now depleting the streams that fed Mono Lake, and I could see exposed salty flat areas (playas) exposed to the wind, just like at Owens.

I “borrowed” an ARB air sampler and got permission to place it on the property of a local Mono County rancher. The data showed that indeed Mono Lake was going the way of Owens, but at a slower rate. So I added a Mono-to-Owens comparison in my 1979 Owens Final report, and the ARB accepted my report, not realizing that they had officially affirmed my view that LADWP practices were condemning Mono Lake to the same fate as Owens. Well, Mary then said, “What could you do for \$30K at Mono?” (The ARB staff knew that at UC Davis, our students were willing to work for little money). That funding turned into a 14-year project that helped save Mono Lake from the devastation that Owens Lake underwent. It also brought Ginny and me together on the same project – she in a major way as lawyer for the Department of Fish and Game protecting the streams, I in a lesser role as an expert on dust for the State Lands Commission. So we were part of the team in 1994 that “Saved Mono Lake.”

Tales from the field: The Battle over the Grand Canyon

At UCLA, a bunch of us, grad students in Physics, did mountain climbing in the Sierra Nevada west of the Owens Valley. We could see the smog of Los Angeles and the San Joaquin Valley spilling over into the desert. Thus starting in 1972, bolstered by our new capabilities to measure smog, I submitted every 2 years a proposals to the National

ITEM 11.1.

161 Science Foundation for air quality studies in national parks. In 1977, the US EPA noticed
 162 my efforts and funded us for a small program at Zion, Bryce, ad Canyonlands NP, all
 163 impacted by coal fired power plants. This was soon extended to 40 sites, including the
 164 Grand Canyon. All of this came to a crashing end in 1981, when Ronald Reagan
 165 demanded a massive reductions in EPA funding, and down we went!

166 **2. Shut down Tom – attempt No. 2**

167 **Ronald Reagan, President, 1981**

168 Generic gutting of U.S. EPA and our efforts to control smelters and power plants.

169 Details: Chapter 19, I Can See Clearly Now, the Sulfur's Gone (visibility)

170 But with the help of small amounts of National Park Service money and a bunch of bright,
 171 hard working mostly undergraduate students, we persevered, and our revenge is detailed
 172 in Chapter 19.

173 **Tales from the field: The World Trade Center**

174 President George W. Bush “had a cow” (confirmed by two independent sources close to
 175 the White House) in 2003 when he saw my summary from the American Chemical Society
 176 meeting about how smoke from the smoldering wreckage of the World Trade Center imperiled
 177 the health of rescue and salvage workers. In direct contrast to oft-repeated official administration
 178 statements, I declared that the air at the WTC site was not “safe to breathe.” A little yellow
 179 sticker on the statement that was handed to Bush said “Look what UC [University of California]
 180 is doing to us,” and he retaliated by shutting down much of my federally funded research. How
 181 did this happen? Like so many people, I initially felt powerless to help in the WTC disaster, but I
 182 became especially alarmed when I saw a threatening blue haze coming from the collapse pile in
 183 which people were working. When my colleague Bob Leifer from New York called to ask me
 184 for one of our air samplers, I was delighted to help. He used it to gather air samples in lower
 185 Manhattan for three months. I analyzed the samples at Davis and had the results by December
 186 2001.

187 I called the New York office of the US EPA Region II, and offered the data to them to help
 188 upgrade health for the workers. But the EPA brushed off my information because some official
 189 in Washington had decided that this was “a regulatory matter.” The assumption was that the

ITEM 11.1.

190 stinking smoke from the collapse piles was identical chemically to the equal amount of mass
191 seen in the average city. That statement is clearly ridiculous, but it is a consequence of the Clean
192 Air Act's designation of ambient mass as the sole criterion for assessing the effects of airborne
193 particles on human health. Because of this fundamental weakness in the Clean Air Act, about
194 11,000 mostly young and previously healthy workers developed diminished lung function, 6,000
195 are seriously ill, and about 1,000 had to go on permanent disability. Heart attacks at an early age
196 are sure to follow.

197 **3. Shut down Tom – attempt No. 3**

198 **George W. Bush, President, 2003**

199 Particle-polluted air in the vicinity of the collapsed World Trade Center was not safe to
200 breathe, despite what the feds said. Details: Chapter 8, Ultra-fine Metal.

201

202

203

Table of Contents

204

205 *Chapters and sections*

206 **Section A: The facts you need as antidotes to the “conventional** 207 **wisdom”**

208 **1. Air Pollution – How Bad Is It, Really?**

209 Answer: That depends on when and where it occurs

210 **2. Objective Risks and Subjective Safety**

211 The famous factor of 1,000

212 **3. The Clean Air Act: It Is the Best of Acts**

213 The federal Clean Air Act (CAA) in fact and fiction

214 **4. The Clean Air Act: It Is the Worst of Acts**

215 The “dark alley” problem

216 **Section B: The Four Horseman of the Apocalypse: Proven Killers!**

217 **5. “Smoke Gets in Your Eyes” – and Your Lungs, Your Heart, Your Brain**

218 Cigarette and cigar smoke

219 **6. “99 Miles From L.A.” ... and My Eyes Still Watered.....**

220 Ozone, both bad cop and good cop

221 “I’m breathing on a jet plane...”

222 Burn, baby, burn! Baywatch vs. Big Bang Theory geeks.....

223 Ozone impact on Yosemite and Sequoia NP

224 **7. “Black, Black, Black Is the Color of My True Love’s ...” Exhaust.....**

225 Diesel exhaust

226 Sacramento Bee op-ed on VW cheating

227 Diesel trains and rail yards

ITEM 11.1.

228	8. It Was an “Itsy Bitsy Teenie Weenie Yellow ...” Ultra-fine Metal.....
229	Copper and other ultra-fine transition metals
230	Ultrafine particles and the massive governmental screw-up
231	at the World Trade Center.....
232	Shut down Tom – attempt No. 3.....
233	Section C: Mitigation – Yes, You Can Do Better
234	9. Outdoor Air Quality – My Way or the Highway.....
235	Living with heavily trafficked roadways
236	10. Indoor Air Quality – as Clean as You Want it!
237	Indoor mitigation: potentially the most effective line of defense
238	Build your own high-volume, ultrafine particle whole-house air cleaner
239	Section D: Potentially Devastating, But Limited in Space or Time
240	11. Get the Lead Out!.....
241	Automotive lead, probably the worst idea ever
242	Cleanup of the Exide lead battery recycling plant
243	Cautionary tale not yet learned! Cadmium
244	Shut down Tom – attempt No. 1
245	12. The Mad Hatter Had a Point.....
246	Mercury and other toxic metals
247	13. Wood Smoke Is Good Smoke?
248	The controversy continues
249	Smoke from stoves and fireplaces
250	14. The Pollutants That Can Shut Down a Freeway
251	Soil dust and PM ₁₀
252	The \$1.2b debacle at Owens (dry) Lake
253	The Oceano Dunes Off-Road Vehicle Area

ITEM 11.1.

254	15. It May Be Organic, But It Still Sucks!
255	Biologicals, valley fever, and allergens (indoor mitigation)
256	Smoke from medical lasers.....
257	16. On Little Cat’s Feet
258	Pollution-enhanced fogs
259	17. Asbestos
260	Full employment for ambulance-chasing lawyers
261	18. “Mrs. Brown, You’ve Got a Lethal Daughter”
262	Radon: The mother is harmless, but she has a killer daughter!
263	Section E: And Finally, Some Good News
264	19. I Can See Clearly Now, the Sulfur’s Gone
265	Haze and visibility reduction
266	The 2008 Olympics.....
267	Visibility degradation at Yosemite and Sequoia NP.....
268	Shut down Tom – attempt No. 2.....
269	Section F: And Then Some Bad News
270	20. “We Have Met the Enemy, and They Is Us”
271	Aerosols and global climate change
272	Appendix A
273	Outdoor air Mitigation
274	Detailed instructions for evaluating your threat from roadways
275	Appendix B
276	Indoor air mitigation
277	Detailed Instructions for building your own ultra-filtration system
278	

ITEM 11.1.

Introduction

279

280 ***You tell me that I deserve cleaner air than I am getting?***

281 Oh, Yes! One car in 10 on California highways makes the air twice as bad as it should be
 282 for the nine cars whose owners pay extra for the right fuel and properly maintain their vehicles.
 283 We know how to remove that car, but it is not being done.

284 ***Aren't we protected by the Clean Air Act?***

285 The 1973 federal Clean Air Act (CAA), one of the best laws ever passed, is about 50 years
 286 old and has fallen way behind modern science.

287 ***Isn't everything I need to know on U.S. EPA and state websites?***

288 No. Much is based an antiquated standards that do not represent
 289 modern science.

290 ***Do those paper masks you see people wearing in Beijing and elsewhere protect you from***
 291 ***smog?***

292 No. Most smog easily passes through them. They are good for catching sneezes.

293 ***Does staying indoors protect you from wood smoke from wild fires?***

294 Not a lot. About 2/3 to ¾ of wood smoke penetrates into the average house.

295 ***Is it true that the extra \$2.25 billion that Californians have to pay for ethanol added to***
 296 ***gasoline in the winter is futile, because it produces essentially no gain in air quality?***

297 Yes.

298 ***Finally, does the current air quality in the U.S. pose threats from which you should and can***
 299 ***protect yourselves?***

300 Answer: Most assuredly yes, and this book can help.

301 Americans are inundated with government analyses and news reports that are simply not
 302 based on fact. Many represent the best information circa 50-some years ago, when the federal
 303 Clean Air Act (CAA) was proposed, but fundamental errors in how the CAA was written and
 304 vast advances in health science result in regulations that are:

ITEM 11.1.

- 305 • too strong in some instances, and
306 • fatally weak in others.

307 In this book I give you my personal take on the most scientifically valid analyses and
308 conclusions, based on the 46 years during which I dedicated myself to fighting air pollution, in
309 the process of which I have punctured some myths propagated via “conventional wisdom.” We
310 have learned a great deal about the impacts of the most dangerous components of air pollution.

311 But here’s the good news: protection is available for you and your family members, and
312 you can do it yourself! You’ll learn how by reading this book. Each chapter is arranged with
313 three parts:

- 314 1. Introduction and description of the pollutant
315 2. Information explaining how you can protect yourself
316 3. Nitty gritty details and references for further information

317 Then two appendices go into detail of

- 318 1. how to evaluate the impacts of living with roadways and
319 2. how to build air filters that clean up indoor air from the most dangerous pollutants that
320 slip through normal house filters..

321

ITEM 11.1.

322 **Section A**

323 **The facts you need as antidotes to the “conventional**
324 **wisdom”**

325

ITEM 11.1.

Chapter 1

Air Pollution – How Bad Is It, Really?

Answer: That depends on when and where it occurs.

News flash: The World Health Organization estimated in 2014 that the deaths of about 7 million people per year were attributable to air pollution, constituting about 6.7 percent of all deaths worldwide.

Sounds pretty scary, but ...

- 3.3 million of these deaths per year are due to outdoor air pollution, including 1.6 million annually in China alone. Some 88 percent of those premature deaths occurred in low- and middle-income countries. **Do you live there? I thought not.**
- 2.6 million of these deaths per year are due to people who use wood stoves to do their cooking, likewise in low- and middle-income countries. **Is that your situation? I thought not.**

If you live in another part of the world with either naturally good air quality or in a country that has made serious strides in cleaning up their own pollution, consider yourself fortunate in that regard. But hot spots and problems remain, with sharply enhanced disease and death rates in limited areas and during certain times of the year.

- Do you live downwind of a road where heavy braking of cars and trucks is common, such as at a freeway downgrade? **Is that your situation? Your chance of death by heart attack is about 30 percent worse than it is for people a few miles away** (Chapter 8, Ultra-fine metal).
- Do you love to take a summer evening stroll in your city? **Is that your situation? You may not ever know you are at risk until the body count climbs from Legionnaires' disease, since nobody routinely monitors the air for this lethal threat** (Chapter 15, Biologicals, valley fever, and allergens).

ITEM 11.1.

- 351 • Do you live downwind of a rail and/or truck multimodal transport center? **Is that your**
 352 **situation? Your death rate from cancer may be increased by a few percent** (Chapter 7,
 353 Diesel exhaust).
- 354 • Do you live and work in dusty areas of the Southwest? **Is that your situation? You may be at**
 355 **risk of a devastating fungal attack that can be lethal** (Chapter 15, Biologicals, valley fever,
 356 and allergens).
- 357 • Did your kids grow up within one mile of a freeway? **Is that your situation? Their lung**
 358 **function can be permanently reduced as much as 30 percent by the age of 18** (Chapter 8,
 359 Ultra-fine metal).
- 360 • Does your son play football or does your daughter play soccer in early fall, when ozone is
 361 high? Is that your situation? **Their lungs may be permanently scarred, especially if they**
 362 **really exert themselves and breathe through their mouths** (Chapter 6, Ozone).

363 **But conversely:**

- 364 1. The American Lung Association recently listed Sacramento among the 10 worst in the
 365 country. **Is this true? Fear not. The metric the Lung Association uses is deeply flawed**
 366 **(Chapter 4, the Clean Air Act: It is the Worst of Acts).**
- 367 2. I have an old house with asbestos containing “popcorn” on my ceilings. **Is this your**
 368 **situation? You are not at risk** (Chapter 17, Asbestos).

369 To go much further than this requires us to understand what types of air pollution harm and
 370 kill, and how you can seriously mitigate or completely avoid or the threats. It also requires us to
 371 address questions of risk and safety that go way beyond your evening scare TV news program (if
 372 it bleeds, it leads) headlines or – much, much worse – the internet Chamber of Horrors (and we
 373 have a product that will cure all your ills – shipping and handling extra).

374 Historically, there were two types of air pollution events with documented health impacts
 375 from very different causes and dispersed places. The first and by far the more common and most
 376 lethal was a combination of industrial and coal smoke and fog (smog) in the Eastern United
 377 States, Europe, and the rest of the world. The second was identified first in California, but other
 378 places are also affected. This type is invisible, but causes an eye-stinging, lung-constricting

ITEM 11.1.

379 pollution. Regretfully, it also goes by the name “smog,” although “photochemical smog” is a bit
380 better.

381 Classic smog

382 Classic smog events are recorded as far back as the Roman Empire, but modern efforts
383 accelerated with the heavy industrialization of the 19th century. In the U.S., city and regional
384 government agencies enacted regulations to control smoke, and alliances of urban smoke
385 inspectors gradually grew into a national and international association.

386 Smoke went from being an ugly nuisance to a serious public health concern after several
387 lethal air pollution episodes, including:

- 388 • in the Meuse Valley in Belgium, in 1930, in which 6,000 people were sickened and 60 died
- 389 • in Donora, Pennsylvania, in 1948, where an air pollution episode killed 20 people and
390 numerous animals, and half of the town’s 12,000 residents became ill due to uncontrolled
391 emissions from industrial facilities

392 However, the modern focus on air pollution as a serious health hazard finally came to a
393 head in London in 1952.

- 394 • A “killer fog” (which later became known as smog, the combination of smoke and fog)
395 blanketed London for several days. Analysis almost immediately showed sharply increased
396 death rates. More than 4,000 deaths (recent estimates say 12,000) were attributed to “killer
397 fog” in London.

398 England responded with prohibitions on burning soft coal in London, and started
399 measurements by color of smog particles on filters, the British “smoke-shade” measurements.
400 Another “killer fog” that enveloped London in 1956 resulted in 1,000 more deaths than normal.
401 Conditions have improved substantially in Great Britain since then.

402 But the problems continue, with massive pollution in the developing world, including a
403 dense wave of choking smog in the winter of 2013 that paralyzed Harbin and other cities in
404 northeastern China.

405 The government of China estimates that residents in the northern part of the country
406 experience a 5.5-year reduction in lifespan due to smog. Unlike prior episodes, many of the

ITEM 11.1.

407 modern episodes have measurements, unlike earlier episodes where only estimates were
 408 available. Harbin reached 1,000 micrograms of particles per cubic meter of air, versus a US EPA
 409 standard 35 micrograms of particles per cubic meter of air, each the average over a single day .

410 ***Nerd alert!** Particles suspended in the air, dust and particulate smog, are called the atmospheric*
 411 *aerosol. The mass of all particles is compared to the volume of air. The units are in an odd*
 412 *mixture of old and modern forms, with the mass of particle in grams and the volume of air in*
 413 *cubic meters. Thus, micrograms of particles per cubic meter of air is written $\mu\text{g}/\text{m}^3$.*

414 Quantitative measurements allow comparisons of levels and health impacts and, in some
 415 cases, identification of sources. I experienced some pretty dire air quality as I spent time in
 416 heavily polluted areas in China, India, Taiwan, Korea, Japan, Mexico, Chile, and other places
 417 where the conditions were and are grim.

418 As we mentioned earlier, the World Health Organization report estimated that 7 million
 419 people die each year from air pollution, almost all in developing countries. Indoor cooking with
 420 wood and coal stoves are the largest single contributing factor. I was struck by this statistic while
 421 working on a National Science Foundation air quality study in China in 2001. People were using
 422 coal to cook chestnuts on the crowded streets, and the air was acrid with coal fumes. Air quality
 423 conditions are better in the United States, Western Europe, and other developed countries
 424 because the threat was identified earlier and activities to mitigate were initiated and continue.

425 **Photochemical smog**

426 In California, the first recognized episodes of a different type of sharply degraded air
 427 quality occurred in Los Angeles in the summer of 1943. Visibility was only three blocks and
 428 people suffered from smarting eyes, respiratory discomfort, nausea, and vomiting. The
 429 phenomenon was termed a “gas attack” and blamed on a local butadiene plant. The situation did
 430 not improve when the plant was shut down. But by 1947, the problem obviously had become
 431 more serious. Legislation authorized formation of the Los Angeles County Air Pollution Control
 432 District (LAAPCD), followed eight years later by a district for the Bay Area, and then standards
 433 encompassing all California counties were adopted. LAAPCD initially tackled known pollution
 434 sources, including backyard trash incinerators.

435 Dr. Arie Haagen-Smit, a Cal Tech agronomist who was concerned about vegetation
 436 damage, discovered the nature and causes of photochemical smog. He determined that nitrogen

ITEM 11.1.

oxides and hydrocarbons in the presence of ultraviolet radiation from the sun formed a new kind of air pollution, photochemical smog – a key component of which is ozone (the term “smog” is still misleading, as often it contains neither smoke nor fog).

The subsequent sections of this book discuss the most important components of air pollution, both from particles (classic smog) and gaseous photochemical smog (ozone). In each case, the text summarizes actions that you can take to protect yourself, and Chapter 10 (Indoor Air Quality – Air as Clean as You Want it!, and Appendix B) contains details explaining how you can remove particles and gases from the indoor air that you breathe.

Gaseous pollutants

Gaseous pollutants consist of very small molecules with a unique chemical composition. Thus they are inhaled just like air, into the deep lung, and cause immediate as well as delayed impacts. The two about which we have to worry today in terms of health are carbon monoxide and ozone.

Carbon monoxide (the chemical formula for which is CO) replaces oxygen in the blood and the body becomes starved for oxygen, leading to loss of consciousness and, in extreme cases, death. The effects are prompt, and long-term effects are usually absent. It is almost never a problem in outside air today because the catalytic converter has as a nice byproduct: the conversion of CO to CO₂ (carbon dioxide), which is harmless on local scales (but see Chapter 20, Global climate change). Committing suicide by using the exhaust of a properly maintained California car today is almost impossible. However, there are a small minority of cars (~ 10%) that cheat by various means, and these “gross emitters” emit as much pollutant, including CO, as all the other cars combined. But carbon monoxide continues to be a problem inside houses due to charcoal grills and some other sources that can emit massive amounts of CO. This threat is minimized by the requirement for houses to have CO monitors.

The fact that we won the battle against CO emission from well-maintained cars decades ago has not prevented one of the most egregious rip-offs of essentially everybody who drives a gasoline car in the U.S. Take the example of California, where drivers consume about 15 billion gallons of gas each year. For the winter months, federal law requires addition of alcohol as a means of introducing extra oxygen to aid in converting CO to CO₂, in an attempt to help the

ITEM 11.1.

“gross emitters”. Of course, oxygen in the air is free, and we pay dearly for the alcohol, often ethanol, which is grown in Iowa and other agricultural states using petroleum-based fertilizers. The alcohol component reduces gas mileage by about 15 percent. So during the four months of winter, California uses about 5 billion gallons of gasoline, costing around \$15 billion. The 15 percent loss of mileage equates to a penalty of \$2.25 billion, for essentially no gain in air quality. This calculation does not even factor in the cost of the alcohol.

Ozone is another story. Unlike atmospheric oxygen (written as O_2 because the molecule contains two oxygen atoms), ozone has an extra oxygen atom, resulting in a chemical formula of O_3 . In your body or on your skin or eyes, the extra oxygen atom oxidizes (burns!) biological molecules, causing immediate irritation and pain, and resulting in long-term scarring.

Other gaseous pollutants can occur near natural or industrial sources, but these are beyond the scope of this book. Probably the nastiest among them are hydrogen sulfide (H_2S) which has a rotten egg odor and can kill at low concentrations. This is a problem in refineries. Another is acrolein (C_3H_4O), which gives that acrid smell when you heat fat too high in cooking. It can cause bleeding in nasal passages and other membranes. It has a very low EPA safety threshold level.

Much alarm and controversy arose following the October 2015 discovery of a large methane leak in Los Angeles caused when an underground storage facility ruptured. While methane in high concentrations can explode, and even cause asphyxiation, it is not toxic. The numerous resulting complaints about respiratory distress and eye watering were mostly likely psychosomatic, based on the lack of health impacts from pure methane (CH_4) at ambient levels. What people smell is the odor agent added to all natural gas so it can be detected before leaks become serious.

Particulate pollutants

Nerd alert! I have spent 45 years studying particles in the air, and I am still appalled at how much I don't know. Particles are inherently complex, unlike gasses. Carbon monoxide is always one carbon bound to one oxygen, no matter how it is made. But particles are like snowflakes (which are a form of atmospheric aerosols), everyone is unique. But the good news is that particles, unlike gasses, retain signature of how and where and when they were made, which is like fingerprinting or DNA in solving crimes. So you, dedicated reader, should feel free to skip through this topic quickly knowing you can always come back to this chapter when the need arises.

ITEM 11.1.

498 Particles in the air, the “atmospheric aerosol,” encompass every liquid and solid particle
499 that is small enough to remain in the air for a reasonable amount of time, from less than an hour
500 to days and beyond. Some of the most important natural sources of aerosols include water
501 droplets in clouds, windblown dust from dry areas in strong winds, pollen and other biological
502 aerosols, smoke from naturally occurring forest fires, volcanic eruptions, and sea salt spray near
503 the coasts.

504 Particulate pollution, so-called smog aerosols, are human-made atmospheric aerosols.
505 Many, many such synthetic sources emit particles into the air, but the two key factors are:

- 506 1. How rapidly are they are injected into the atmosphere, and
507 2. How long they stay in the air before they are removed by settling out or sticking to vegetation
508 and other solid surfaces.

509 Both of these vary enormously by particle source and size, with re-suspended dust, sea salt
510 and other mechanical aerosols being injected in massive amounts, but then settling rapidly back
511 to the surface.

512 On the other hand, small amounts of very fine and ultra-fine particles from certain sources
513 including brake drums are injected in much smaller amounts, but they are too fine to settle and
514 persist, building up in concentration.

515 Because particles are enormously larger in mass than gas molecules, they have both
516 variable size and complex chemistry.

517 Removal rates versus particle size are shown in Figure 1-1.

ITEM 11.1.

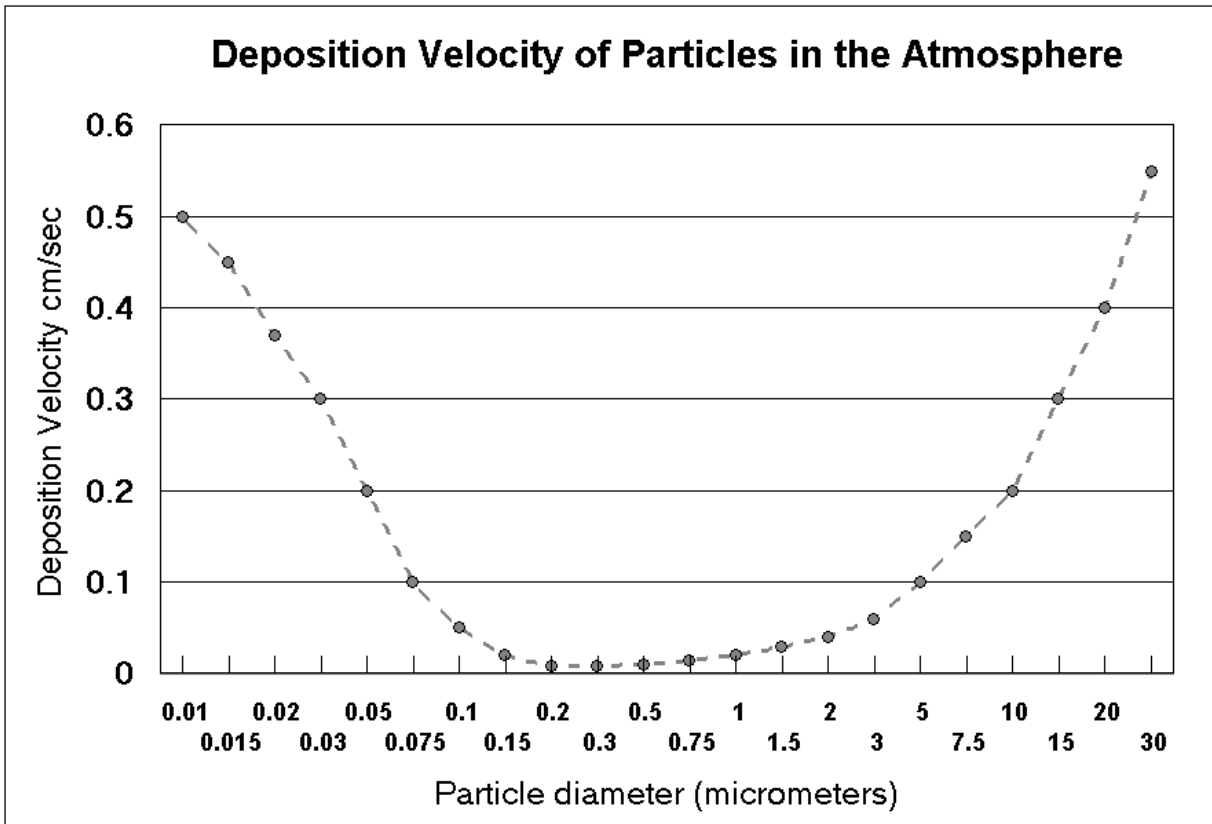


Figure 1-1. Particle removal in the atmosphere, including diffusion to the ground and surfaces for small particles, and settling to the ground by gravity for the large particles.

For large particles, the mechanism is simple. They are so heavy that they settle quickly to the ground or any surface. As they become somewhat finer, below 2.5 μm , the viscosity of the air slows them and their removal is slower.

The very finest particles are bounced around by the molecules in the air and can diffuse to a surface, if a surface is present. In addition, if they can pick up water, they grow rapidly in size until they become so large that further growth slows. This happens for particles of about 0.3 μm or less in diameter.

For particles in the 0.1 to 1 μm size range, both of these removal mechanisms are weak, so particles persist in the atmosphere and accumulate in these size ranges.

ITEM 11.1.

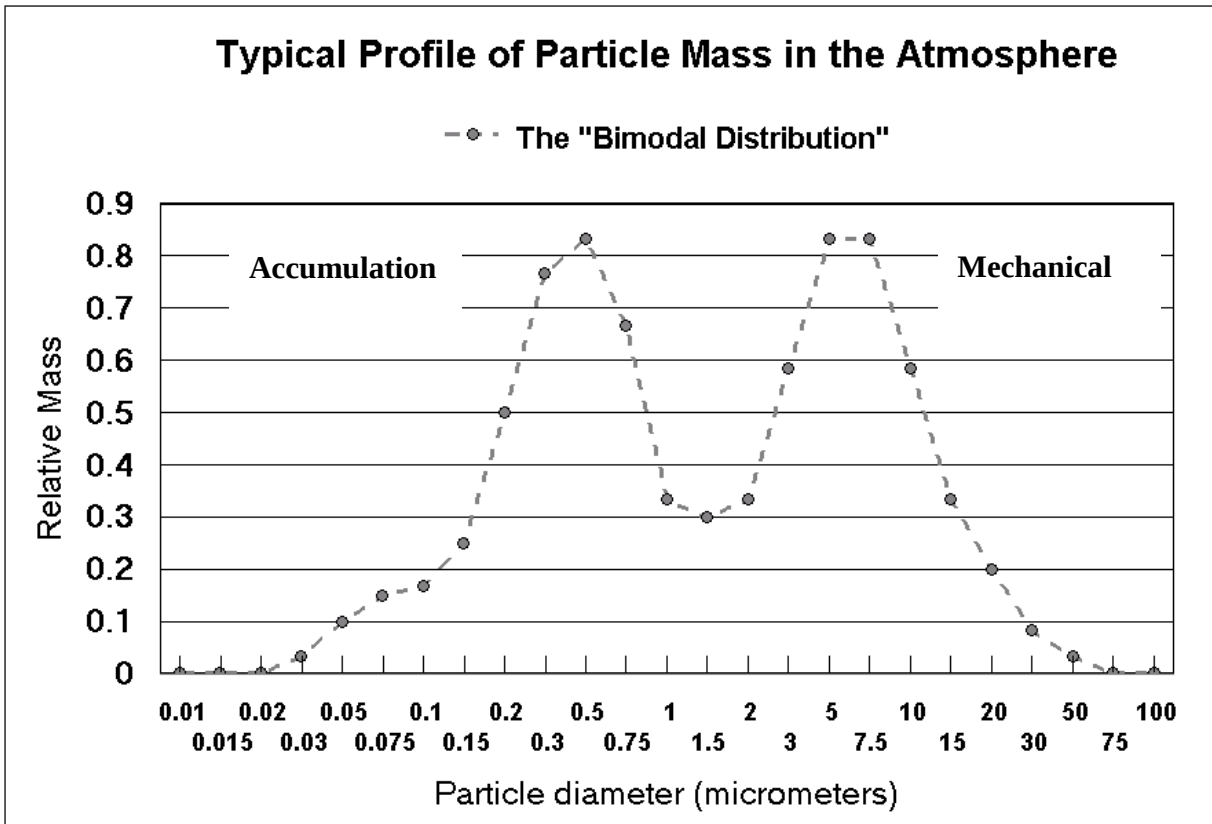


Figure 1-2. The size of particles in the atmosphere.

The result of the rates of emission into the atmosphere and removal from the atmosphere result in the "bimodal distribution," discovered by University of Minnesota mechanical engineering professor Kenneth T. Whitby during the early air pollution studies in Los Angeles in 1972. He found that particles in the air fell into two sizes, or size modes, as shown in Figure 1-2.

- fine particles around 0.3 μm , and
- coarse particles around 10 μm ,

The coarse particles are caused by mechanical means (including dust and sea salt) fall into the "mechanical mode," peaking roughly around 10 μm in diameter. The fine mode, called the "accumulation mode," accumulates around 0.3 μm because they are too large to diffuse to surfaces and too small to fall to the ground. This mode includes many industrial pollutants, wood smoke, and particles that have converted from gases to nitrates, sulfates, or other aerosols that pick up water and grow in size. This is the mode that causes haze. There also is a small mode in mass from combustion around 0.1 μm , often dominated by diesel exhaust.

ITEM 11.1.

Particle size is vital in determining how far aerosols can travel from their source to you, and where they end up in your body. In terms of human health, Figure 1-3 shows where the particles go in your body.

Coarse particles are captured by your nose and throat, and you tend to swallow them. Those that are finer collect in the bronchial tract, causing irritation and coughing. Very fine aerosols go to the deep lung, where they can create problems, and also can pass into the bloodstream and your heart. They can be much more damaging to health than particles you swallow. We use the plot throughout the book, adding where each kind of particle ends up in your body.

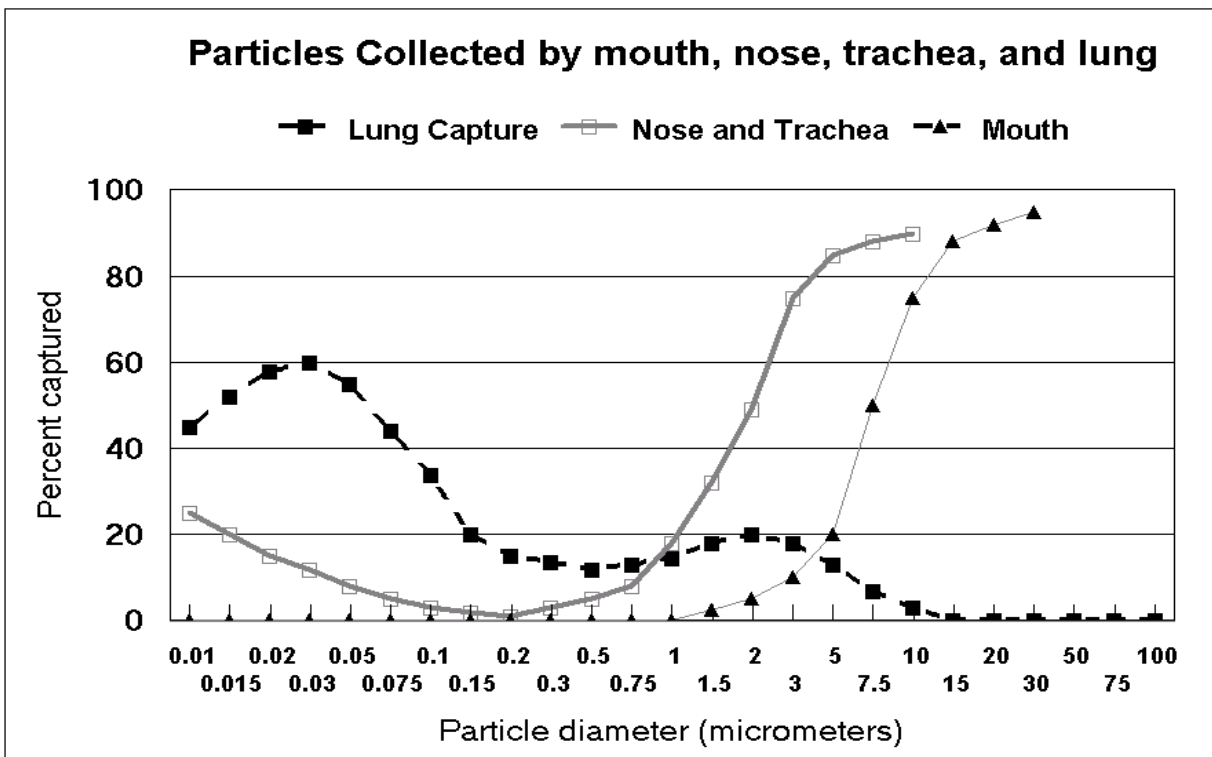


Figure 1-3. Particle collection into your body.

Real World Example:

Cancer and the San Bernardino railyard (1)

The ports of Long Beach and Los Angeles are by far the largest points of entry for Asian commerce on the West Coast. However, since the area is congested, ships are unloaded into

ITEM 11.1.

trucks that then drive about 70 miles northeast until they can arrive at the major Burlington Northern Santa Fe (BNSF) rail hub in San Bernardino, CA. The intermodal facility is the largest in the western United States. The combination of heavy truck traffic and a major rail yard raised concerns about residents downwind of the facility, largely because of diesel exhaust.

The California Air Resources Board (ARB), using analyses from the Office of Environmental Health Hazard Assessment (OEHHA) estimated that the excess cancer rates downwind of all railyards in California, including San Bernardino. The highest was downwind of the intermodal truck/rail facility in San Bernardino, 55 miles east of downtown Los Angeles. The value was on the order of 2,500 excess cancer deaths/million lifetime (70 years). That sounds scary, until you realize that cancer deaths are about $\frac{1}{4}$ of all deaths, or 250,000/lifetime, so the additional impact of the railyard was about a 1% increase. Further, this increase occurred over only a relatively small area, affecting < 1,000 people, with lesser values more widely spread. Thus the railyard, while locally a hazard, pales beside the hazard of pollutants spread across the entire Los Angeles basin.

We will return to this example in each of the next three chapters.

References

- Key events in the history of air quality in California:
<http://www.arb.ca.gov/html/brochure/history.htm>
- Whitby, K. T., R. B. Husar, and B. Y. H. Liu. "The aerosol size distribution of Los Angeles smog." *Journal of Colloid and Interface Science* 39.1 (1972): 177-204.
- Sehmel, G.A. 1975. Summary of particle dry deposition velocities to oceans. Retrieved from <http://www.osti.gov/scitech/biblio/7293029>
- Seinfeld, John H., and Spyros N. Pandis. 1998. *Atmospheric Physics and Chemistry*. New York: John Wiley and Sons.

ITEM 11.1.

Chapter 2

Objective Risks and Subjective Safety

The famous factor of 1,000

From the top: We can define risk and safety roughly as follows:

1. Risk is the objective numerical probability of a negative outcome.
2. Safety is a subjective personal judgment on the acceptance of risk.

“The Famous Factor of 1,000”

The factor of 1,000 came originally from a UCLA Professor Chauncey Starr, who pointed out that people were 1,000 times more tolerant of risks that they assumed themselves, voluntarily, than those imposed upon them from outside sources. An example might be a vegan who drinks only bottled water but rides a motorcycle without wearing a helmet.

This is an example of the difference between risk and safety, described in two excellent books: *Of Acceptable Risk: Science and the Determination of Safety* by William W. Lowrance (May 1976), and more recently in *The Norm Chronicles: Stories and Numbers About Danger* by Michael Blastland and David Spiegelhalter (May 2013).

For a given quantitative risk, people evaluate the safety of the risk according to their own perceptions. Lowrance gives a series of criteria that govern people in their evaluation of safety. For a given risk, how do we evaluate it?

Safe

Accepted voluntarily

Avoidable

Effects are immediate

Risks are well understood

Not Safe

Imposed by outside forces

Inescapable

Effects are delayed

Risks are uncertain

ITEM 11.1.

Common risks	Dread risks
Effects are temporary	Effects are permanent
Risks can be avoided	Risks are unavoidable
Risks come with job	Risks outside of work

607

608 Air pollution obviously is an imposed risk, inescapable (here this book will help), with
609 both prompt effects (ozone, for example) and delayed effects (heart attacks) with uncertain risks.
610 Pretty much hits all the “hot button” items if one believes that the impacts are dire. Regretfully,
611 some well-meaning groups cater to this factoid (Steven Colbert would have used “truthiness”).

612 The *Norm Chronicles* helps a lot, putting risks into easily identifiable categories –
613 “Micromorts” and “Microlives.” It has table in the back that presents such estimates in
614 excruciating detail, and the book is worth purchasing for these tables alone.

615 **A micromort** is a 1 in a million chance of dying during a 70-year lifetime.

616 This is a reasonably easy metric to use as it is in common usage, but based largely on data
617 from England plus Wales, 2010 He includes other sources on occasion, including world and USA
618 data.

619 **A microlife** is a unit of risk equivalent to a half-hour change in life expectancy for each
620 day of risk exposure.

621 As an example, smoking 15 to 24 cigarettes per day leads to 10 microlives lost per day, or
622 a 7.5-year reduction in average lifespan beyond 35 years.

623 In context, then, living in polluted Mexico City costs residents there one-half microlife per
624 day, or 0.6 years of lifespan, in comparison to relatively clean London. On the other hand, 5
625 servings of veggies (prompting an *increase* of 4 microlives per day) and 20 minutes of exercise
626 (+ 2 microlives per day) add to your lifespan.

627 Merely living 70 years is 25,567 days. Thus each day takes away 39 microlives (1,000,000
628 divided by 25,567 days) from your lifespan. If you choose to smoke and ride your Harley

ITEM 11.1.

629 without a helmet costs you bunches of microlives above and beyond your normal 39
630 microlives/day. If you need to go deeper, I strongly recommend getting the book.

631 **Real World Example: Cancer and the San Bernardino railyard (2)**

632 Using the same example as in Chapter 1, the ARB/OEHHA estimate was circa 2,500 excess
633 cancer deaths/million lifetime. This is about 1% of the total cancer death rate so it is 10 x the
634 1,000 to 1 ratio of the Chauncey Starr hypothesis. Thus, this level of hazard is considered
635 unacceptable. What is acceptable? In many situations, a rate of 100 excess cancer deaths is used,
636 which falls below the 1,000 to 1 safety/risk ratio. Other cases are even lower.

637 **References**

638 Lowrance, William W. 1976. *Of Acceptable Risk: Science and the Determination of Safety*. Los
639 Altos, Calif.: William Kaufmann.

640 Blastland, Michael and David Spiegelhalter. 2013. *The Norm Chronicles: Stories and Numbers*
641 *About Danger and Death*. New York: Basic Books.

642

643

ITEM 11.1.

Chapter 3

The Clean Air Act: It Is the Best of Acts ...

The federal Clean Air Act (CAA) in fact and fiction

The federal Clean Air Act (CAA, 1970, with 1977 and 1990 amendments) is probably the most important environmental action the United States has achieved. I earned my Ph.D. at UCLA in 1965 during the height of the smog period, when my eyes would tear from the ozone, and months would pass before the haze lifted enough to see the nearby mountains. More recently, my research has resulted in a lot (= way too much) of time I spent in places around the world where the air is perpetually brown (light brown = sunny, dark brown = rainy) and people live in a sepia-colored box about 2 miles on a side. So whenever I return to the U.S. and see blue skies, I bless the Clean Air Act and the U.S. EPA, state, and its mandatory local regulations that cleaned up the air.

The Clean Air Act requires the EPA to set “national ambient air quality standards” (NAAQS) for six common air pollutants. These routinely found air pollutants (also known as “criteria pollutants”) are found all over the United States. Determination of these “criteria pollutants” dates back to the best understanding we had of air pollution circa 1970. This legislation was largely driven by Eastern U.S. urban areas, plus ozone in California. The sinister six are:

1. particle pollution (often referred to as particulate matter)
2. photochemical oxidants and ground-level ozone
3. carbon monoxide
4. sulfur oxides
5. nitrogen oxides
6. lead

ITEM 11.1.

669 These pollutants can harm your health and the environment, and cause property damage.
 670 EPA calls these pollutants “criteria” air pollutants because it sets NAAQS for them based on the
 671 human health-based and/or environmentally based criteria (characterizations of the scientific
 672 information).

673 The original driver was health impacts:

- | | | |
|-----|-----------------------|--|
| 674 | 1. Particulate matter | causes illness and, at high levels, death |
| 675 | 2. Ozone | affects breathing, and causes stinging eyes and other problems |
| 676 | 3. Carbon monoxide | results in loss of oxygen at low levels, death at high levels |
| 677 | 4. Sulfur oxides | Important near industrial sources like refineries, converts to |
| 678 | | sulfates, a major component of acid rain and hazes |
| 679 | 5. Nitrogen oxides | key component for ozone, part of particulate matter |
| 680 | 6. Lead | toxic in many ways, with major developmental problems in |
| 681 | | children including mental retardation |

682 “In the more than 40 years since its enactment, the Clean Air Act has made steady progress
 683 in reducing the threats posed by pollution and allowing us all to breathe easier,” Laura Allen, the
 684 EPA’s deputy press secretary, said. “The Clean Air Act saves lives and strengthens the American
 685 workforce, and, as a result, the economic value of clean air far exceeds the costs. The Clean Air
 686 Act is a comprehensive statute that encompasses many different programs and parts. Each of
 687 these plays an important role in meeting the overall goal of improving public health by reducing
 688 air pollution.”

689 How was this accomplished? Two of the primary tools the U.S. EPA has are:

- 690 • Ambient air standards designed to protect health and welfare (including visibility in national
 691 parks and wilderness areas), and
- 692 • Control of emissions into the air that compromise achievement of these standards.

693 The governing regulation on ambient air standards is Section 109 b 1 of the Clean Air Act:

694 Clean Air Act 109 b.1

695 “National primary ambient air quality standards, prescribed, under subsection (a) shall

ITEM 11.1.

696 be ambient air quality standards the attainment and maintenance of which in the
697 judgment of the Administrator, based on such criteria and allowing an adequate margin
698 of safety, are requisite to protect the public health. Such primary standards may be
699 revised in the same manner as promulgated.”

700 The standards are established for the criteria pollutants by analysis of the science available
701 worldwide, and especially the peer-reviewed literature. This work is evaluated by the Clean Air
702 Scientific Advisory Committee (CASAC), which then makes recommendations to the EPA
703 administrator. EPA staff members also adds their own expertise, supported by EPA research
704 carried out in its laboratories, and by contractors, including universities.

705 The EPA administrator also has the authority to set emission standards, and these have
706 been used in most cases wisely. But often a long delay occurs between the scientific research and
707 enactment of regulations. The EPA took almost 20 years to match California’s removal of lead
708 (and sulfur) from gasoline, a delay caused to some extent by intense political pressure.

709 Once a standard has been chosen and promulgated, it often is presented in a user-friendly
710 form, its measurement on the Air Quality Index (AQI). The level 100 in the AQI represents the
711 current standard. State and local agencies are required to monitor the air we breathe in
712 conjunction with the National Ambient Air Quality Standards (NAAQS) approved by the EPA’s
713 Office of Research and Development. These agencies operate several thousand air quality
714 monitors for the criteria pollutants.

ITEM 11.1.

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

715

716 Figure 3-1. The levels of the Air Quality Index (AQI), with the original in glorious color.

717 The AQI is widely used in two types of measurements: for ozone and fine PM_{2.5} aerosol mass.
 718 "PM" is an abbreviation for "particulate matter." PM_{2.5} refers to particulate matter that is smaller
 719 than 2.5 millions of a meter (2.5 micrometers or 10 µm) in diameter. Let's consider the aerosol
 720 mass in the PM_{2.5} standard. The AQI is divided into six categories, with 100 representing the
 721 current 24-hour standard for mass. Since that EPA standard is 35 µg/m³ (micrograms per cubic
 722 meter) for 24 hr PM_{2.5} aerosols, the AQI is set to equal 100 on the AQI scale.

	AQI	Mass
Good	0 to 50	0 µg/m ³ to 12 µg/m ³
Moderate	50 to 100	13 µg/m ³ to 35 µg/m ³
Unhealthy for sensitive groups	100 to 150	35 µg/m ³ to 55 µg/m ³
Unhealthy	150 to 200	55 µg/m ³ to 150 µg/m ³
Very unhealthy	AQI 200 to 300	Mass 150 µg/m ³ to 250 µg/m ³
Hazardous	250 to 500	250 µg/m ³ to 500 µg/m ³

723 Table 3-1. The six categories of the Air Quality Index.

ITEM 11.1.

Note that the standard was $65 \mu\text{g}/\text{m}^3$ up to 1997. At varying times and in some countries the aerosol mass vastly exceeds the “hazardous” rating.

The fine aerosol mass, $\text{PM}_{2.5}$, also tends to be regional in nature. Figure 3-2 illustrates a comparison of $\text{PM}_{2.5}$ mass data for two sites in Sacramento, California, about 5 miles apart. One is downtown at the intersection of 13th and T streets, and the other in the suburbs. Yet for $\text{PM}_{2.5}$ the levels are usually similar for both locations.

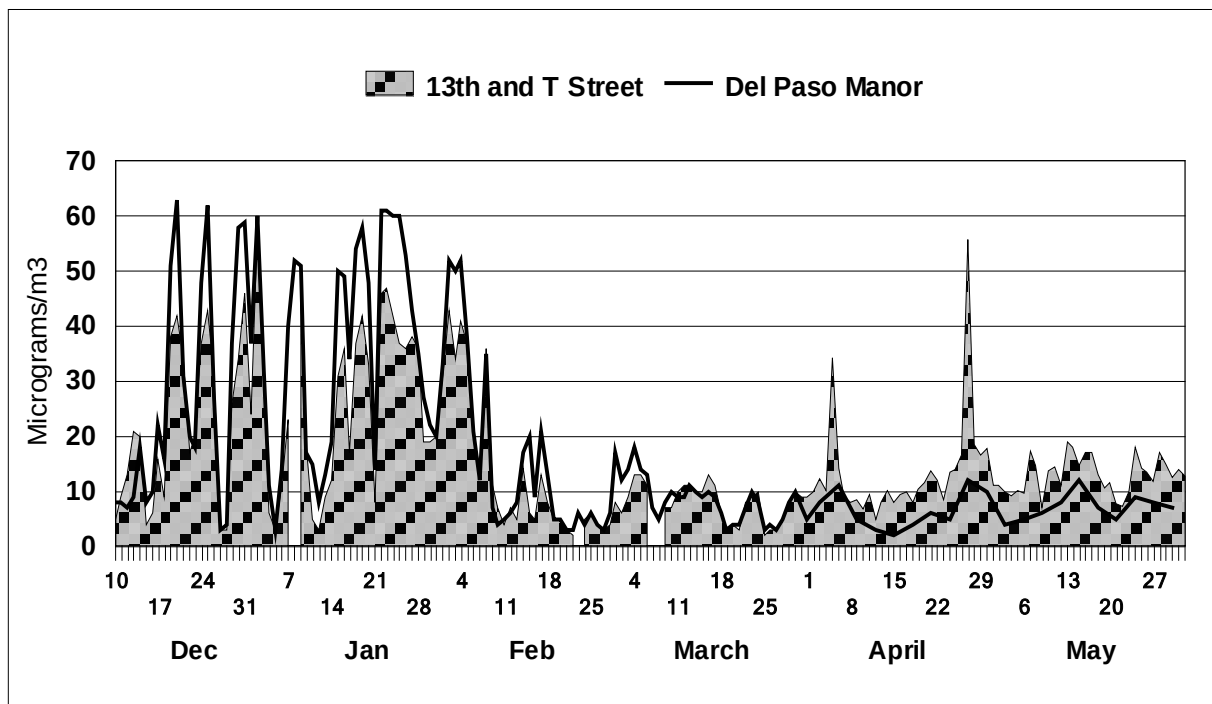


Figure 3-2. Example of $\text{PM}_{2.5}$ aerosols at two sites about 5 miles apart in Sacramento. Note the similarity between the sites, showing a regional aerosol, and the effect the inversion breakup in spring.

For ozone, an AQI of 100 is set at an 8-hour average ozone level of 0.076 ppm. The actual regulatory standard is actually a little lower, as it is set for the fourth-highest daily maximum 8-hour concentration in a given year, and averaged over 3 years. One such map for Sacramento on a bad day in summer is shown in Figure 3-3.

ITEM 11.1.

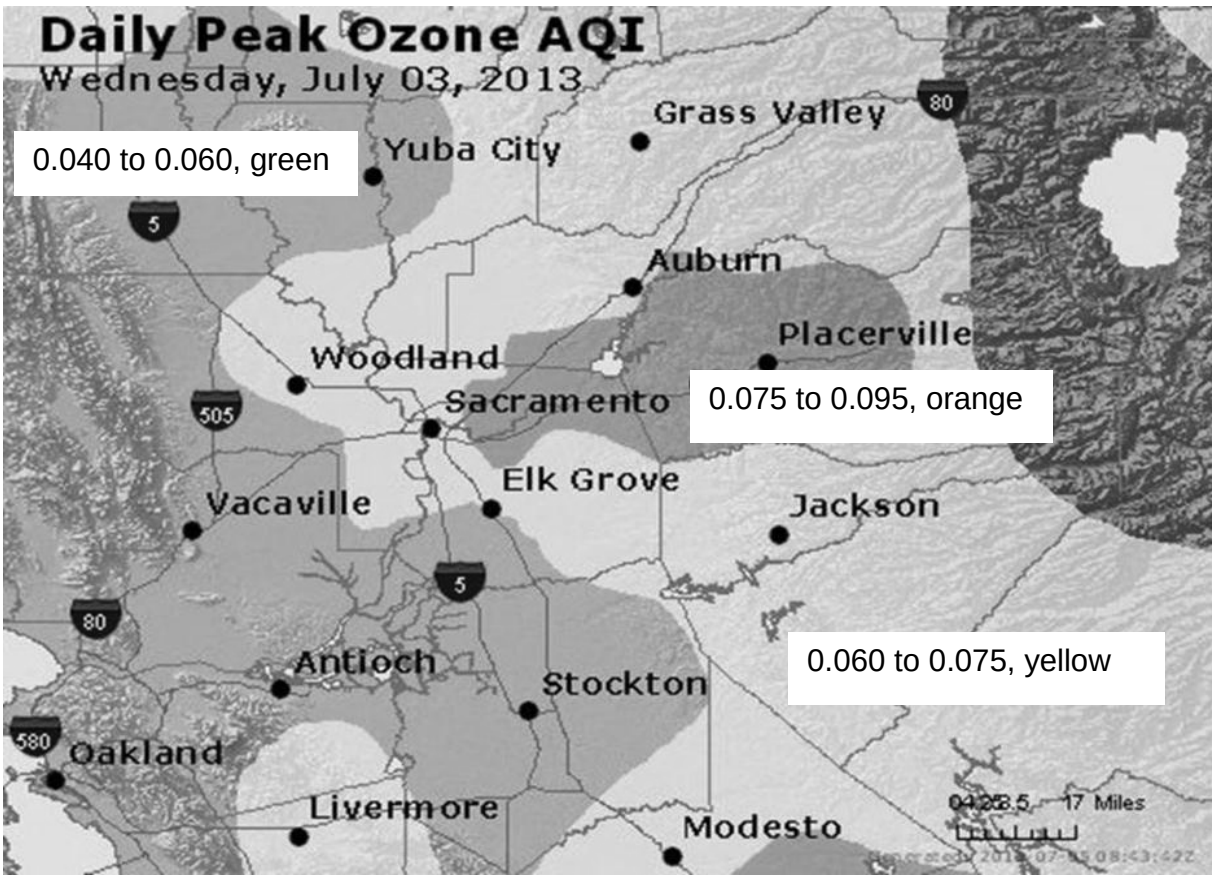


Figure 3-3. Typical ozone map on a polluted summer day. Winds were from the west. Sacramento would be in a yellow region, (Moderate) and Placerville orange (unhealthy for sensitive groups).

Some programs examine the air in more detail. Those include Speciation Trends Network (STN), which measures in mostly urban areas, and Interagency Monitoring for Protected Visual Environments (IMPROVE) takes measurements in national parks and wilderness areas where visibility is protected under the CAA. I was instrumental in the creation of IMPROVE and was Principal Investigator for aerosols for it and its predecessors for 20 years. As my part of IMPROVE, I worked for decades following the mandates of the CAA in the 1977 amendments to “Prevention of Significant Deterioration” of visibility in Class 1 designated areas (selected national parks, wilderness areas, and other natural habitat areas). With a series of air quality studies, mostly in the West, and NPS-driven EPA mandates, we cleaned up most of the large

ITEM 11.1.

752 sulfur sources in the west. (See Chapter 19, “I Can See Clearly Now, the Sulfur’s Gone,” for an
753 example.)

754 The 1990 amendments set in train programs to sharply reduce U.S. sulfur emissions,
755 mostly from coal-burning power plants, but gave industry the flexibility to determine the
756 method. Changes to low-sulfur coal and use of SO₂ scrubbers scrubbers on coal fired power
757 plants, copper smelters, and other industrial sources have resulted in sharp reductions of
758 emissions and significant improvements in air quality and visibility in the Eastern U.S., which
759 we documented in the IMPROVE program.

760 So what are the problems? There are several, which are discussed in Chapter 4, the Clean
761 Air Act’s “dark alley” problem. The list includes:

- 762 1. The wording of the Clean Air Act itself (Clean Air Act 109 b.1, “... and allowing an adequate
763 margin of safety ...”). This relates to the discussion of quantitative risk versus subjective
764 safety in Chapter 2, the “Famous Factor of 1,000.
- 765 2. The “criteria pollutants” – the best science circa 1970. We can do better today. This especially
766 is a problem with aerosol mass.
- 767 3. The “precautionary principle,” which leads to nonscientific regulations far removed from
768 scientific reality.
- 769 4. Ignoring the role of naturally occurring species that can also be human-caused pollutants.
770 Ozone and aerosol mass are two prime examples.

771 But in many important ways, it is still “the best of acts....”

772 Nitty-gritty details

773

774 ***Nerd alert!*** Here follows a bunch of federal jargon. The numbers and letters refer to sections of
775 the enormous Code of Federal Regulations (CFR). Don’t sweat the details!

776

ITEM 11.1.

777 Current U.S. EPA Ambient Air Standards

Pollutant [final rule cite]	Primary/ Secondary	Averaging time	Level	Form
Carbon monoxide [76 FR 54294, Aug 31, 2011]	Primary	8-hour	9 ppm	Not to be exceeded more than once per year
		1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]	Primary and secondary	Rolling 3-month average	0.15 µg/m ³ (1)	Not to be exceeded
Nitrogen dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]	Primary	1-hour	100 ppb	98th percentile, averaged over 3 years
	Primary and secondary	Annual	53 ppb	Annual mean
Ozone [73 FR 16436, Mar 27, 2008]	Primary and secondary	8-hour	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle pollution Dec 14, 2012	PM _{2.5}	Primary	Annual	12 µg/m ³
	PM _{2.5}	Secondary	Annual	15 µg/m ³
	PM _{2.5}	Primary and secondary	24-hour	35 µg/m ³
	PM ₁₀	Primary and secondary	24-hour	150 µg/m ³
Sulfur dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]	Primary	1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

778 Table 3-2. Current air quality standards. The two most commonly presented for AQI are
779 shaded.

780

ITEM 11.1.

781 **Real World Example: Cancer and the San Bernardino railyard (3)**

782 How does the Clean Air Act cover the BNSF railyard case? The criterion for local impact is fine
 783 particulate mass, PM_{2.5}, and the small additional mass from the railyard is lost in the mass of
 784 aerosols blowing in from downtown Los Angeles to the west. Thus, there is no provable
 785 violation of the EPA PM_{2.5} fine mass standard. Such analyses may be used by developers and
 786 community planners to allow building of residences directly downwind of railyards. Such a
 787 development was built in Roseville right against the railyard fences in an area identified years
 788 before by the ARB as hazardous due to the railyard. Their analysis was confirmed by our work
 789 (Cahill et al 2011 c), yet the buildings were constructed even after all these data were available

790 **Sources for additional information**

- 791 • Key Events in the history of air quality in California:
 792 <http://www.arb.ca.gov/html/brochure/history.htm>
- 793 • U.S. Environmental Protection Agency overview of the federal Clean Air Act and air
 794 pollution: <http://www2.epa.gov/clean-air-act-overview>

795

796 .

797

798

Chapter 4

The Clean Air Act: It Is the Worst of Acts ...

The “dark alley” problem

Well, labeling the Clean Air Act (CAA) the “worst of acts” probably is a bit of an overstatement, but considering the role that air plays in our lives, the reach of the Clean Air Act can be profound and even invasive. I like the slogan of the American Lung Association: “When you can’t breathe, nothing else matters.” The Clean Air Act has such powerful authorizing legislation, and the EPA administrator who upholds the mandates of the CAA has such enormous credibility, that when the EPA goes off track, the consequences can be pretty bad.

Many of the problems lie in the act itself, based on the best science of 50 years ago, but the world has moved on, and the Neanderthal mandates refuse to die. Examples:

1. Inadequate regulation of lethal pollutants

Example: very fine and ultra-fine metals (see Chapter 8, “It Was an Itsy Bitsy Teenie Weenie Yellow ...” Ultra-fine Metal)

2. Overregulation of essentially harmless pollutants

Example: violations of PM_{2.5} mass from hydrated ammonium nitrate in Fresno

3. The EPA’s proposal of a new ozone standard breathtakingly close to the natural ozone background in large parts of the West

Wry observation: since controlling normal pollutants has barely made any difference in the ozone level, let’s reduce these pollutants even more, and maybe the result will be different (Chapter 6, “99 Miles From L.A.” ... and My Eyes Still Watered).

4. Forced all cars to add ethanol to the gasoline to reduce carbon monoxide in a few older cars. So everybody gets poorer gas mileage with minimal to no reduction in air pollution, at a cost of a about 1 billion dollars/month in California alone.

ITEM 11.1.

824 5. The EPA's capitulation to White House pressure to downplay the harmful effects to which
825 rescue and salvage workers at the World Trade Center disaster were subjected, leading to
826 more than 10,000 very sick people facing early death (Chapter 8, "It Was an Itsy Bitsy Teenie
827 Weenie Yellow ..." Ultra-fine Metal).

828 The point of this chapter is to explain some of the problems with which I am personally
829 involved, and to first of all help you, the reader, to avoid those health impacts not adequately
830 handled by the EPA. I suggest some solutions, many of which are already well known to EPA
831 scientists but not implemented.

832 I also raise these points because California alone among all the states has the capability of
833 developing and implementing air pollution standards more stringent than the U.S. EPA because
834 California was doing this work before the EPA was even formed. I was delighted to be part of
835 the team in California that did exactly this in 1976, – mandating use of the catalytic converter
836 on automobiles, as well removal of lead and sulfur from gasoline. Eventually the nation and
837 world followed, to an enormous benefit.

838 Now we need to lead again.

839 **Problem No. 1:**

840 **Linear extrapolation and background or natural "pollutants"**

841 The Clean Air Act assumes that a pollutant has a definable certain level below which no
842 harm will occur "to public health," with "an adequate margin of safety." We must analyze what
843 being "safe" means, as opposed to the quantitative evaluation of risk. The problem arises when
844 the pollutant is of such a nature that harm occurs at any level, so no level can be considered
845 "safe," to say nothing of "an adequate margin."

846 Two key examples are:

847 1. Radiation

848 2. Ozone

849 **Radiation:**

ITEM 11.1.

The energy in radiation can come in three forms, all products of decaying radioactive elements: alpha particles (the nuclei of helium), beta particles (fast electrons), or gamma rays (photons like light but at a much higher energies). The energy level of each of these is so high that a single particle can destroy a cell, so there is no level at which damage declines to zero.

Ozone:

The ozone molecule, three atoms of oxygen bound together (O_3), seeks to return to the stable and harmless state we breathe, O_2 , and releases its extra oxygen and a lot of energy to biological molecules, also capable of destroying a cell. Again damage occurs at any level, as with radiation, and ozone is in fact sometimes called “radio-mimetic” (mimicking radiation).

Ozone and radiation also share another similarity – both have important natural sources that have persisted during the long evolution of mankind. Over the course of this evolution, our bodies have developed defenses that can repair damage from radiation and ozone when they occur at typical background levels. Thus, there is no reason to “protect public health” from background levels of radiation and ozone.

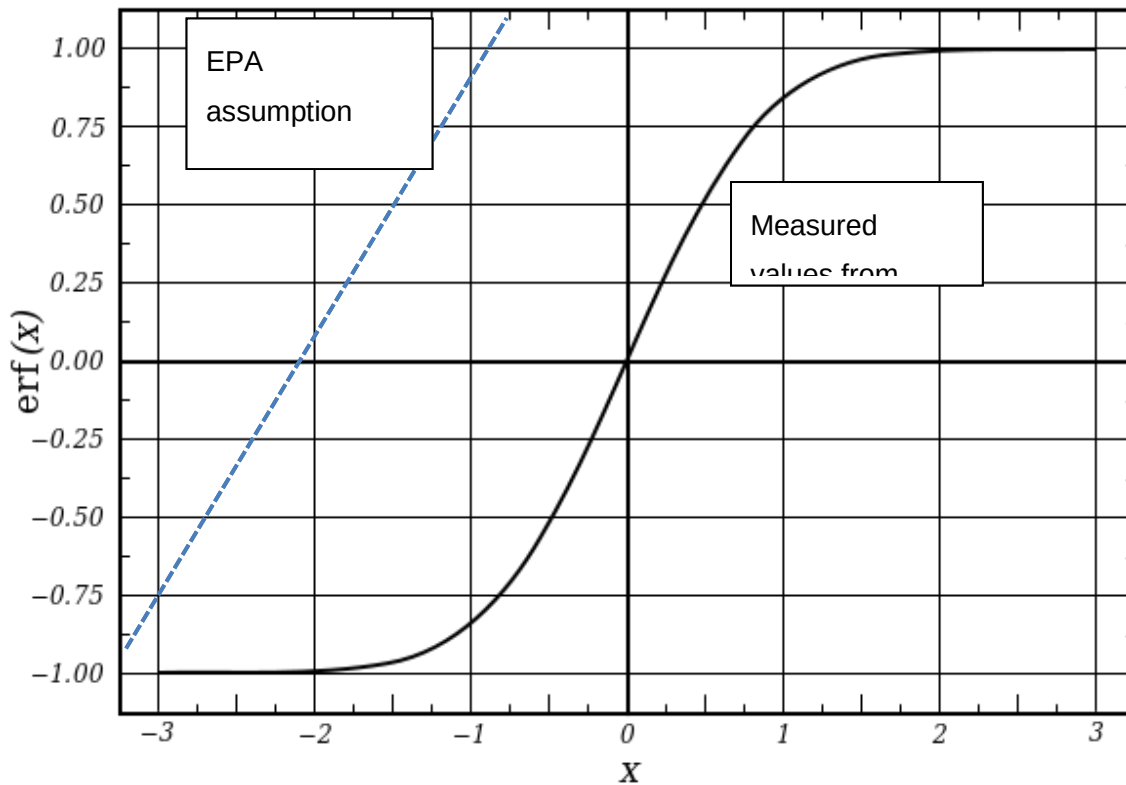
The problem arises from research that focuses on the damage caused, and does not take into account the human repair mechanisms. The EPA uses a linear extrapolation to zero in its analyses, driving air quality standards to ever-lower regulatory thresholds as better and better tests detect damage at ever lower levels.

This problem first occurred with radiation, and decades of studies were able to assess both the damage and repair mechanisms. These tests revealed that damage such as radiation-induced tumors followed a “sigmoid distribution,” not the linear extrapolation used by the EPA. One key proponent of the sigmoid distribution pattern for radiation measurement is Professor Marvin Goldman and the UC Davis/AEC Beagle project. In this multi-generational study at low radiation levels, no tumors were seen in the beagle bones until after some threshold had been passed.

Examples of “linear extrapolation” and “sigmoid distribution” are shown below in Figure 4.1. This example, based on the Beagle studies and many other long term tests, shows that in reality some level of damage can be incurred without any lasting health impacts. This allows the

ITEM 11.1.

878 concept of a “threshold”, while the “linear extrapolation” demands standards set at an impossible
 879 level – zero!



880
 881 Figure 4-1. Linear and sigmoid distributions for radiation-induced damage.

882 Thus, threat to public health should be measured from the point of occurrence of
 883 significant damage that results in physical harm.

884 Regretfully, no equivalent tests have been done for ozone, and into this gap unwise
 885 regulations have sprouted (see the “dark alley” problem, below).

886 Problem No. 2:

887 The “precautionary principle”

888 This discrepancy causes EPA to take the most pessimistic interpretation of any results, no
 889 matter how fragmentary, thereby inducing it to set ever lower regulatory thresholds in a
 890 misinformed effort to prevent harm. This “principle” has led the EPA to set standards that do not
 891 even remotely reflect the best information of science. One extreme test result on laboratory rats

ITEM 11.1.

892 can result in human standards that are patently wrong. Meeting such standards can cost both
 893 money and an erosion of public support for the Clean Air Act. Unfortunately, once these
 894 standards have been set, they are really difficult to correct, partially because equally misguided
 895 environmental organizations fight to retain them.

896 Rat studies, for example, identify the compound acrolein as causing nosebleeds in rats at
 897 very high levels. Acrolein is a liquid that is produced in cooking when fat burns and breaks down
 898 chemically. These high concentrations used in the rat experiments are then extrapolated many of
 899 orders of magnitude (factors of 10) to levels that assign acrolein the lowest-triggered regulation
 900 threshold of any non-cancer causing compound. Ambient measurements using techniques that
 901 employed canisters that are not suitable for a highly reactive compound like acrolein, and are
 902 thus filled with error; most such calculations have been removed from data records. Even so,
 903 peer-reviewed papers of both ambient concentrations and health impact studies have been unable
 904 to change this regulation. Yet, if you believe it, any person deep frying fat in a kitchen should be
 905 having uncontrollable nosebleeds.

906 **Problem No. 3:**

907 **The criteria pollutants**

908 The “criteria pollutants” encompass carbon monoxide, lead, nitrogen dioxide, PM_{2.5} particle
 909 mass, PM₁₀ particle mass, ozone and sulfur dioxide. Their classification as such dates back to the
 910 best understanding we had of air pollution circa 1970. This was largely driven by Eastern urban
 911 areas of the United States. But some of criteria pollutants are zombies that died decades ago, and
 912 no longer reflect current threats to health (see Nitty Gritty details, Table 4-1).

913 ***The seven “criteria pollutants”***

- 914 1. Carbon monoxide: rarely a problem in ambient air
- 915 2. Lead: removed from gasoline as required for catalytic converter, but “legacy lead” in soil
 916 can be re-suspended (see Exide, Chapter 9, “Get the Lead Out!”)
- 917 3. Nitrogen dioxide: solved for cars by lower octane fuels and engines; still a problem with
 918 high-temperature combustion, power plants, and diesel engines.
- 919 4. Aerosol mass, PM_{2.5}: violations persist, but are they sources of harm? (see Chapter 4)

ITEM 11.1.

5. Aerosol mass, PM₁₀: Local problem only (see Chapter 14)

6. Ozone: a major problem (see Chapter 6, “99 Miles From L.A.” ... and My Eyes Still Watered)

7. Sulfur dioxide: CAA amendments circa 1990 reduced sulfur – a major success story – but it still detracts from visibility (see Chapter 19, Haze and visibility reduction)

The EPA administrator has the authority to set emission standards, which have been used wisely in most cases. But long delays often occur between scientific findings and enactment of regulations. Nearly 20 years passed before the EPA, under intense political pressure, matched California’s regulations requiring removal of lead (and sulfur) from gasoline.

Example of a poor criteria pollutant: Health effects and aerosol mass

Development of quantitative ways to measure particulate air pollution took a long time. Early efforts involved assessment of the color and density of smoke from a stack, or the color seen on an air filter.

Industrial health concerns drove a need to collect particles and determine their composition, as a means to more accurately assay threats to workers’ health. The method involved measuring the mass of all the particles of 35 micrometers (μm) or less that someone could ingest. Researchers developed a device called a “high-volume filter sampler” (Hi-Vol) that was essentially a vacuum cleaner and filter in a metal shed. The filter paper was weighed and could be used to determine toxics, including benzene-soluble organics, metals such as lead (the chemical symbol of which is Pb) and cadmium (Cd), fluorides, radioactive materials and biologically active non- metals, sulfate, nitrate and ammonium.

From the amount of air passing through the filter, a mass concentration could be derived – the mass of particles per volume of air, currently micrograms per cubic meter of air (μg/m³). Flow in Hi-Vols is typically around 1 m³ (1 cubic meter) of air per minute, or 1440 m² air/day on a 8-inch-by-10-inch (516 cm²) glass fiber or clean paper filter. Thus, if one has 100 μg/m³ of average ambient aerosol mass over 24 hours, the total mass collected will be 144 mg, well within the capabilities of the scales available since World War II. A major advance occurred in the 1950s, when researchers realized that after exposure in a nuclear reactor, these Hi-Vol filters

ITEM 11.1.

948 become mildly radioactive and yielded quantitative data on scores of elements. Statistical
949 methods were soon developed, and a major increase in knowledge about air pollution followed.

950 With the initiation of the Clean Air Act in 1967, ambient air standards were promulgated,
951 and a measurement standard for aerosol mass on a Hi-Vol called “total suspended particulates”
952 (TSP) was chosen as the criterion. Even today, TSP values can be used to establish lead levels in
953 the air.

954 A major advance came in 1969, when groups of university and state scientists gathered on
955 the roof at Cal Tech for the 1969 “Cal Tech Smog Caper.” The success of this essentially
956 volunteer initiative led to the first major air pollution study in Los Angeles, 1972, one of the
957 major results of which was development of ways to measure particle mass versus size. Ken
958 Whitby and the University of Minnesota scientists discovered the famous “bimodal distribution”
959 of aerosol mass in the atmosphere (Figure 1-2), which has dominated our understanding of
960 aerosols since that time. I was involved in the first measurements of aerosols versus size, time
961 and composition, using the new energy dispersive X-ray analysis techniques (X-ray fluorescence
962 and proton-induced X-ray emission [PIXE], which uses protons from a cyclotron to excite X-
963 rays) that could measure almost all elements on thin filers and substrates.

964 With increasing information about the importance of finer or inhalable particles, the EPA
965 standard was converted to particles below 10 μm , called PM_{10} , circa 1987. The present PM_{10}
966 standard is 150 $\mu\text{g}/\text{m}^3$. Recent estimates put the 1952 London “killer fog” mass at $8,000 \pm 5,000$
967 $\mu\text{g}/\text{m}^3$, helping to explain the high death rate.

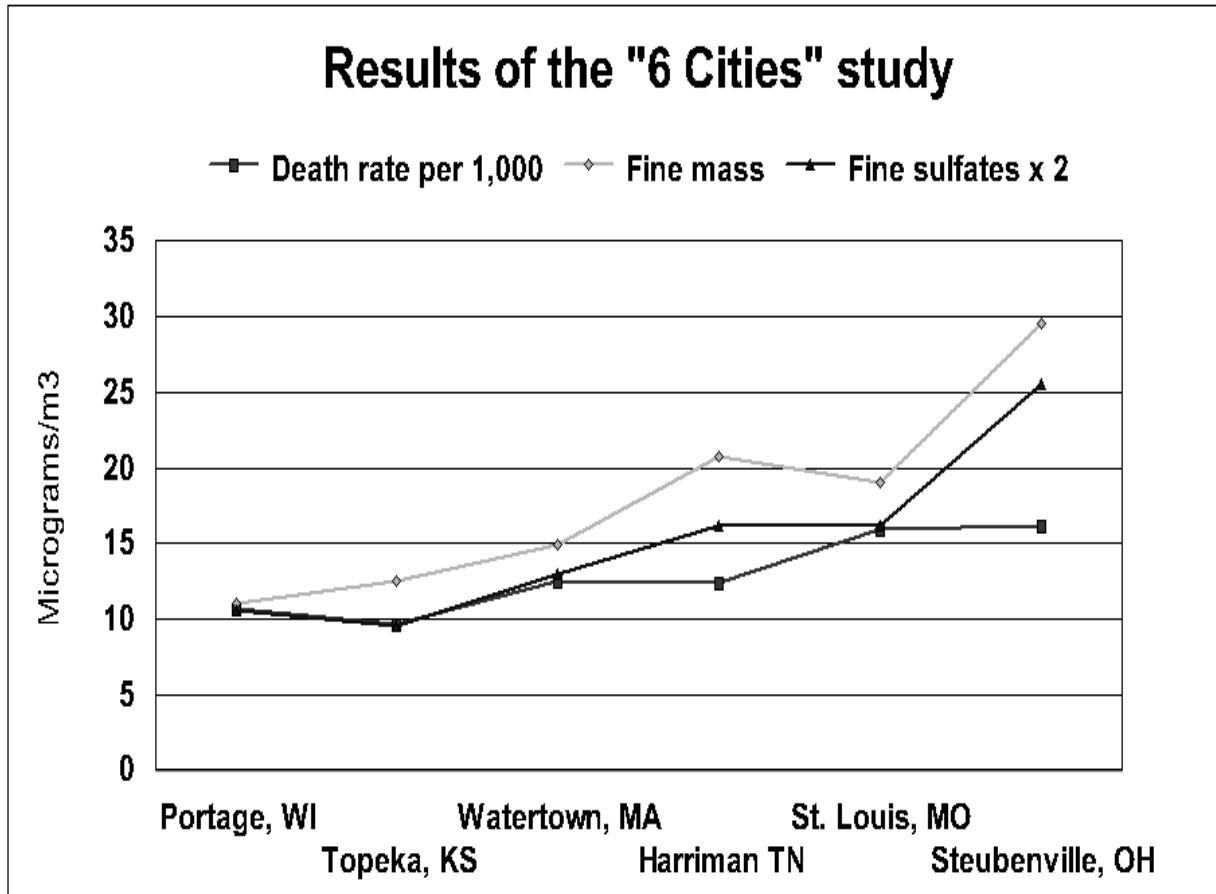
968 In the late 1980s scientists embarked on major long-term studies of aerosols and health,
969 the most famous of which was a study of six cities: Portage, Wisconsin; Watertown,
970 Massachusetts; St. Louis, Missouri; Topeka, Kansas; Harriman, Tennessee; and Steubenville,
971 Ohio. These cities were chosen because they spanned levels of air pollution, from very clean to
972 heavily impacted.

973 In response to results of the pioneering “6 Cities” study that showed a statistical
974 association between fine mass and death rate, the size criterion was reduced around 1997 to 2.5
975 μm to better reflect the size of particles that enter human lungs (Figure 4-3). The current EPA
976 mass standard is set for two different averaging times. In order to protect from really bad days,

ITEM 11.1.

977 the level is set at $35 \mu\text{g}/\text{m}^3$ for a full day, 24hr. The EPA also set a standard that covers an entire
 978 year, good days and bad, and it is lower, $12 \mu\text{g}/\text{m}^3$, annual average.”

979 The problem is mass. In the “6 Cities” study, sulfates were actually better correlated to
 980 death rates than mass, but mass was the unit chosen. Why? Because ammonium sulfate dissolves
 981 in lung fluid and is not toxic. Most $\text{PM}_{2.5}$ mass is pretty harmless, but something buried in mass
 982 is lethal, yet the EPA is not controlling for that.



983

984 Figure 4-2. Plot of the data from the “6 Cities” study used to set the EPA $\text{PM}_{2.5}$ mass
 985 standard.

	Portage WI	Topeka KS	Watertown MA	Harriman TN	St. Louis MO	Steuben- ville OH
Follow-up person years	21,618	16,111	19,882	17,836	17,715	17,914
Deaths	232	156	248	222	281	291

ITEM 11.1.

Deaths per 1,000 person years		10.7	9.7	12.5	12.4	15.9	16.2
Total mass	µg/m ³	34.1	56.6	49.2	49.4	72.5	89.9
Inhalable mass	µg/m ³	18.2	26.4	24.2	32.5	31.4	46.5
Fine mass	µg/m ³	11.0	12.5	14.9	20.8	19.0	29.6
Sulfate	µg/m ³	5.3	4.8	6.5	8.1	8.1	12.8
Acidity							
SO ₂	Ppb	4.2	1.6	9.3	4.8	14.1	24.0
NO ₂	Ppb	6.1	10.6	18.1	14.1	9.7	21.9
Ozone	Ppb	28.0	27.6	19.7	20.7	20.9	22.3
Smokers		36	33	40	37	35	35
Former smokers		24	25	25	21	24	23

986 Table 4-1. Data from the “6 Cities” study (Dockery et al, 1996)

987 The Clean Air Scientific Advisory Committee (CASAC) provides independent advice to
 988 the EPA Administrator on the technical bases for EPA's national ambient air standards.
 989 However, according to Congressional testimony, the chair of the PM panel said that CASAC did
 990 not endorse the PM_{2.5} levels that the EPA set. Two members did not agree that any PM_{2.5}
 991 standard was warranted; eight members supported a PM_{2.5} standard in principle but refused to
 992 support any specific ranges; seven members supported levels above the proposed EPA ranges;
 993 but only four members supported a level at or near the lower EPA levels. CASAC concluded that
 994 the science was too weak to lend support for any of the specific levels that the EPA chose.

995 That didn't stop the EPA administrator in 1997 from setting levels below what any of the
 996 best scientists thought as supportable: 35 µg/m³ for 24 hr PM_{2.5}, 12 µg/m³ annual average PM_{2.5}.
 997 There are times and locations where the 24 hr standard is shredded by factors of times 20 or
 998 more. This includes not only the historical examples like the London killer fog but current era
 999 events, Fairbanks, AK (forest fires, Chapter 13) to Beijing in 1988 during the Olympics
 1000 (visibility, Chapter 19).

ITEM 11.1.

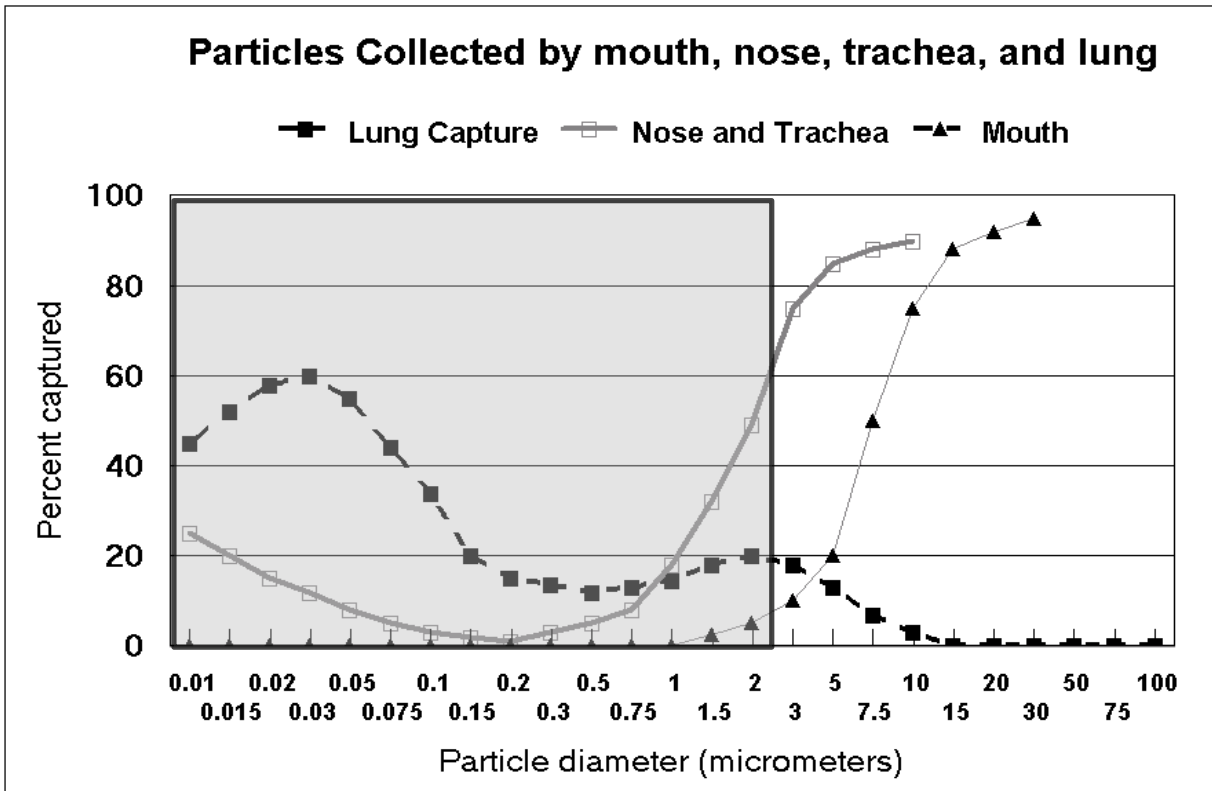


Figure 4-3. Past and current size cuts for U.S. EPA Clean Air Act ambient air monitoring of particulate mass. The gray shaded area shows the size range for the PM_{2.5} standard.

New data has further shown the potential implications of even finer particles in endangering human health, the ones so fine they can pass into the bloodstream. Some researchers have engaged in discussions about a new ultrafine standard such as PM_{0.1} or even PM_{0.25}, because almost all mass with particle diameters smaller than 0.25 μm is toxic.

However, in addition to the problem of ultra-fine particles and the deep lung-cardiovascular impacts, the mass standard does not reflect particle composition. As an example, coastal sites routinely exceed PM₁₀ due to sea salt, which dissolves in lung fluid and is completely harmless. The same occurs for other lung-soluble aerosols – hydrated ammonium nitrate, for example, with minimal to no health impacts at ambient concentrations. **This is like looking for the keys you lost in a dark alley under a nearby lamppost because the light there is so much better.**

ITEM 11.1.

1016 This is a really important problem in the Clean Air Act, and one that must be rectified
 1017 because it results in overly strict mass regulations on harmless particles without exerting any
 1018 control over lethal particles. Subsequent chapters in this book present several such examples.

1019 This is not news to the scientific staff of the U.S. EPA. In 2002, at a meeting of the
 1020 American Association for Aerosol Research (AAAR), U.S. EPA pulmonary toxicologist Robert
 1021 Devlin summarized the threats for particles in the air. The threats included:

1022 1. Coarse aerosols – see Chapters 14 (Soil Dust and PM₁₀) and 15 (Biologicals, valley fever, and
 1023 allergens)

1024 • These are particles between 10 µm and 2.5 µm that statistically continue to show up as
 1025 potentially compromising to health, even though they do not penetrate into the deep lung.

1026 2. Acidic aerosols (not treated in this book because they occur only industrially)

1027 • Acidic aerosols do not usually constitute a problem except near strong sources; sulfuric
 1028 acid from the World Trade Center collapse piles were a factor in the health impacts.

1029 3. Biological aerosols (see Chapter 15, Biologicals, valley fever, and allergens)

1030 • Scientists now realize biological aerosols pose a greater threat than they generally
 1031 realized in the past. The presence of valley fever (a really nasty fungal infection) and
 1032 other diseases, along with biological aerosols, are an immediate threat to life in the Near
 1033 East.

1034 4. Carcinogens (see Chapter 7, Diesel exhaust)

1035 • Very fine and ultrafine aerosols including carcinogens such as benzo[a]pyrene are largely
 1036 derived from diesels and industrial sources. They produce about 70 percent of all “excess
 1037 cancer mortality”, namely cancer mortality above the death rate that would have occurred
 1038 without the pollution. mortality.

1039 5. Very fine < 0.25 µm metals (see Chapter 8, Copper and other ultra-fine transition metals)

1040 • Iron (Fe), Nickel (Ni), Copper (Cu) and Zinc (Zn) are all capable of damaging lungs,
 1041 especially in children. Such damage manifests itself in reduced lung function for children
 1042 living near freeways. These elements infiltrate the air in the form of metallic dust from
 1043 brake drums and pads, as well as discharge from some manufacturing processes.

ITEM 11.1.

1044 6. Ultra-fine insoluble particles < 0.1 μm diameter (see Chapter 8, **Ultra-fine metal**)

- 1045 • These pass deep into the lung, which captures them with high efficiency. Ultra-fine
- 1046 insoluble particles cause cardiovascular problems, including ischemic heart disease, as
- 1047 they pass from the lung into the cardiovascular system. They also have potential to
- 1048 damage brain tissue.

1049 Of all these compounds that actually harm people, only carcinogens from diesels have been

1050 effectively controlled by source reduction, although routine PM_{10} monitoring can help coarse

1051 aerosol control. To this list of dangerous agents we must add:

1052 7. Toxic metals – see Chapters 11 (Get the Lead Out) and 12 (Mercury and other toxic metals)

1053 The California Department of Toxic Substances Control (DTSC) list 19 species, including:

- 1054 i. Coarse, > $\text{PM}_{2.5}$ mercury, cadmium, lead — serious health impacts, but usually
- 1055 handled by simple face masks
- 1056 ii. Fine, $\leq \text{PM}_{2.5}$ same list, but 10 to 20 times more dangerous because they go
- 1057 deeper into the lung and have to be cleared through the
- 1058 bloodstream

1059 Protection protocols will be developed for each type of particle in later chapters.

1060 In summary, the EPA continues to press states to keep lowering $\text{PM}_{2.5}$ mass in the hope

1061 that by doing so, the actual harmful stuff will also miraculously go away. This is at best wildly

1062 optimistic but vastly expensive, and at worst positively corrosive, because it delays resolving

1063 problems that really matter to human health.

1064 For this reason, and despite the statistical association of $\text{PM}_{2.5}$ mass and human morbidity

1065 and mortality (Table 4.1), this book does not contain a separate section on $\text{PM}_{2.5}$ mass per se.

1066 The topic is better handled by the individual species that are known to cause death, too often

1067 hidden in the unhelpful metric of total mass.

1068 Likewise, ozone regulations are being pushed into levels where natural background

1069 dominates. Shutting down all agriculture, industry, and transport can never achieve such a

1070 standard.

ITEM 11.1.

1071 If the EPA continues to force dumb actions on the nation, then it opens the door for
 1072 Congress to rise up and smite the law down, with incalculable potential harm if done poorly.
 1073 Knowing Congress, most scientists hate to contemplate that risk, so they keep their mouths shut.
 1074 We must do better.

1075

1076 **Real World Example: Cancer and the San Bernardino railyard (4)**

1077 From the previous chapter, we can see that the PM_{2.5} mass standard would not protect residents
 1078 living directly downwind of the BNSF intermodal railyard in San Bernardino. From the analysis
 1079 above, here are two key problems: 1) the PM_{2.5} mass standard does not reflect the additional
 1080 health impact of very fine and ultra-fine particles that penetrate deep into the lung and
 1081 translocate into the cardio-vascular system. 2) The PM_{2.5} mass standard does not take into
 1082 account the toxicity of the aerosols. An exception was made for ambient concentration of lead as
 1083 evidence of its toxicity kept mounting.

1084 As an example of the problems caused by a mass standard, in the late 1980s, the new PM₁₀ mass
 1085 standard was established. This initiated PM₁₀ aerosols measurements at many West Coast sites.
 1086 However, gross violations occurred due to harmless sea salt. The law should have been changed,
 1087 but instead data were ignored, sampling sites changed, etc. This was typical of the many patches
 1088 required to maintain the PM standards, TSP, PM₁₀, and PM_{2.5}. A standard of PM_{0.25}, 10- x
 1089 smaller, would help, since almost everything smaller than 0.25 µm is toxic.

1090 **Reference**

- 1091 • Dockery, Douglas W., C. Arden Pope, Xiping Xu, John D. Spengler, James H. Ware, Martha
 1092 E. Fay, Benjamin G. Ferris, Jr., and Frank E. Speizer. 1993. "An Association Between Air
 1093 Pollution and Mortality in Six U.S. Cities." *New England Journal of Medicine* 329: 1753

1094

1095

ITEM 11.1.

Section B

The Four Horsemen of the Apocalypse

Proven killers, all, and they still slay the unprepared.

The next four pollutants – cigarette smoke, ozone, diesel exhaust and ultra-fine metals – are the ones most likely to harm the largest number of people in the United States today.

Consistent attempts to mitigate the impact of the first three have been under way, with varying degrees of success. Massive campaigns have reduced cigarette smoking by about 60 percent, but the rise of “vaping” nicotine in e-cigarettes and smoking marijuana pose new threats.

The massive success in reducing ozone in Los Angeles and the San Francisco Bay Area, attributable to California’s adoption of the catalytic converter and low-octane gasoline, has not been replicated at other locations in the U.S. For example, ozone reduction programs have been an almost total failure in California’s Central Valley.

Diesel exhaust from long-haul trucks has been sharply reduced by orders of magnitude, but three-axle diesels, cheating by manufacturers of diesel cars, and slow progress in expansion of passenger rail services show much work needs to be done.

Almost no effort has been made to reduce discharge of ultra-fine metals from vehicular brakes despite growing evidence of the multiple impacts of ultra-fine metals:

- heart attacks in the elderly
- reduced lung function in children, and (probably)
- autism in fetuses

ITEM 11.1.

1117

Chapter 5

1118

**“Smoke Gets in Your Eyes” – and Your
Lungs, Your Heart, Your Brain**

1119

1120

Cigarette and cigar smoke

1121

**Impacts: Lung cancer, chronic obstructive pulmonary disease, (COPD), heart attacks, and
many, many more**

1122

1123

Introduction

1124

Tobacco is a dirty weed,

1125

I like it

1126

It satisfies no human need,

1127

I like it

1128

It makes you thin, it makes you lean

1129

It takes the hair right off your bean

1130

It's the worse damned stuff I've ever seen

1131

I like it

1132

1133

That was the ditty going around among teenagers when peer pressure convinced me that I

1134

had to start smoking to be “cool.” It was summer on Nantucket Island, and so I bought a few

1135

packs and started smoking. I was about 16. If you believed the ditty's claim that the only

1136

detrimental effects of tobacco were weight loss (which I did not regard as such a bad thing,

1137

because I tended to go pudgy) and hair loss (sometime in the very distant future), then its major

1138

impact would be on my allowance, because cigarettes were costly. However, after a couple of

1139

packs, I decided I really neither liked smoking nor the smell that stuck to my hair and clothes.

1140

Nor was I unable to discern any marked increase in my social success. So at the end of summer, I

1141

quit and never took it up again.

1142

Lucky me.

ITEM 11.1.

1143 There is no question today that smoking as a type of pollution stands out from almost
 1144 every other air pollution source (except perhaps some toxic metals) as a health disaster. In the
 1145 *Norm Chronicles*, the loss of lifespan is about 7.5 years as a result of smoking 15 to 24 cigarettes
 1146 per day.

1147 **How can I protect myself?**

1148 That's easy to answer.

- 1149 1. Don't smoke (see CDC summary in "Nitty-gritty details")
- 1150 2. Don't "vape." That's a sure way to get heavy addicting nicotine. For other health impacts,
 1151 the jury is out.

1152 **About secondhand smoke**

1153 No level of secondhand smoke, no matter how low, is harmless – especially to children.
 1154 Fortunately, an excellent test for the substance cotinine has been developed. Cotinine is a
 1155 compound that forms after nicotine enters the human body. A simple urine analysis shows if
 1156 people have been exposed to nicotine in any form. And while the Centers for Disease Control
 1157 estimates that 2.4 million people have died from secondhand smoke since 1964, the levels are
 1158 steadily decreasing. In 1988–1991, the CDC determined that 88 percent of all non-smokers had
 1159 been exposed, but that figure declined to 25 percent by 2001.

1160 You can protect yourself and your family from secondhand smoke by:

- 1161 • quitting smoking if you are not already a nonsmoker
- 1162 • prohibiting anyone from smoking in or anywhere near your home
- 1163 • forbidding anyone to smoke in your car, even with the windows open
- 1164 • making sure your children's day care center and schools are tobacco-free
- 1165 • seeking out restaurants and other places that do not allow smoking (if your state still allows
 1166 smoking in public areas)
- 1167 • teaching your children to stay away from secondhand smoke
- 1168 • being a good role model by refraining from smoking or using any other type of tobacco

ITEM 11.1.

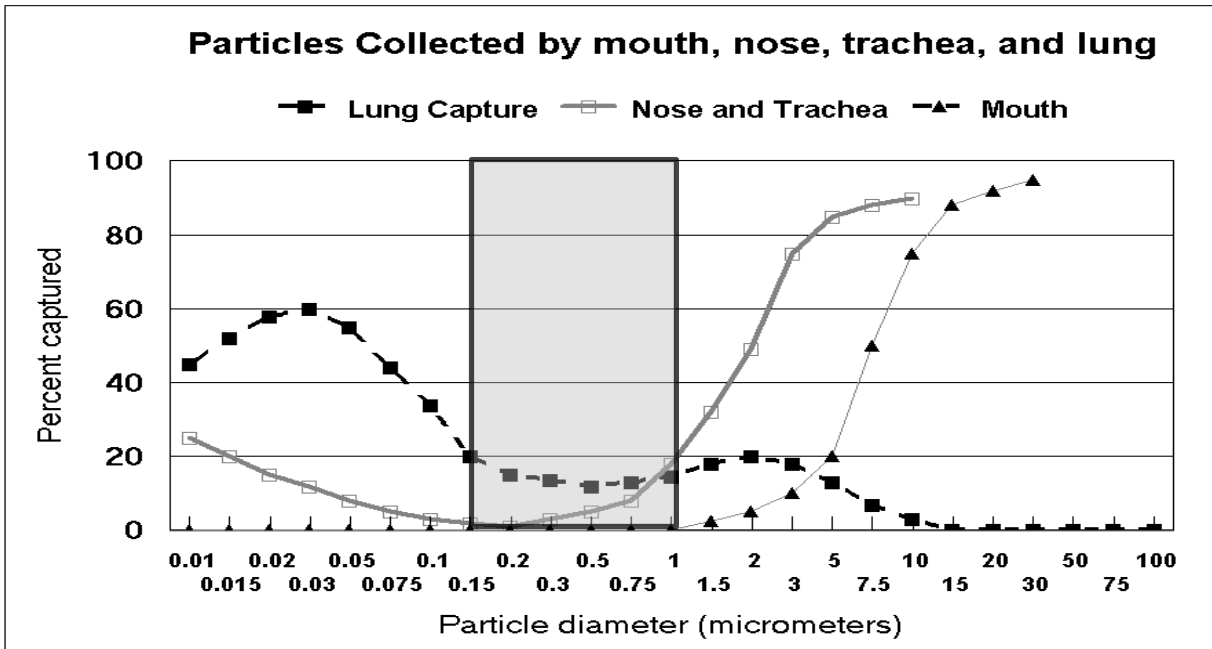


Figure 5-1. The shaded area shows the size profiles and lung deposition for smoke.

Note that most of the smoke you inhale is then exhaled – which is why people can blow smoke rings. If you hold the smoke in for a longer time, lung deposition is increased.

Nitty-gritty details

Smoking is the leading preventable cause of death in the United States. Cigarette smoking causes more than 480,000 deaths each year in the United States. This is about one in every five deaths.

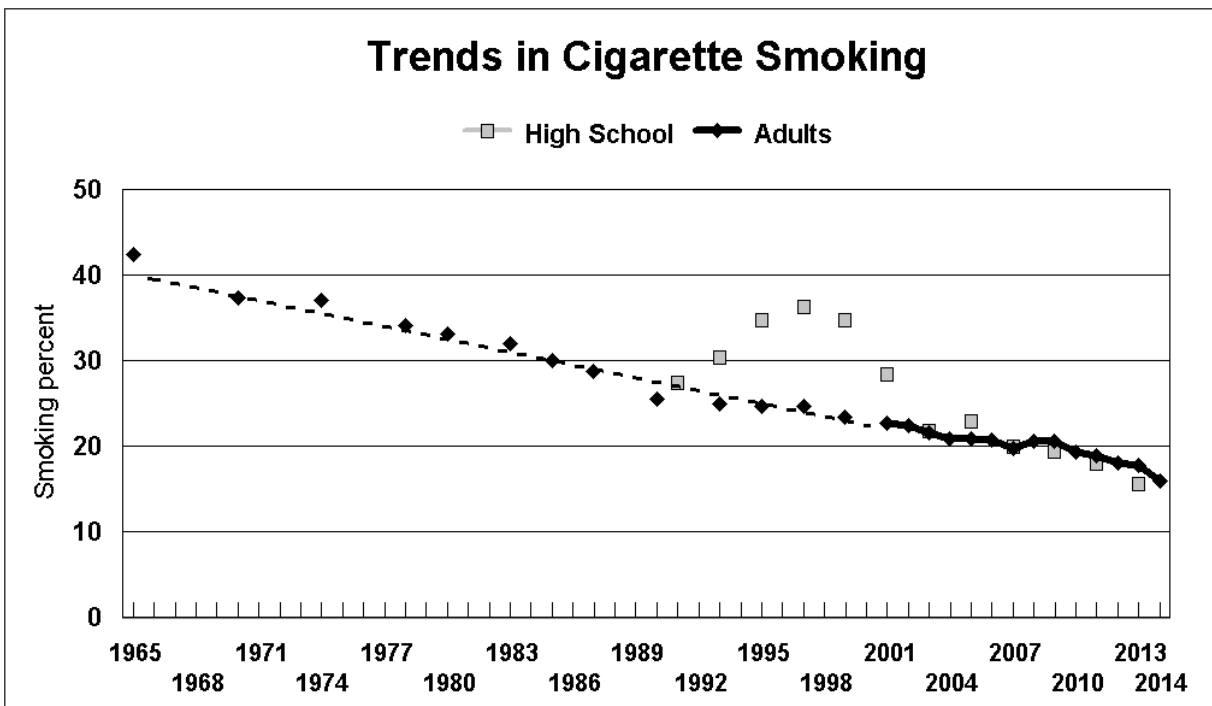
Smoking causes more deaths each year than all of these hazards combined:

- human immunodeficiency virus (HIV)
- illegal drug use
- alcohol use
- motor vehicle injuries
- firearm-related incidents

Consider these facts:

ITEM 11.1.

- 1184 • More than 10 times as many U.S. citizens have died prematurely from cigarette smoking than
1185 have died in all the wars fought by the United States during its history.
- 1186 • Smoking causes about 90 percent (or 9 out of 10) of all lung cancer deaths in men and
1187 women. More women die from lung cancer each year than from breast cancer.
- 1188 • About 80 percent (or 8 out of 10) of all deaths from chronic obstructive pulmonary disease
1189 (COPD) are caused by smoking.
- 1190 • Cigarette smoking increases risk for death from all causes in men and women.
- 1191 • The risk of dying from cigarette smoking has increased during the past 50 years for men and
1192 women in the United States.



1193

1194 Figure 5-2. Trends in cigarette smoking in the United States

1195 **References**

1196 Centers for Disease Control (CDC) is all over this one

1197 (http://www.cdc.gov/tobacco/data_statistics/fact_sheets/)1198 **Thank You for Smoking**, a wonderful movie, with its infamous MOD Squad of lobbyists

1199 (Merchants of Death – tobacco, liquor, and firearms.)

ITEM 11.1.

1200

Chapter 6

1201

**“99 Miles From LA” ... and My Eyes
Still Watered**

1202

1203

Ozone, both bad cop and good cop

1204

Impacts: Lung inflammation and loss of capacity, and aging of skin and eyes

1205

Introduction

1206

1207

1208

1209

1210

1211

1212

I grew up in rural New England on a small farm, but when I went to college, my parents couldn't maintain the farm themselves, and accepted a transfer with IBM (= I've Been Moved) to San Francisco. I remember flying out from Holy Cross College in Worcester, Massachusetts, on the spring break in 1957, and after a grim and snowy trip across the United States, descending through the clouds into the glorious greens and blues of San Francisco and its bay. I remember how clean and fresh the air seemed, and the wonderful and strange scents of the local coastal vegetation.

1213

1214

1215

1216

1217

1218

1219

However, in 1958, my father was transferred again, this time to Los Angeles, which is one of the reasons I attended graduate school at UCLA. I started at UCLA in summer 1959, and had occasion to go over to CalTech (the California Institute of Technology) in Pasadena, where my nuclear colleague worked. It was miserable, my eyes would tear, and leave little black edge channels down my cheeks. There were mountains all around the city, but I never saw most of them, or Catalina Island, until November, when suddenly a wind cleared out the L.A. basin, as the flat plain on which Los Angeles was built is known locally.

1220

1221

1222

1223

1224

1225

Everybody knew the situation was intolerable, but despite a number of modest changes in car engines (some actually made things worse), the air still kept getting worse. Dr. Arie Haagen-Smit, a chemist working on vegetation damage, had discovered in 1951 the nature and causes of the eye irritation and the choking feeling in human lungs was caused by photochemical smog. He determined that nitrogen oxides and hydrocarbons gases in the presence of ultraviolet radiation from the sun forms smog (a key component of which is ozone).

ITEM 11.1.

Why was this so important? Everybody knew the ozone was awful, causing prompt health problems as well as, we assumed, delayed health impacts. Powerful social and political forces aligned and pushed California to pioneer air pollution research and regulations with serious teeth. For decades before the U.S. EPA or other countries caught on, the local Los Angeles County Air Pollution Control District was involved in efforts to reduce local air pollution, including banning backyard trash incinerators. With the formation and strengthening of the California Air Resources Board around 1972, many research universities banded together to understand and mitigate the problem.

After a considerable battle, California was allowed to adopt the catalytic converter to destroy the hydrocarbon gases and to mandate low-octane gasoline to reduce oxides of nitrogen. Reduction of octane required removal of lead and (at my urging) sulfur from gasoline. The success of the California ozone control measures – requiring both the catalytic converter and the switch to lower octane gasoline to control oxides of nitrogen – have been dramatic. As Figure 6-1 shows, Los Angeles had reached 2016 federal standards by 2002.

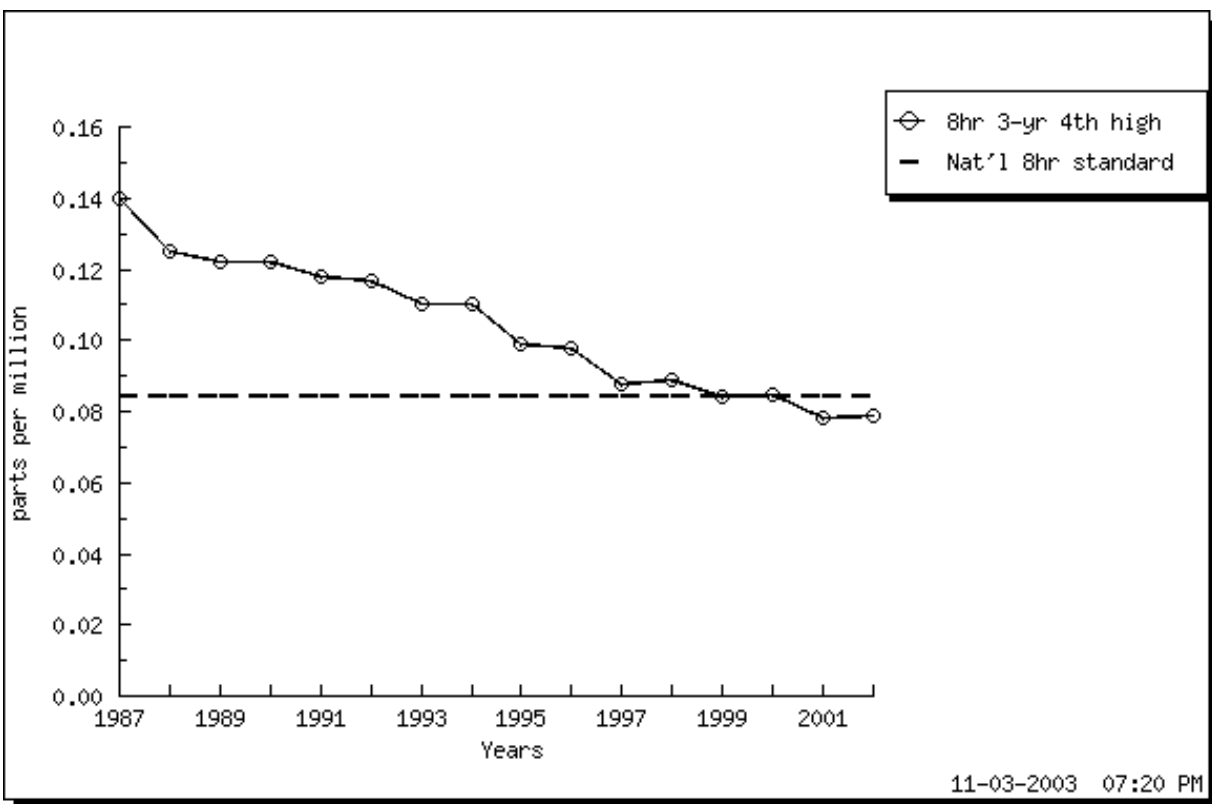


Figure 6-1. Reduction in eight-hour ozone levels in Los Angeles, 1987 to 2002.

ITEM 11.1.

How can I protect myself?

Of all the significant pollutants, ozone is almost unique in that it is both dangerous and relatively easy to avoid. The key factor is its high ozone reactivity; if the ozone (O₃) touches almost anything, especially organic matter – including human skin, eyes, lungs, trees – it is destroyed. So let's start with the basics:

1. Do your homework. Use the ozone maps on TV, data from your local air pollution agencies, the web and other reliable sources.
 - Identify locations where ozone is highest
 - Be aware of times when ozone peaks
2. Live where ozone is minimal, including coastal areas and remote parts of far Northern California
 - But in the Central Valley foothills, ozone is worse there than on the valley floor
 - Try to avoid being downwind of a major metropolitan area
3. Live under a tree canopy. Measurements show ozone can be reduced by almost a factor of 3 under a dense tree canopy. So living under a tree canopy reduces your ozone exposure to only about 1/3 of what it would have been in an open field.

Because ozone is only a summer problem, these can be deciduous.
4. Avoid being outdoors in peak ozone times, hot days in the afternoon.
 - Ozone is greatly reduced inside an air conditioned house, especially if it contains a lot of organic matter such as indoor plants and natural fabrics.
5. Avoid sports in the afternoon, because breathing through your mouth increases lung damage.
 - Playing sports during the afternoon smog peak almost guarantees increased lung damage in children.

Nitty-gritty details**History of Ozone and Oxidant Ambient Air Quality Standards**

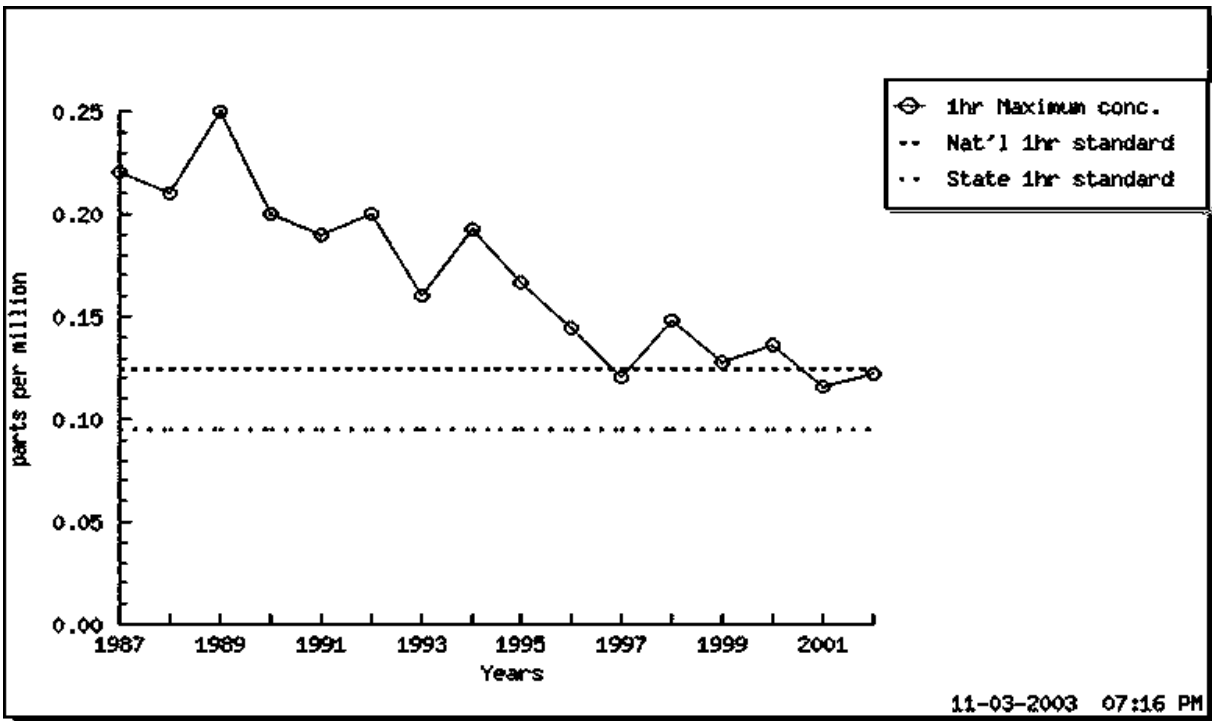
ITEM 11.1.

Year	Pollutant	Concentration (parts per million)	Averaging time	Notes
1955	Oxidant	0.68 ppm	1 hour	Maximum ozone level ever seen in Los Angeles
1955	Oxidant	0.50 ppm	1 hour	First of Three Alert Stages – Developed for Los Angeles County Air Pollution Control District
1959	Oxidant	0.15 ppm	1 hour	First statewide oxidant standard – set at the lowest concentration at which eye irritation, vegetative damage and visibility reduction have been reported.
1969	Oxidant	0.1 ppm	1 hour	Standard set to prevent or abate eye irritation and possible impairment of lung function in persons with chronic pulmonary disease.
1970	Oxidant	0.10 ppm	1 hour	Standard level set to prevent aggravation of respiratory diseases and to prevent or abate eye irritation.
1975	Oxidant as ozone	0.10* ppm	1 hour	Standard level set to prevent aggravation of respiratory diseases. *Defined the highest level of ozone that can be present without adverse health effects.
1988	Ozone	0.09* ppm	1 hour	Standard set to prevent aggravation of respiratory diseases.
2005	Ozone	0.09 ppm	1 hour	Standard set to prevent the following short-term health effects: <i>one-hour and multi-hour exposures</i> - lung function decrements, and symptoms of respiratory irritation and <i>multi-hour exposures</i> – airway hyper-reactivity and airway inflammation.
2015	Ozone	0.070* ppm	8 hour	
2015	Ozone	0.035 ppm	8 hour	Estimated ozone global background

1266 Table 6-1. History of oxidant and ozone standards in California.

1267 While excess ozone episodes in Los Angeles and the Bay Area are decreasing in
 1268 proportion to decreases in the raw materials, organic gases and oxides of nitrogen, in the
 1269 California Central valley ozone stays stubbornly high, showing that another unknown non-
 1270 anthropogenic source is in operation. This is shown in Figures 6-2 and 6-3, and similar graphs
 1271 occur for the 8-hour data.

ITEM 11.1.



1272

1273 Figure 6-2. Reduction in one-hour ozone levels, Los Angeles, California, 1987 to 2002.

1274 Recall that in 1955, it reached 0.68 ppm.



1275

1276 Figure 6-3. Reduction in one-hour ozone levels, Fresno, California, 1987 to 2002.

ITEM 11.1.

1277

Los Angeles (downtown)		Reductions	
	8 hr. ozone	55%	
Reactive organic gases	ROG	55%	
Oxides of nitrogen	NO _x	48%	
Average of ROG and NOx reductions		51%	
	Yield	(0.55/0.51)	108 %
Bay Area (Fremont)			
	8 hr. ozone	43%	
Reactive organic gases	ROG	37%	
Oxides of nitrogen	NO _x	50%	
Average of ROG and NOx reductions		44%	
	Yield	(0.43/0.44)	98 %
San Joaquin Valley (Fresno)			
	8 hr. ozone	4%	
Reactive organic gases	ROG	55%	
Oxides of nitrogen	NO _x	33%	
Average of ROG and NOx reductions		44%	
	Yield	(0.04/0.44)	9 %

1278 Table 6-2. "Yield" of ozone reduction vs. precursor reduction.

1279 For Los Angeles, the yield is 108 percent, which means that for every reduction in gaseous
 1280 precursors, you get almost exactly the same reduction in ozone, and in fact 8% more. For the
 1281 Bay Area, the reductions are also almost 1 to 1, but the Central valley, very little reduction in

ITEM 11.1.

1282 ozone is achieved despite massive reductions in local precursor gasses. Obviously, other factors
1283 are involved, including transport and natural sources.

1284 Pollution precursor reductions from vehicles obviously are not working in the Central
1285 Valley. This is also shown by the fact that the non-peak mean summer ozone is about the same
1286 along the entire length of the valley, from the heavily polluted south to the largely pristine north.
1287 Isoprene from blue oaks and nitrogen outgassing from Mediterranean grasses may be involved.

1288 The way the CAA is written, new health impact data could well drive the ozone standard
1289 below the California Central Valley ozone natural background. This is the same problem faced
1290 earlier by ambient radiation. This was “solved” by a workaround that ended up with the standard
1291 set well above natural background.

1292 **Stratospheric ozone, the “good cop”**

1293 The sun bathes the Earth in a wide range of light frequencies, including hard ultraviolet,
1294 from the highest energy and most damaging, UVC, to UVB and UVA. Fortunately for us, 99
1295 percent of it is absorbed in the stratosphere, at elevations of between 35,000 and 40,000 feet.
1296 Here the ultraviolet converts normal oxygen O₂ into ozone, and only a tiny amount of UV
1297 reaches ground level. The ozone layer is intense, and contains about 90 percent of all the ozone
1298 in the entire atmosphere. The Los Angeles smog also removed the ground-level ultraviolet as the
1299 UV was busy turning O₂ into O₃ at about 1,000 feet above our heads, at the top of the smog
1300 layer.

1301 Life would be a lot more difficult for all living creatures if we didn’t have ozone – I mean
1302 the ozone layer in the stratosphere. It blocks much of the ultraviolet light from the sun, which
1303 otherwise would have serious effects on Earth – not the least of which would be greatly
1304 increased skin cancer.

1305 According to NOAA, “In the stratosphere, the region of the Earth's atmosphere from 6 to
1306 30 miles (10 to 50 kilometers) above the surface, the chemical compound ozone plays a vital role
1307 in absorbing harmful ultraviolet radiation from the sun. During the past 20 years, concentrations
1308 of this important compound have been threatened by human-made gases released into the
1309 atmosphere, including those known as CFCs. These chemical compounds as well as
1310 meteorological conditions in the stratosphere, affect the concentration of stratospheric ozone.”

ITEM 11.1.

1311 The key point is that medium wavelength ultraviolet light has enough energy to break up
 1312 the standard O₂ molecule into two free oxygen atoms. These then attach themselves to standard
 1313 molecular oxygen to make O₃, ozone. The ozone layer is about 5 ppm, but varies widely in space
 1314 and time. That is adequate to remove about 98 percent of the incoming ultraviolet.

1315 Some compounds, however, can destroy ozone molecules if they reach the stratosphere,
 1316 allowing ultraviolet light to reach the surface of the Earth. The most powerful are
 1317 chlorofluorocarbons, carbon tetrachloride and some other industrial solvents, and CFC
 1318 refrigerants. This process, however, requires very cold temperatures and the absence of light in
 1319 order to remove a large fraction of the ozone shield. This happens most strongly in winter in the
 1320 Antarctic, under the famous "Ozone Hole." Fortunately, very little exposed biomass exists at
 1321 these latitudes, so the effects are limited. The Arctic is just a shade too warm in winter to form a
 1322 strong ozone hole, which is fortunate for us because the "Ozone Hole" would have much more
 1323 serious impacts on a well-developed biosphere.

1324 As the threat became better known, the United States, Canada, and Norway removed CFCs
 1325 from aerosol spray cans, and pressured the rest of the world to do likewise. Finally, the Montreal
 1326 Protocols were signed in 1987 and since amended to phase out manufacture of compounds that
 1327 damage the ozone layer.

1328 Recent evidence shows that this measure is working, despite the long lifetime in the
 1329 atmosphere of some of the compounds.

1330 **I'm breathing on a jet plane ... ozone and other airplane pollutants**

1331 Ozone is brought into aircraft cabins from the high-altitude (good) ozone layer, and can be
 1332 responsible for eye irritation, and other undesirable effects. In addition, due to the large number
 1333 of passengers in the aircraft cabin, high concentrations of dust, fibers, bacteria, and other
 1334 microorganisms may exist there. All of these are potential health hazards to crews and
 1335 passengers. In order to enhance passenger and crew health and comfort, the high-efficiency
 1336 particulate air (HEPA) filters and catalytic converters aboard aircraft must control these
 1337 contaminants.

1338

1339

ITEM 11.1.

Contaminant	Solution
Bacteria, fungi and viruses	True HEPA filters with microbial efficiency of >99.999% because viruses are so small
Dust and fibers	HEPA filters with efficiency of 99.97% DOP (or 99.99%NaCl) for submicron particles
Odors, organic gases	Adsorbent filters
Ozone	Catalytic converters and adsorbent filters

1340 Table 6-3. Contamination type and removal technologies.

1341 **Burn, baby, burn!**

1342 Ever wonder why the geeks of *The Big Bang Theory* TV series are as pale as ghosts, while
 1343 the comely babes in *Baywatch* were richly tanned? Well, *Big Bang* geeks stay indoors a lot, but
 1344 the Los Angeles smog has abundant raw materials to make ozone from ultraviolet light in a layer
 1345 about 1,000 feet above ground. While I attended grad school at UCLA in the 1960s, during the
 1346 peak of the ozone impacts, it became well known that you could lounge by a swimming pool all
 1347 day in Pasadena in the summer without becoming sunburned. But if you drove a few miles to
 1348 Santa Monica and the ocean beaches, you would be fried in an hour.

1349 That's because the smog layer of Los Angeles, including high ozone levels, was blocking
 1350 ultraviolet at inland sites. This shield was absent at the ocean with its clean marine winds. So,
 1351 ironically, L.A.'s smog probably reduced the skin cancer rate in the basin.

1352 **Ozone and Yosemite and Sequoia national parks**

1353 The inability of California to control ozone in the Central Valley poses a continuing threat
 1354 to the forest of the California national parks downwind (east) of the Central Valley. High ozone
 1355 levels prematurely age the long needles of the Jeffrey pine. These needles need to last three or
 1356 four years for the tree to recover the energy consumed in making them, so when ozone forces
 1357 them to drop too early, the tree is starved of energy and becomes vulnerable to insect and
 1358 drought threats.

ITEM 11.1.

Ozone has had a devastating impact on forests downwind of Los Angeles. Ozone has weakened the Jeffrey pines to the point that large sections of forests have died out and have been replaced by chaparral shrubbery.

The problem is exacerbated by the fact that when ozone is transported into the mountains each day, it lingers day and night, and is present in the morning when plant stomata open. In the valley, nitric oxide (NO) from cars destroys the ozone each night. Thus the average ozone levels in the mountains is actually higher than on the highly polluted valley floor. Lookout Point, at around 6,000 feet elevation, is directly upwind of the Giant Sequoias. Happily, the Giant Sequoias themselves are tough old critters and do not appear to be greatly harmed by the ozone.

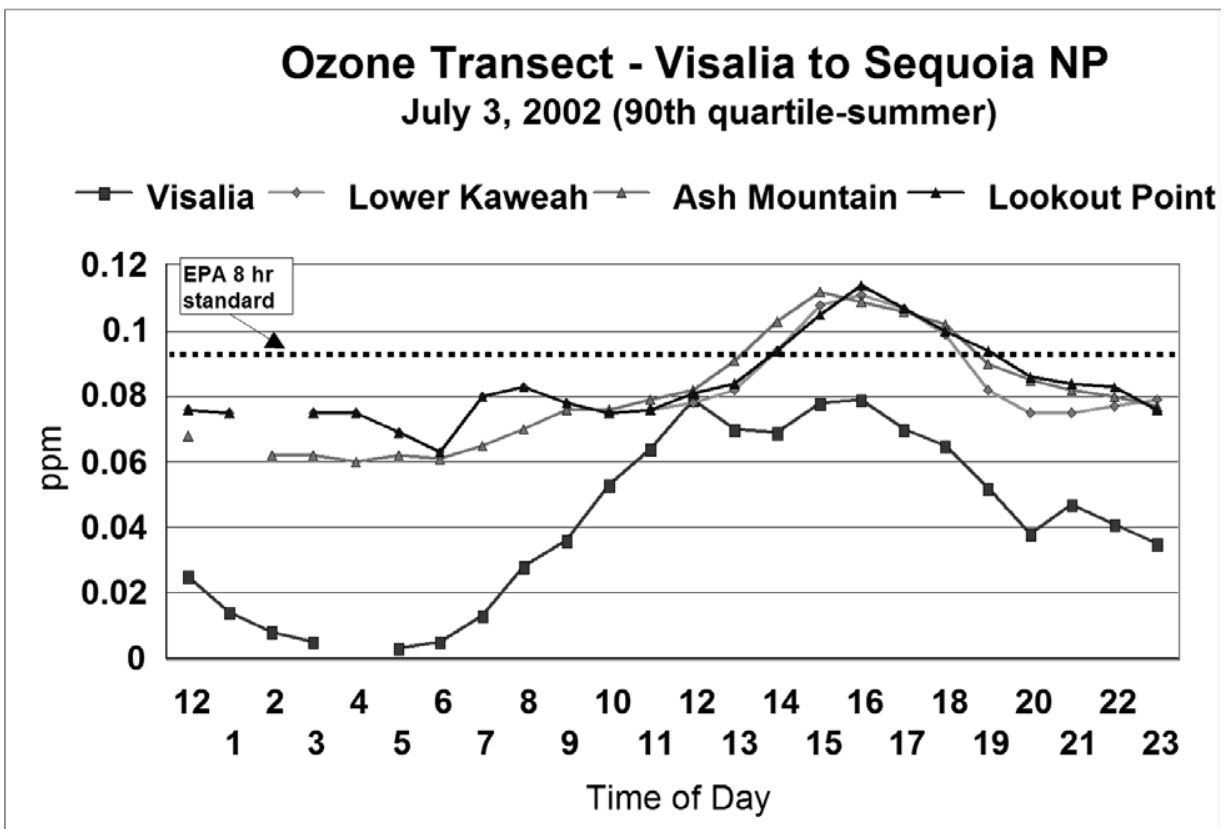


Figure 6-4. Ozone at Sequoia National Park.

Free radicals

Nerd alert! This topic is very important because much of the damage induced by air pollution arises from the generation of free radicals in your body. However, the topic is technical to the point of opaqueness. Don't sweat the details!

ITEM 11.1.

"Free radical," from Merriam Webster: "an especially reactive atom or group of atoms that has one or more unpaired electrons; especially one that is produced in the body by natural biological processes or introduced from an outside source (as tobacco smoke, toxins, or pollutants) and that can damage cells, proteins, and DNA by altering their chemical structure."

Free radicals and other reactive oxidation species (ROS) are derived from the normal process of breathing oxygen – the metabolic process of which acts like a controlled form of fire. The ability to oxidize food makes oxygen-breathing creatures far more powerful, but metabolic processes also cause damage to cells that must be continually repaired. These normal processes accompany other sources of free radicals, one of which – ozone

Ozone (O₃) is a powerful oxidizer that donates its extra oxygen to cells, damaging or destroying the cell. Further, in the process, extra electrons are often liberated, in turn, for more free radicals until corralled by an antioxidant, which fortunately are abundant in the fluid in your lung. Other external sources include ionizing radiation. Ozone is called "radio-mimetic" because both it and ionizing radiation have so much available energy that any amount can destroy a cell. Another source – cigarette smoking – already was discussed. Chapter 8 discusses another source of free radicals – reduced very fine iron steals an electron in the lung tissue, leaving a free radical that bounces around killing cells until absorbed. Thus, loss of lung function is seen in children living near freeways, and recent data points to very fine iron from brakes and the like as a potential source. Industrial chemicals and other contaminants add to the voluminous list.

A report presented at the American Chemical Society meeting in Denver in 2015 disclosed that free radicals in mice can turn off the immune system, leading to an immune system that has not been trained and, in later life, contributing to overreactions, infections, and asthma

References

- California Air Resources Board iADAM (aerometric data analysis and management) air quality data statistics: <http://www.arb.ca.gov/adam/>
- U.S. Environmental Protection Agency – ozone layer protection information: <https://www.epa.gov/ozone-layer-protection>

ITEM 11.1.

Chapter 7

***“Black, Black, Black Is the Color of My
True Love’s ...” Exhaust******Diesel exhaust***

Major impacts: Lung cancer, heart and lung disease, mental impacts, asthma and more

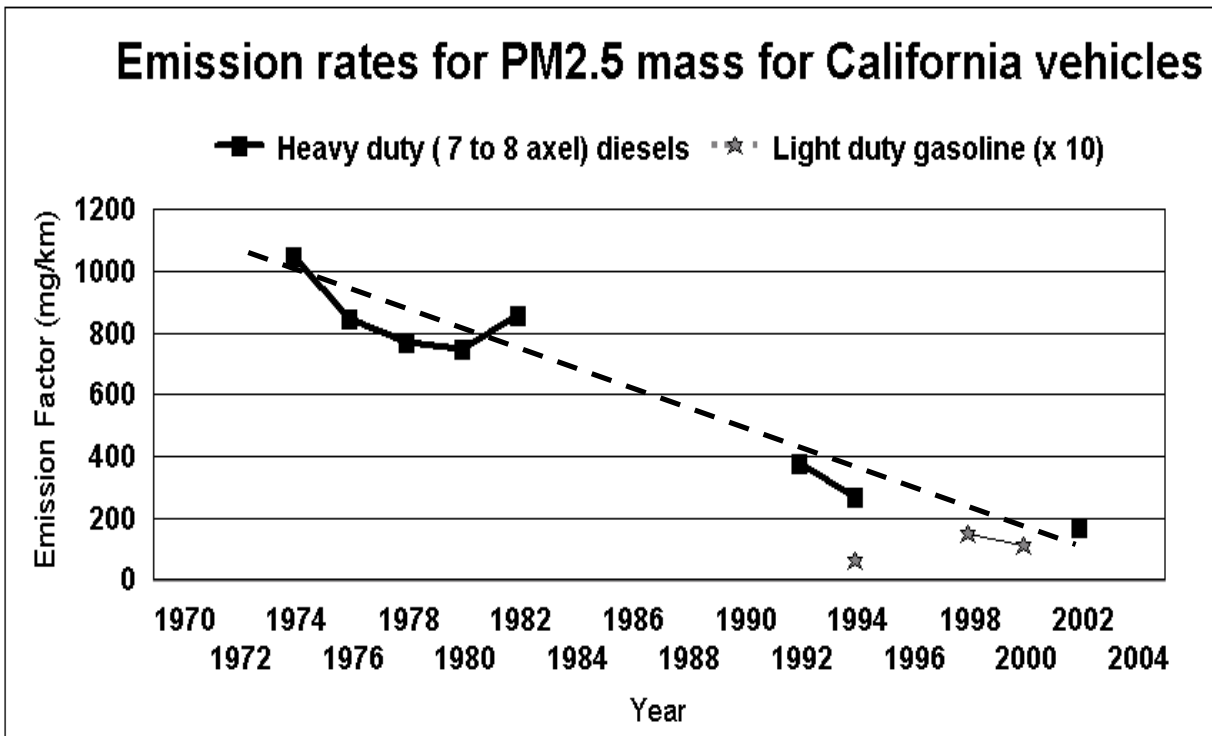
Introduction

California’s Proposition 65 (the Safe Drinking Water and Toxic Enforcement Act of 1986) mandates an inventory listing toxic materials and public warnings of their presence. The list is long, but one substance alone, diesel exhaust, accounts for 70 percent of the airborne toxic effects of all toxic air contaminants (TAC) combined. The primary problem is heavy polycyclic aromatic hydrocarbons (PAHs) caused by incomplete combustion of heavy petroleum fuels. But diesel exhaust warrants many other concerns, too. In a recent study, prenatal exposure to PAHs was correlated with physical changes in children’s brain structure along with mental problems, slower reasoning, hyperactivity, and more.

The reason why diesel exhaust is so polluting and toxic is inherent in diesel combustion. The walls of the engine’s cylinders must be kept relatively cool, but the combustion in the center is very hot. This allows partial combustion of the heavy fuel and the generation of polycyclic aromatic hydrocarbons (PAHs), the most problematic carcinogenic compounds in the atmosphere. And while diesel exhaust is ubiquitous, There are areas of special concern in certain locales. Many of these are downwind of rail yard and truck multimodal facilities. For example, the plume of materials from the BNSF Railway facility in San Bernardino, California, was estimated at about 2,500 excess cancer deaths per lifetime. Note that since the lifetime risk of cancer is on the order of one quarter of all deaths (250,000 afflicted among each million in population), the excess amounts to only about a 1 percent increase even in this especially impacted area with just a few thousand people.

ITEM 11.1.

1428 One key reason for this relatively low risk today is the 91 percent reduction in diesel
 1429 emissions from trucks during the past 30 years, from 1,100 milligrams of emissions per
 1430 kilometer traveled (mg/km) in 1972, to about 100 mg/km in 2002, as Figure 7-1 shows. Further
 1431 progress is occurring, resulting in development and production of very clean-burning diesel
 1432 engines. This is well advanced in long-haul trucks, but almost totally lacking in three-axle diesel
 1433 vehicles (including school buses, dump trucks and delivery vans) and, regrettably, most trains.
 1434 Cars pose special problems in trying to maintain diesel soot reduction techniques, assuming they
 1435 are not part of some scam (viz. Volkswagen)



1436

1437 Figure 7-1. PM_{2.5} emission factors for heavy- and light-duty trucks, 1972–2002. Cars
 1438 produced about one-tenth the emission volume that trucks do.

ITEM 11.1.

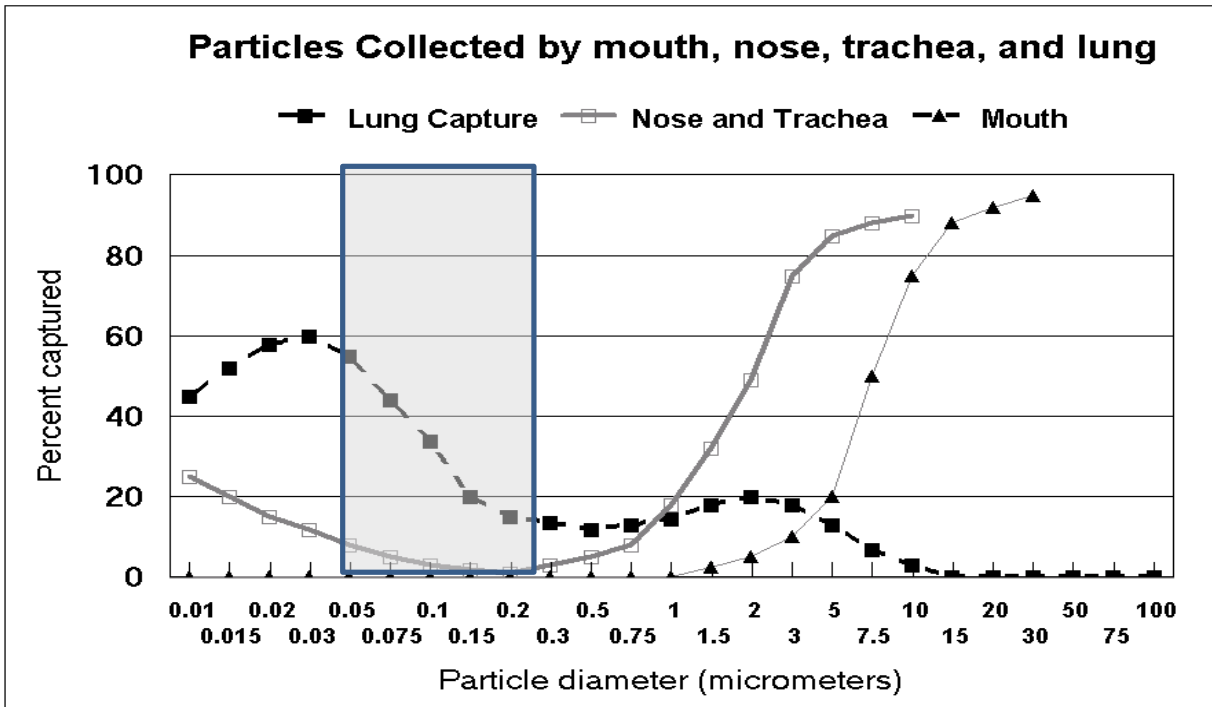


Figure 7-2. The gray shaded area shows the size range and lung deposition for diesel exhaust.

And on top of this, there is Volkswagen. I was amazed in 2009 that it ever made the ARB's smog emission limits. Well, a "defeat device" that sensed when the car was being tested turned on emission controls. Once testing was done, the device turned off the pollution control system, after which time the car emitted 10 to 40 times more nitrous oxide than allowed.

Even greater problems appear in Europe, where about half of all cars have diesel engines. That may be why Paris and other European cities still have such dirty air, despite claims of widespread use of "clean diesel." In addition, the manufacturers' mileage claims are inflated by about 40 percent, using tricks while they do their own tests.

How can I protect myself?

Essentially all diesel exhaust comes from one of seven sources:

1. Heavy duty (typically eight-axle) diesel-powered trucks on freeways and major highways
2. Lighter duty (often three-axle) diesels on secondary streets, such as delivery and dump trucks, school buses, and the like

ITEM 11.1.

- 1455 3. Railroad diesel engines, especially downwind of a rail yard
- 1456 4. Off-road and construction diesel-powered equipment
- 1457 5. Diesel-fueled water pumps for agriculture
- 1458 6. Peaking diesel-powered electric backup generators used to respond to short term power
- 1459 needs
- 1460 7. Diesel-powered cars

1461 Do your homework. Explore the websites of transportation agencies and other reliable

1462 sources for data on heavy truck use.

1463 For each of the diesel sources given above, different types of protection are needed:

- 1464 • For sources 1 and 2 (diesel on vehicular roadways), follow the “How can I protect
- 1465 myself” guidelines in Chapter 8 for ultra-fine particles and in Chapter 9 for highways.
- 1466 • For diesel source 3, become aware of railroad activities, and especially rail yards, because
- 1467 some of the worst levels of toxic air contaminants occur downwind of rail-truck facilities.
- 1468 Check the Chapter 7 (Diesel exhaust) section about the Roseville, California, rail yard.
- 1469 That segment shows that diesel exhaust in rail yards is more toxic than that emitted by
- 1470 trucks on roadways.
- 1471 • For diesel sources 4 and 5, don’t sweat it, as they are not close to you for extended
- 1472 periods.
- 1473 • For source 6, learn where such generators are in relation to wind direction, and ascertain
- 1474 how often they run. Usually such facilities, if in cities, have particle controls on them.
- 1475 • For source 7, read on to learn more about Volkswagen cheating.

1476 **More about Volkswagen's diesel cheating**

1477 Cheating on “clean diesels”? I am shocked! Shocked! But I was really shocked when told

1478 in 2009 that the Volkswagen diesel had passed the ARB’s stringent dynamometer emission tests.

1479 Make no bones about it – diesel combustion is essentially filthy, and only by extensive and

1480 expensive efforts can its problems be overcome. I had no clue that a corporate fix was on.

ITEM 11.1.

1481 There had been several earlier examples of shenanigans with “defeat devices” by
1482 homegrown and foreign auto companies, but this one from Volkswagen was a lulu, with
1483 pollution up to 40 times greater than the maximum allowable standard. The heart of the matter is
1484 that California’s vaunted vehicle testing and validation programs have an “Achilles heel”: what
1485 is seen in laboratory dynamometer tests is not what appears on the highway. Volkswagen knew
1486 that, and if not for a fluke West Virginia based on-road test that revealed the discrepancy, could
1487 have continued cheating for years to come.

1488 This is not the first time lab results and real-world results differed. I was working on lead
1489 pollution from highways in 1973. We had models from the U.S. EPA, but California wanted to
1490 validate these by on-road testing. My work found that the elevated freeways that were supposed
1491 to be the cleanest by the EPA model were the dirtiest, dumping 400 percent more lead than the
1492 California standard into downwind houses. My data helped Jerry Brown version 1.0 (in his first
1493 term as California’s governor) win a sweeping victory against both industry and the EPA, which
1494 opposed establishment of separate California standards. The stunning reductions in California air
1495 pollution encouraged most of the world to follow California, with the exception of Europe and its
1496 diesel fixation based on mileage claims. But automotive manufacturing companies hire the
1497 contractors to do the testing. What could possibly go wrong in this scenario? It probably explains
1498 why on-road mileage of diesels in Europe is about 40 percent worse than advertised.

1499 By the mid 1980’s, it had become clear that something was wrong in the Los Angeles
1500 basin. Ozone precursor gasses and ozone itself were not decreasing in the way the laboratory
1501 measurements and air quality models predicted. The answer came from a series of tests made in
1502 a freeway tunnel in Van Nuys, in the San Fernando Valley region of Los Angeles. Tunnels are
1503 nice to use because the volume of air and the number and types of cars and trucks were both
1504 accurately known. Thud the tunnel studies were able to compare the predicted auto emissions
1505 from ARB dynamometer laboratory tests to real-world conditions. The tunnel tests revealed
1506 carbon monoxide (CO) and hydrocarbon (HC) emission values 300 percent and 400 percent
1507 higher, respectively, than expected on the basis of dynamometer tests. The on-road tests
1508 identified a sad result – most California cars were clean, but a small number of “gross emitters”
1509 were discharging two-thirds of all highway pollution. These cars include modified vehicles with

ITEM 11.1.

1510 bypassed catalytic converters, old throw-away cars, unregistered cars, cars with fake smog check
1511 clearances, and the like.

1512 In order to rectify the problem of “gross emitters,” the California Inspection and
1513 Maintenance Review Committee (IMRC), a state board on which I served for years, repeatedly
1514 recommended on-road testing to identify “gross emitters.” The technique is actually simple,
1515 using an infrared beam aimed across a freeway on-ramp to measure pollutants. If this test had
1516 been modified to also detect nitric oxide (NO), that would have immediately identified the diesel
1517 cheaters, and the pollution would have been stopped years ago. Regretfully, the IMRC was shut
1518 down in 2011.

1519 And even post-Volkswagen, laboratory dynamometer tests cannot protect us in real-world
1520 conditions. “Wear” aerosols – from the roadbed, resuspended freeway dust, brake drums, and
1521 other sources resulting from abrasion, cannot be realistically measured in the lab. But health data
1522 on children living near freeways in Los Angeles, and our data on heart disease in the Central
1523 Valley, show that roadways are still causing health problems. Medical studies points to “wear”
1524 aerosols and ultra-fine metals from brakes as potentially toxic agents. This very important
1525 problem of very fine and ultra-fine metals from brakes will be covered in the next chapter.

1526 California needs to initiate truly realistic on-road testing not only to catch “gross emitters”
1527 and to detect cheating by “defeat devices,” but also to measure “wear aerosols” by size and
1528 composition. These tests should include realistic freeway actions such as braking and
1529 accelerating, as I and my team are doing in an ongoing U.S. EPA study in Detroit. Only with
1530 such data can we propose legislation that can rectify these problems and protect the health of
1531 Californians.

1532 **The special case of diesel trains and rail yards**

1533 The Union Pacific rail yard in Roseville, 15 miles northeast of Sacramento, California, is
1534 one of the largest in the western United States, and has a major repair and testing missions. As
1535 normal operating procedure, diesel engines are often left idling for extended periods of time.
1536 California Air Resources Board analysis in 2004 indicated about 900 excess cancer deaths per
1537 lifetime downwind of the rail yard. Note that the BNSF intermodal rail yard in San Bernardino
1538 had a predicted cancer death rate of about 2,500 per lifetime, much worse than Roseville.

ITEM 11.1.

We participated in tests of rail yard impacts both for diesel and other pollutants emitted from the repair activities. One of the goals was to make a direct measurement of diesel components, and especially the heavy PAHs like benzo[a]pyrene, a potent carcinogen in diesel smoke, for comparison with the ARB model. We also wished to evaluate other potential particulate pollutants emitted by comparing downwind sites to upwind or control sites. Figure 7-3 illustrates a comparison between a downwind site (Denio's Roseville Auction) and an upwind site for sulfur, associated with the sulfur in diesel fuel. Many other metallic aerosols followed the same pattern.

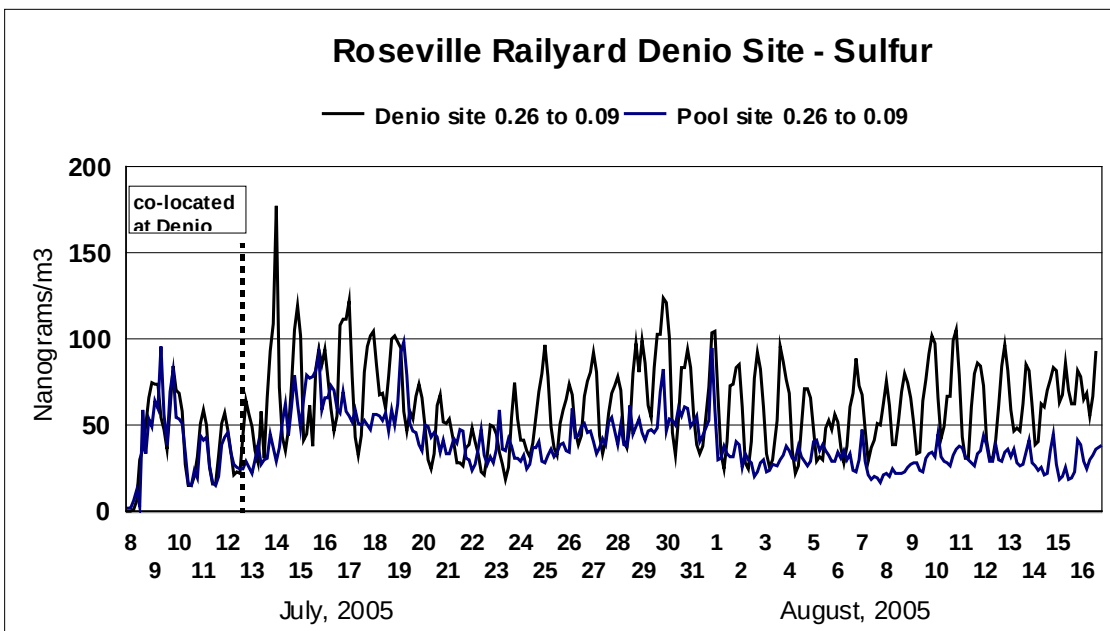
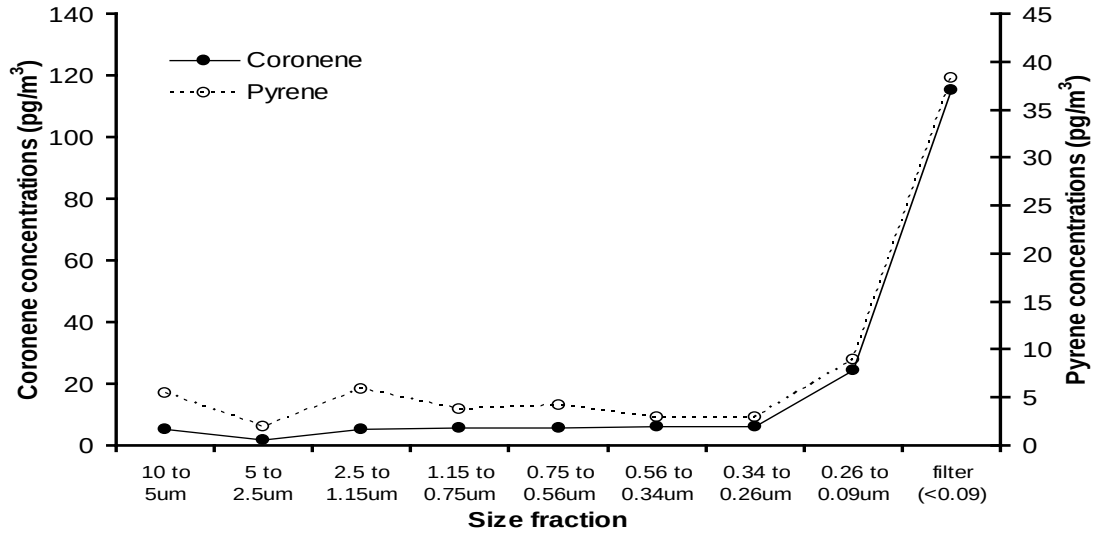


Figure 7-3. Comparison of very fine sulfur, Denio site vs. an upwind site.

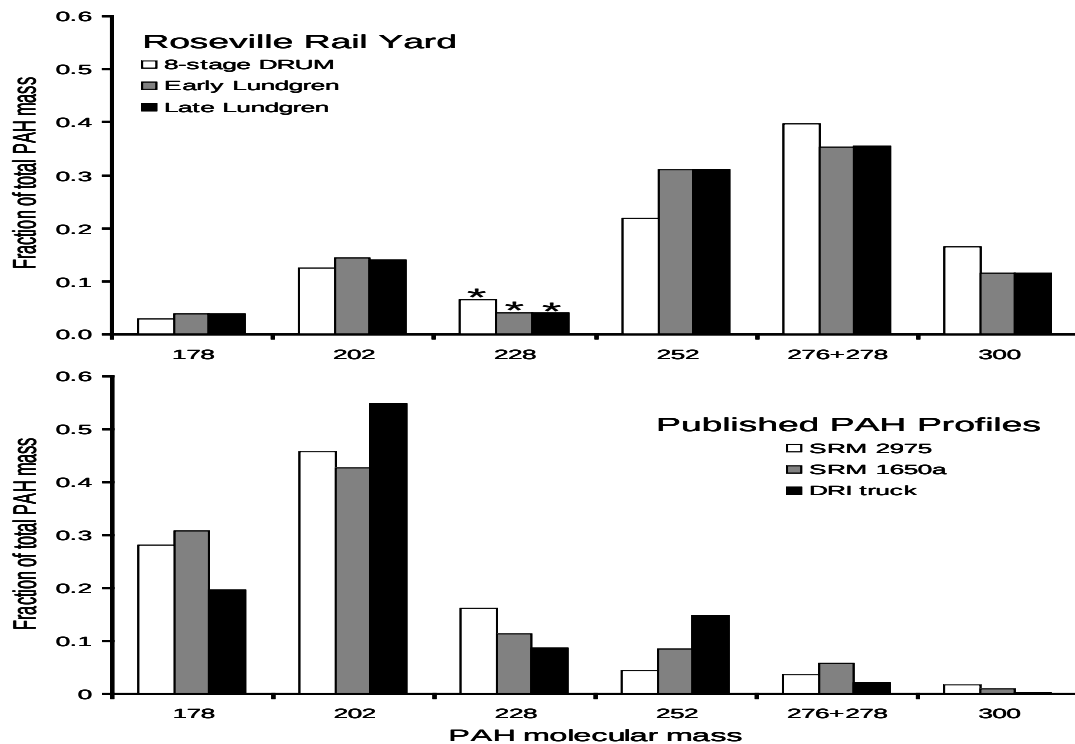
For the comparison of cancer death rates, we measured speciated organics as a function of particle size. Figure 7-4 is one such plot, showing that these PAHs deposit deep in the lung.

ITEM 11.1.



1551

1552 Figure 7-4. Roseville rail yard coronene and pyrene concentrations (pg/m³) delineating
 1553 the different size fractions of the eight-stage DRUM sampler (Davis Rotating-drum
 1554 Universal size-cut Monitoring impactor) and the after-filter.



1555

1556 Figure 7-5. Comparison of Roseville rail yard and truck diesel PAH profiles.

ITEM 11.1.

Rail yards have a variety of diesel sources – some of which are unique to them, such as idling diesels and stationary diesels under test, as in the Roseville rail yard. As an additional complication, the BNSF rail yard in San Bernardino is an intermodal facility that is subject to heavy truck traffic from the Port of Los Angeles and Long Beach. Both diesel testing and port-to-rail transit traffic are likely to generate enhanced cancer rates downwind.

References

- Cahill, Thomas A., Thomas M. Cahill, David E. Barnes, Nicholas J. Spada, and Roger Miller. 2011. “Inorganic and Organic Aerosols Downwind of California’s Roseville Railyard.” *Aerosol Science and Technology* 45: 1049–1059. doi:10.1080/02786826.2011.580796.
- Cahill, Thomas A. (P.I), Thomas M. Cahill, David E. Barnes, Nicholas J. Spada, Steven S. Cliff, Kevin D. Perry, and Erin Fujii. November 1, 2007. “Final Report to the Health Effects Task Force (HETF), Breathe California of Sacramento-Emigrant Trails: Mass, Organic, And Elemental Aerosols by Size, Time, and Composition at the Union Pacific Rail Road’s Roseville Railyard.”
- Gertler, Alan, Mahmoud Abu-Allaban, William Coulombe, John A. Gillies, William R. Pierson, C. Fred Rogers, John C. Sagebiel, Leland Tarnay, and Thomas A. Cahill. 2002. “Measurements of Mobile Source Particulate Emissions in a Highway Tunnel.” *International Journal of Vehicle Design* 2001, 27:86–93. doi:10.1504/IJVD.2001.001954.
- Zielinska, B. et al. 2004. “Final Report of the Diesel Studies.” Desert Research Institute.

Chapter 8

“It Was an Itsy Bitsy Teenie Weenie Yellow ...” Ultra-fine Metal

Copper and other ultra-fine transition metals

Major impacts: Cardiopulmonary conditions, especially ischemic heart disease and permanent loss of lung function in children

[For the antiquity-challenged, the 1960 song that inspired the title of this chapter was about a young girl suffering a mild case of hypothermia due to a questionable swimwear choice.]

Introduction

I probably take more pride than I should or deserve for highlights in my career – the first, the only, the biggest. But I am embarrassed about one record. I am told that I hold the record at the Trauma Intensive Care Unit of the University of California, Davis, Medical Center for the most ribs broken in a single fall from a ladder – seven – by a patient who survived. Knowing that now, I really should not have been climbing a long ladder onto the roof of Arden Middle School in the rain with my colleague, Betty Turner (combined ages circa 140 years) on that December day in 2002.

We were responding to a request by the principal to add Arden Middle School to a network of air sampling stations we were setting up. The network was designed to evaluate the effects of freeways on Sacramento, as part of our research with the Health Effects Task Force of what is now Breathe California of Sacramento-Emigrant Trails (at that time an affiliate of the American Lung Association). The study focused on the health-compromising implications of aerosols from two heavily traveled north-south freeways, Interstate 5 and California Highway 99. The six-site network stretched 50 miles, from the western side of the Sacramento Valley west of Davis to the foothills of the Sierra Nevada east of Sacramento. The request from the principal of Arden Middle School was based on her concerns about the school’s proximity to the intersection of two main arterials. The school grounds are 50 feet downwind of the signal-controlled

ITEM 11.1.

1604 intersection of multi-lane Watt Avenue at Arden Way, and those streets were and are heavily
 1605 used and often congested. Arterial streets were never part of our plan to evaluate air quality
 1606 adjacent to freeways, but I had one extra air sampler, just brought back from the Aerosol
 1607 Characterization Experiment-Asia (ACE-Asia) study (see Chapter 10, The Mad Hatter Had a
 1608 Point) and, lacking any available staff at that moment, the geezer squad swung into action.

1609 Once again, I am struck about how lucky I have been in my career. I was not at all
 1610 interested in Arden Middle School because it was not part of our plan, but it turned out to be the
 1611 key to unlocking one of the major detrimental health effects affecting the nation. When we
 1612 finally completed our analysis of the results in spring 2003, we discovered that Arden Middle
 1613 School – downwind of 65,000 vehicles per day, 1.5 percent of which are heavy trucks traveling
 1614 on Watt Avenue – was subject to about the same amount of pollution as locations measured
 1615 downwind of Interstate 5 carrying 265,000 vehicles per day, 12 percent of which are heavy
 1616 trucks.

1617 These results were a wake-up call that we had better look more closely at Arden Middle
 1618 School, triggering intensive studies in 2006 and 2007. Table 8-1 illustrates the results of these
 1619 and other comparative studies.

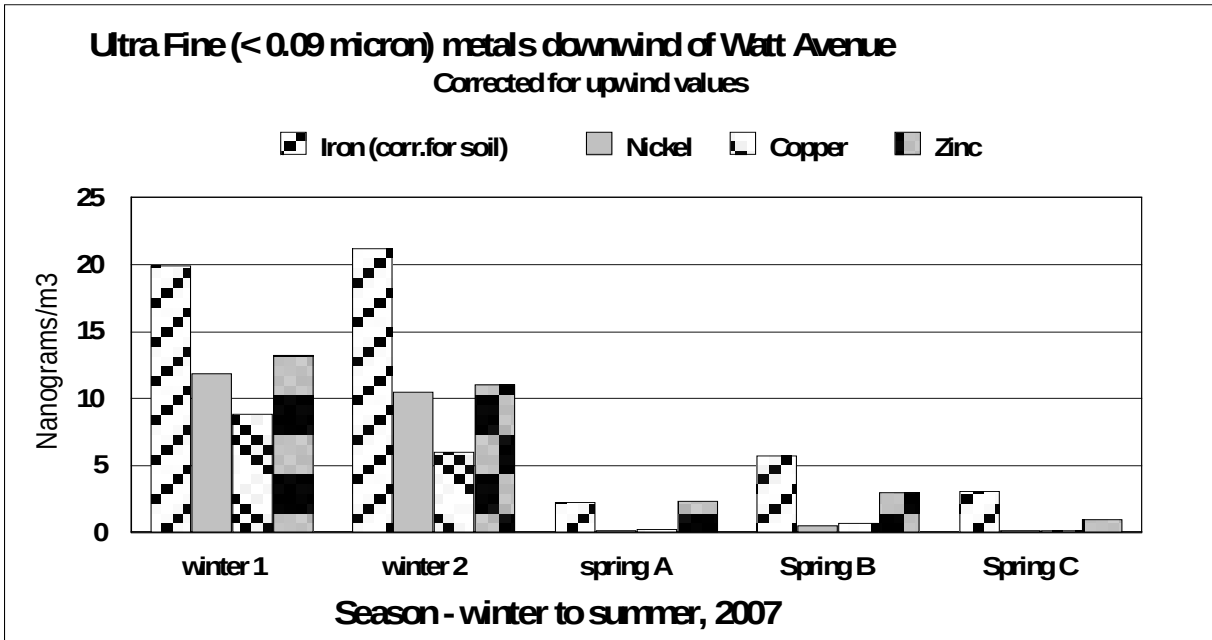
1620

Sampling site	Sampling dates	Mass data, very fine particles	Mass theory, very fine plus ultra-fine	Comment
Size modes		0.26 to 0.09 μm	0.30 to 0.0 μm	
Sacramento, Interstate 5	Winter 2002	4.1 $\mu\text{g}/\text{m}^3$		265,000 vehicles/day
Fresno, 1 st Street	Winter 2001	4.2 $\mu\text{g}/\text{m}^3$		
Arden Middle School, Watt Avenue	Winter 2006	4.0 $\mu\text{g}/\text{m}^3$	6.4 $\pm$ 0.8 $\mu\text{g}/\text{m}^3$	65,000 vehicles/day

1621 Table 8-1. Measurements at Arden Middle School, in suburban Sacramento, and
 1622 comparative data and theory. The theory value is based on three sources, averaged.

ITEM 11.1.

1623 These results could be explained only by the anomalous fact that for the first time in decades we
 1624 were measuring aerosols at a study at a stop light, with braking and acceleration. We all noticed
 1625 the plumes of black smoke when the diesels accelerated as the light turned green.

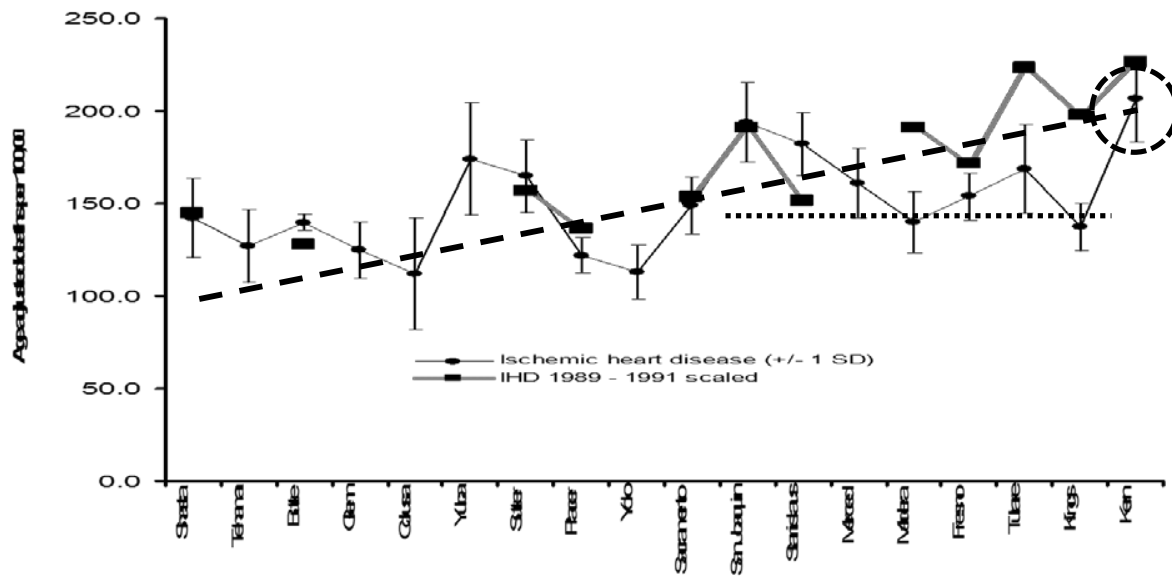


1626

1627 Figure 8-1. Ultra fine metals at Arden Middle School 50 feet downwind of Watt Avenue

1628 Three other long-term research efforts now came to bear. The Health Effects Task Force
 1629 (HETF) already had spent several years looking at the enhanced heart attack death rate in the
 1630 southern San Joaquin Valley, which we showed was associated with enhanced ischemic heart
 1631 disease (HETF, 1997). A separate key study in Los Angeles showed large losses of lung capacity
 1632 in children growing up near freeways. And UC Davis environmental health teams identified a
 1633 relationship between freeway proximity and incidence of autism, with metals a likely cause.

ITEM 11.1.



1634

1635 Figure 8-2. Death rates from heart attacks by location in the California Central Valley.
 1636 The lower dotted line traces the reduced rate of ischemic heart disease that resulted
 1637 from a 1990 cleanup of ultra-fine metals from oil extraction operations. Note that the
 1638 cleanup did not reduce heart attack incidence in Bakersfield (dotted circle), which is
 1639 upwind of most of the oil fields.

1640 A search of the scientific literature confirmed what we already suspected: these metals are
 1641 known constituents of brake pads and drums, plus some zinc from zinc thiophosphate, a
 1642 stabilizing additive in motor oil that we had seen before in ultra-fine modes (Zielinska et al.,
 1643 2004).

1644 All these data led to the hypothesis that the enhanced heart attacks in the southern San
 1645 Joaquin Valley might be caused by ultra-fine particles of brake drums and pads from cars and
 1646 trucks trapped at cities that experience intense winter inversions, as Bakersfield does. With
 1647 assistance from a local non-governmental organization, we did a study in January 2009
 1648 simultaneously measuring coarse, fine, very fine and ultra-fine particles at five sites from
 1649 Redding (at the northern end of California's Central Valley) to Bakersfield (440 miles distant, at
 1650 the southern end of the valley). This study also benefitted from much better data on deaths rates,
 1651 including data that showed one specific source of mortality was ischemic health disease (IHD),

ITEM 11.1.

the largest single cause of death in the San Joaquin Valley. It also used data from extensive EPA studies on metals in rats, and our data from Watt Avenue tying these metals to braking. Thus, in summary, the resulted in peer reviewed papers in a special US EPA journal proving that very fine and ultra-fine insoluble metallic particles were the cause of thousands of fatal heart attacks.

When added to the earlier work on loss of lung function in children growing up near (less than 1 mile) Los Angeles freeways and the data on enhanced autism rates for pregnancies near freeways, the seriousness of the very fine and ultra-fine metals becomes urgent.

And now we know what you can do protect yourselves.

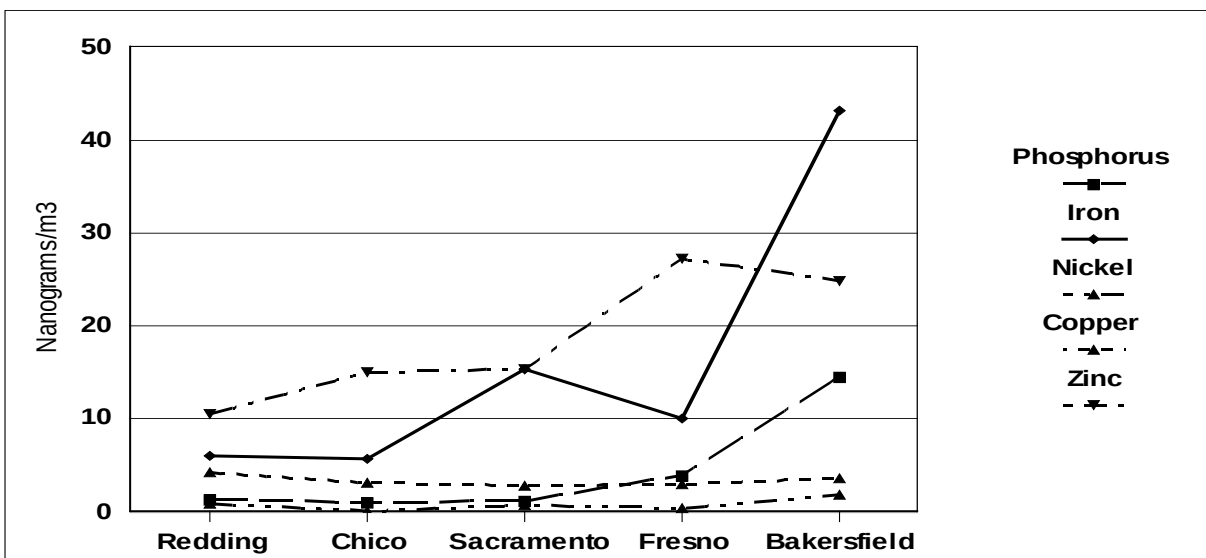


Figure 8-3. Very fine and ultra-fine metals that correlate with ischemic heart disease (IHD) mortality. IHD is usually the largest single reason for heart attack mortality in the California Central Valley.

ITEM 11.1.

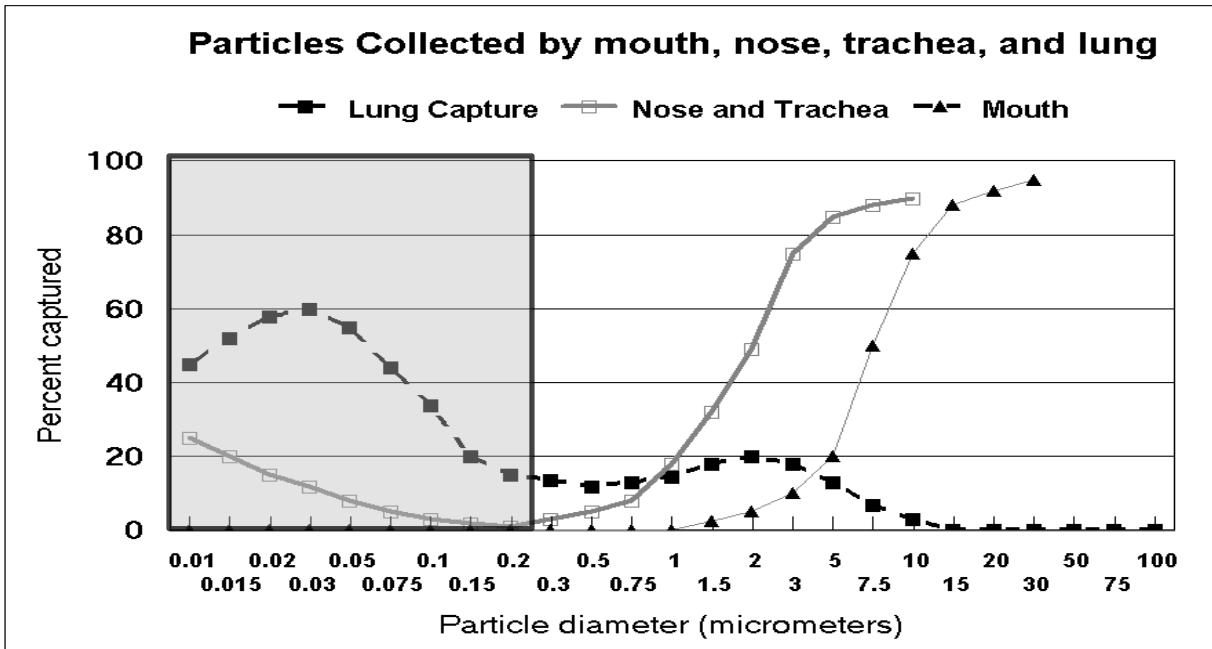


Figure 8-4. The gray shaded area shows the size range and lung deposition for very fine particles with diameters between 0.25 micrometers and 0.1 micrometers, and ultra-fine particles with diameters less than 0.1 micrometers. These are normally written in a short version, for very fine ($0.25 > D_p > 0.1 \mu m$) and for ultra-fine particles, ($D_p < 0.1 \mu m$).

How can I protect myself?

Know the sources:

- Avoid the outdoor areas where such particles exist, especially downwind of roadways where heavy braking routinely occurs (Chapter 9, Outdoor Air Quality)
- Learn of other industrial sources of ultra-fine metals, especially car shredding operations, and ultra-filter the air in your house (Chapter 10, Indoor Air Quality)

Nitty-gritty details

Comparison of diesel exhaust to ischemic heart disease death rates

The California Proposition 65 (law on toxics) limit for notification: 10 deaths per million people per 70-year lifetime, or approximately a **0.001% increase in the total death rate**

ITEM 11.1.

1680 Diesel exhaust is the most ominous of the old Prop 65 toxic air contaminants (TACs),
 1681 resulting in about 70 percent of all cancer cases attributable to TACs combined. Using the fact
 1682 that about 20 percent of all deaths are from either cancer or heart attacks, we can estimate the
 1683 enhanced death rate, deaths per million people per 70-year lifetime:

- 1684 • Downwind of Union Pacific rail repair yard, Roseville, California:
 1685 approximately 800 deaths per million people per 70-year lifetime: **about a 0.5 percent**
 1686 **increase in the cancer death rate**
- 1687 • **VW diesel cheating** (if continued at the present level – estimate by the *Sacramento Bee*):
 1688 approximately 900 deaths per million people per 70-year lifetime: **about a 0.5 percent**
 1689 **increase in the cancer death rate**
- 1690 • Downwind of the worst California rail-truck facility, in San Bernardino
 1691 approximately 2,500 deaths per million people per 70-year lifetime: (ARB report, San
 1692 Bernardino BNSF): about a **1.3 percent increase in the cancer death rate**. This rate equates
 1693 to < (fewer than) 1,000 people in the city of San Bernardino

1694 Now compare that to the impact of very fine and ultra-fine metals from brakes:

- 1695 • Bakersfield, in the city center:
 1696 **approximately 25 percent increase in the heart attack deaths** (this rate affects about
 1697 350,000 people in the city of Bakersfield)

1698 Thus the death rate in Bakersfield, enhanced by approximately 25% in the death rate
 1699 of the single largest source of mortality in a city of 350,000 people, can be compared to the
 1700 enhanced death rate at the worst California site impacted by diesel, about 1.3% in a
 1701 population of no more than a few thousand people. So while vast efforts are being made to
 1702 control diesel, and with considerable success, very fine and ultra-fine metals, proven killers,
 1703 slide by under the radar. As I said in Chapter 4, “...the Worst of Acts”.

1704 **Note added in proof:**

1705 We have just published a paper on Detroit that includes the final statement of the
 1706 abstract: “.....*This result supports earlier publications showing the ability of very fine and*
 1707 *ultra-fine particles to transport to sites well removed from the freeway sources. The*
 1708 *concentrations of very fine and ultra-fine metals from brake wear and zinc in motor oil observed*

ITEM 11.1.

1709 in Detroit have the potential of being a significant component in statistically established $PM_{2.5}$
 1710 mortality rates.”

1711 **Transition metals in coarse, fine, very fine and ultra-fine particles**
 1712 **from an interstate highway transect near Detroit,** Thomas A. Cahill, David E.
 1713 Barnes, Jonathan A Lawton, Roger Miller, Nicholas Spada, Robert D. Willis and Sue Kimbrough
 1714 (the last 2 EPA OAPQS North Carolina), Atmospheric Environment (9/2016)

1715 Detroit is a lot bigger than Bakersfield. The word is getting out.

1716

1717 **References**

- 1718 • Cahill, Thomas A., David E. Barnes, Nicholas J. Spada. 2014. **“Seasonal Variability of**
 1719 **Ultra-Fine Metals Downwind of a Heavily Traveled Secondary Road.”** *Atmospheric*
 1720 *Environment* 94: 173–179.
- 1721 • Cahill, Thomas A. David E. Barnes, Nicholas J. Spada, Jonathan A. Lawton and Thomas M.
 1722 Cahill. 2011. **“Very Fine and Ultra-fine Metals and Ischemic Heart Disease in the**
 1723 **California Central Valley 1: 2003–2007.”** *Aerosol Science and Technology* 45: 1125–1134.
 1724 doi:10.1080/02786826.2011.582194
- 1725 • Cahill, Thomas A., David E. Barnes, Earl Withycombe, and Mitchell Watnik. 2011. **“Very**
 1726 **Fine and Ultra-fine Metals and Ischemic Heart Disease in the California Central Valley**
 1727 **2: 1974–1991.”** *Aerosol Science and Technology* 45:1135–1142.
 1728 doi:10.1080/02786826.2011.582196.
- 1729 • Cahill, Thomas A., Thomas M. Cahill, David E. Barnes, Nicholas J. Spada and Roger Miller.
 1730 2011. **“Inorganic and Organic Aerosols Downwind of California’s Roseville Railyard.”**
 1731 *Aerosol Science and Technology* 45: 1049–1059. doi:10.1080/02786826.2011.580796.
- 1732 • Cahill, Thomas A., Debrina Dutcher, Chris Clark, Jeanette Martin, Theresa McCarthy, and
 1733 David Lipnick. June 1998. **“Comparison of Cardiac and Stroke Mortality to Carbon**
 1734 **Monoxide, Ozone, and Particulate Air Pollutant Concentrations in the Sacramento**
 1735 **region: Final Report to the American Lung Association of Sacramento – Emigrant**
 1736 **Trails.”**

ITEM 11.1.

- 1737 • Cahill, Thomas M. 2010. **“Size-resolved Organic Speciation of Wintertime Aerosols in**
 1738 **California’s Central Valley.”** *Environmental Science and Technology* 44: 2315–2321. doi:
 1739 10.1021/es902936v.
- 1740 • Cahill, Thomas M., and Thomas A. Cahill. 2013. **“Seasonal Variability of Particle-**
 1741 **associated Organic Compounds Near a Heavily Traveled Secondary Road.”** *Aerosol*
 1742 *Science and Technology*. doi: 10.1080/02786826.2013.857757
- 1743 Thomas A. Cahill, David E. Barnes, Jonathan A Lawton, Roger Miller, Nicholas Spada, Robert
 1744 D. Willis and Sue Kimbrough, **Transition metals in coarse, fine, very fine and ultra-fine**
 1745 **particles from an interstate highway transect near Detroit**, in press, *Atmospheric*
 1746 *Environment* (2016)
- 1747 Gauderman, W. J., McConnell, R., Gilliland, F., London, S., Thomas, D., Avol, E., Vora, H.,
 1748 Berhane, K., Rappaport, E. B., Lurmann, F., Margolis, H. G. and Peters, J. (2000). **Association**
 1749 **between air pollution and lung function growth in southern California children.** *Am. J.*
 1750 *Respir. Crit. Care Med.* 162:1383-1390.
- 1751 Volk, H. E., Hertz-Picciotto, I., Delwiche, L., Lurmann, F., and McConnell, R., Residential
 1752 **Proximity to Freeways and the CHARGE Study**, *Environmental Health Perspectives*, **119**, # 6
 1753 , pg 872 – 877 (2011)

1754

1755 **Shut down Tom – attempt No. 3**

1756 ***Ultra-fine particles and the massive governmental screw-up at the World Trade***
 1757 ***Center***

- 1758 • **George Bush, president, 2003 – World Trade Center air was not safe to breathe!**

1759 None of us can forget when we first became aware of the WTC disaster on September 11,
 1760 2001. But my concerns were raised higher when three days later, I saw TV coverage showing
 1761 blue fumes coming up from the collapsed piles after a rainstorm on September 13. Blue smoke is
 1762 bad smoke, especially in industrial fires, because it indicates very fine particles that go deep into
 1763 the lung and even the bloodstream and heart. I felt both helpless and worried for the workers and
 1764 firemen working in such conditions.

ITEM 11.1.

1765 About two weeks later, I received a phone call from Bob Leifer, Department of Energy
1766 physicist with a laboratory on Varick Street in New York. His laboratory was at the southern
1767 limit of sites that still had electrical power. We had collaborated on the Mount St. Helens work,
1768 and I respected his expertise. He asked if I could send one of my Davis Rotating-drum Universal
1769 size-cut Monitoring impactor(DRUM) samplers to him. I had invented the current DRUM
1770 sampler in 1985, and it has been the work horse of my research for decades. It was designed to
1771 address problems with EPA required sampling protocol, which required 24 hr average filters
1772 analyzed only for mass. The standard protocol also calls for operating this unit only one day in 6.
1773 (see Chapter 4) The DRUM gives data in 8 size modes, not one size mode, every 3 hr, not every
1774 24 hr, and is routinely analyzed for mass, 42 elements, soot, and occasionally organic matter.

1775 Well, one had just come back from Beijing and ACE-Asia, (Chapter 19), so a cleaned it
1776 up, reloaded foils, and just made the FedEx pickup at 4 p.m. that Friday.

1777 Robert got the sampler up and running by October 2, and ran it flawlessly until we shut
1778 down in mid-December. At that time, we analyzed the samples at the Advanced Light Source,
1779 Lawrence Berkeley National Laboratory, and at Lawrence Livermore National Lab. By
1780 Christmas we had the results, which showed that, despite what the EPA and White House press
1781 releases asserted, the air was most assuredly not “safe to breathe,” and that people could expect
1782 massive detrimental health effects. These health problems included both the “WTC cough” (from
1783 coarse particles) and loss of lung function and eventual ischemic heart disease (from ultra-fine
1784 particles) as a result of breathing emissions from the fuming collapsed material piles, on which
1785 hundreds worked with minimal protection. There were high levels of strange elements, some
1786 toxic, in very fine size modes, predictably harmful to health.

1787 As soon as I had results in early January, I called EPA Region II, and was told that it was
1788 none of my business. The EPA contact person asked just two questions: “Who asked you to do
1789 it? Who paid for it?” They had zero interest in our findings. Then I asked the University of
1790 California's Washington lobbyist to present our material to the committee headed by then-
1791 Senator Hillary Clinton on this topic. The committee was scheduled to conduct hearings later
1792 that month, and UC contacted her staff and mentioned our work. The Senate staff said that our
1793 work not needed, as they already had their experts lined up, including a senior professor from
1794 New York University. When the hearing was finally held, the NYU professor testified that his

ITEM 11.1.

1795 data showed that the aerosols experienced in New York City were regional in nature from
1796 upwind sources, and not the WTC smolder pile. I was aghast.

1797 Finally, I called my friends at EPA research in North Carolina, and their first question was
1798 “What did you find?” It turns out they at they were not even allowed to go to New York City to
1799 help because it was “a regulatory matter.” Some of them went anyway. So, frustrated at every
1800 turn, we made our results public in a news conference in Davis. Our work was added to work
1801 other work done in September but only now made public. It showed the dust was as basic
1802 chemically as Drano, and hence very irritating and damaging to mucous membranes, information
1803 that had been given to the EPA in September but never released. We got enough ink to get
1804 invited to come to a House of Representatives hearing in New York City at the end of February,
1805 with the U.S. EPA Ombudsman in attendance. I was hesitant to go, but Sylvia Wright of the UC
1806 Davis News Service office said we must go. So Sylvia, my wife Ginny, and I headed off to New
1807 York.

1808 The hearing was bizarre. I was grilled for about an hour, under oath, by the Ombudsman’s
1809 lawyer, replete with leading and compound questions and trickery. They were trying to get at
1810 what EPA Administrator Christie Whitman knew about the dangers of the WTC smoke and
1811 when she knew it. The hearing also focused on asbestos, of which we saw very little. Ginny was
1812 beside herself because I did not have my lawyer to deflect unfair questions. A large audience
1813 there wanted EPA blood. I was very careful to avoid saying any more than I knew.

1814 I subsequently met with Dr. Stephen M. Levin, who was treating WTC workers, and a
1815 reporter for the *New York Daily News* who, unlike the *New York Times*, was covering the story
1816 well. Levin was director of the World Trade Center Worker and Volunteer Medical Screening
1817 Program. I then got a call from ABC News, which did an interview with me at the WTC site that
1818 ran on the national news. Even though six months had passed since the collapse of the towers, a
1819 bitter burned insulation-like smell permeated the air, and the pile was still hot. Sylvia took some
1820 photos at the interview that I have shamelessly used everywhere. Now people knew who we
1821 were, and that, unlike the EPA, we were worried about current and future health impacts. The
1822 “air is safe to breathe” comment was in Whitman’s September press release, which had declared
1823 air at the WTC site and vicinity as “...safe to breathe,” but it was not. We began getting some
1824 strong negative pushback in response to our work.

ITEM 11.1.

1825 As a result of my visibility I got into contact with Cate Jenkins. Cate, a senior EPA
1826 chemist, had become a whistleblower who accused the EPA of underestimating the toxicity of
1827 the fumes in the World Trade Center vicinity. She was under some sort of protection, and people
1828 sent her the most amazing information, which she then copied to us all. We added our results to
1829 her network, and received all sorts of documents. Some of these were reports that would
1830 suddenly appear on the EPA website, only to be removed the next day. Some sort of fix was in
1831 play!

1832 The next action was something new to me. A good friend at U.S. EPA phoned me and
1833 leaked that the EPA was funding a grant at a famous old New York university to challenge my
1834 data. He apologized to me, and I allayed his concerns.

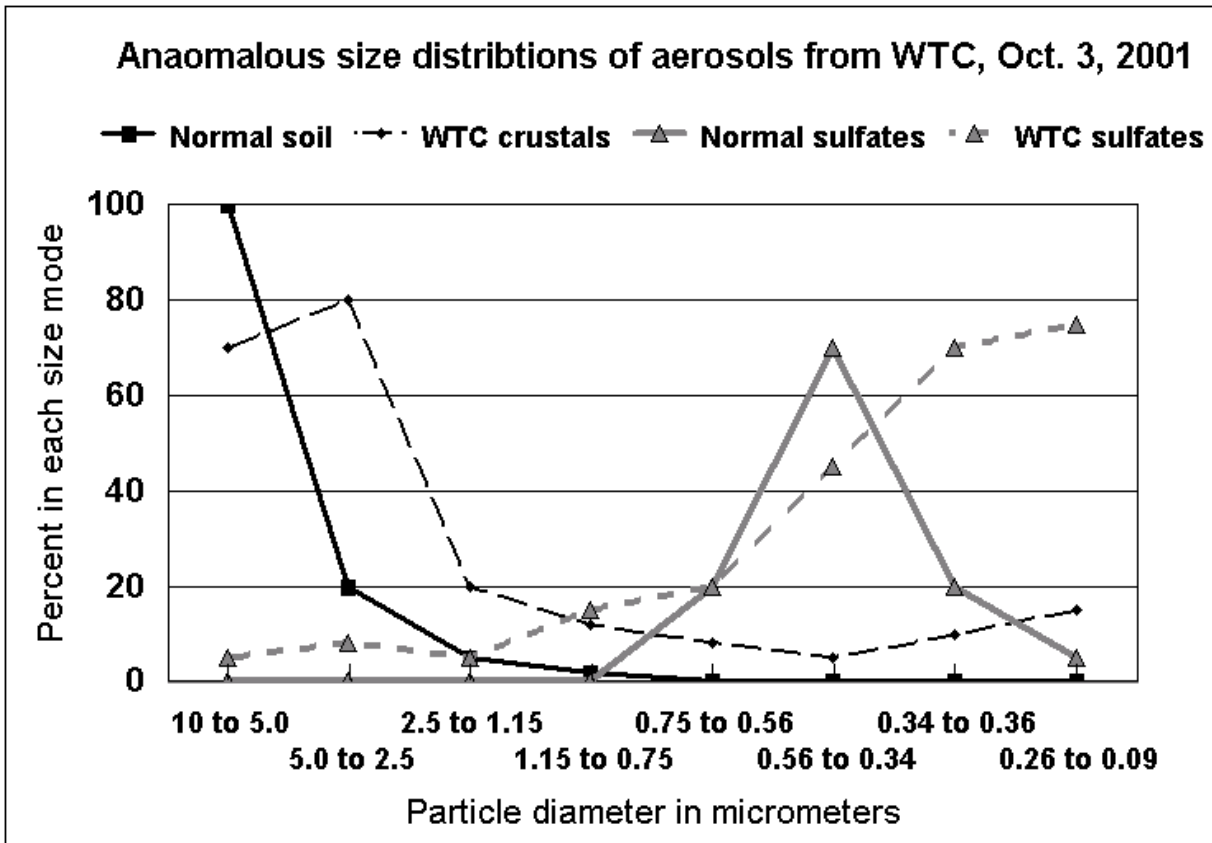
1835 In such situations my only resource was the peer-reviewed literature, which we prepared
1836 and submitted. I have never seen that other group's report (which was never released), but my
1837 data is published in the peer-reviewed literature. One reviewer was so set against our publishing
1838 the data (see Figure 8-5) that the editor had to remove him from the referee list, since everybody
1839 else was effusive in praise of our work. Not only was it important, with the help of the Livermore
1840 lab, but it also was in many ways the most complete aerosol event analysis ever done, with seven
1841 different analytical methods, some done for the first time (Cahill et al., 2004).

1842 I met with and challenged a senior NYU professor on in this testimony before Hillary
1843 Clinton. It turns out that he had made measurements, but at the surface and in the wrong
1844 direction from winds, so despite being closer than we were, he did not see the plume. He did not
1845 have the capability we had with the DRUM and its three-hour time resolution, vital for seeing
1846 plumes from the collapse pile.

1847

1848

ITEM 11.1.



1849

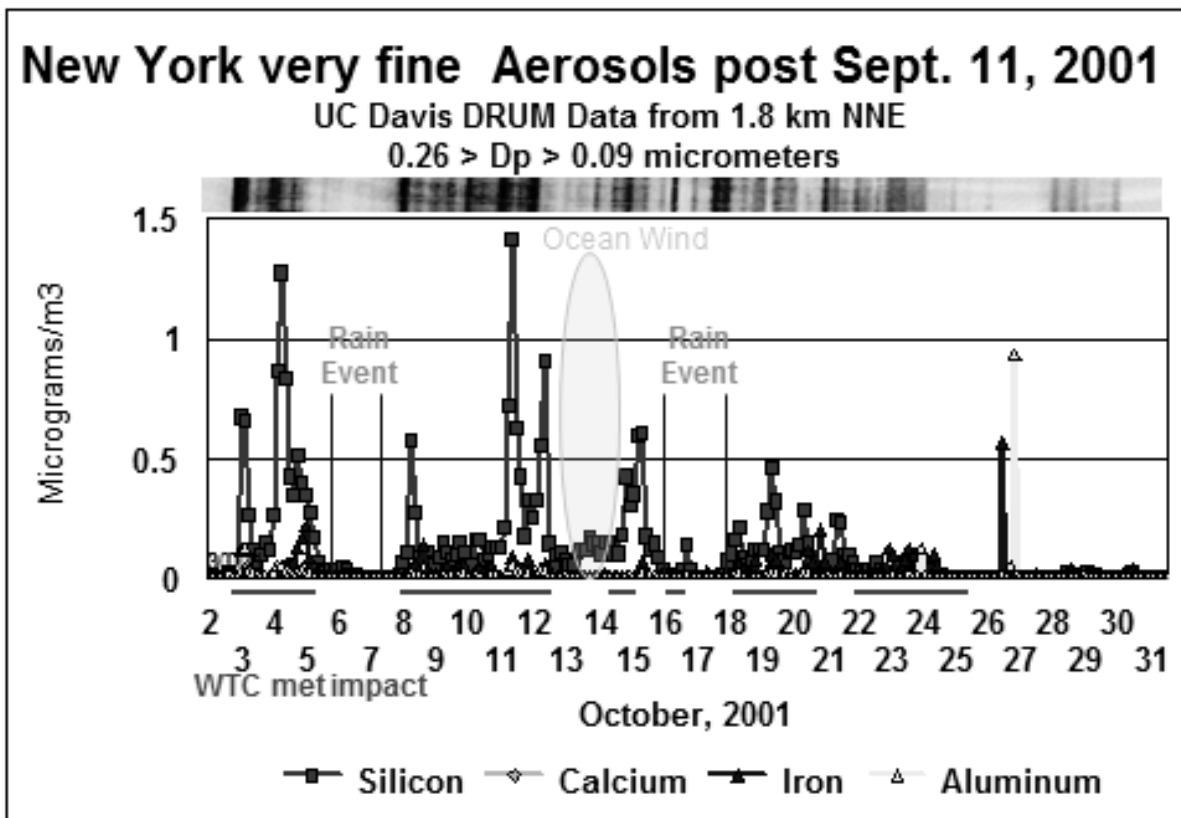
1850 Figure 8-5. Anomalous size distribution of World Trade Center aerosols. The unusual
 1851 aerosols from 2.5 μm to 0.75 μm were as caustic as Drano, burning throat and bronchial
 1852 membranes.

1853 Things began to unravel for the Bush Administration just before the September, 2003
 1854 meeting of the American Chemical Society in New York. The year before, at a national
 1855 American Association for Aerosol Research meeting in North Carolina, I was taken aside by two
 1856 investigators from the Office of EPA Inspector General Nikki Tinsley. She was about to issue an
 1857 extensive report showing how the press releases of Christie Whitman, including cautions on
 1858 health impacts, had been truncated by the White House before release. This was especially true
 1859 for an EPA release in September that "... air was safe to breathe and the water safe to drink." But
 1860 the next phrase was deleted by the White House. My paraphrase: "However, our measurements
 1861 raise concerns for working on the (collapse) pile and people coming back to work closer than
 1862 Water Street." This White House emasculation of Christie Whitman's statement was widely

ITEM 11.1.

1863 reported, and probably helps explain the White House sensitivity to what came next, with me as
 1864 the target, since my work was cited more than 10 times in her report.

1865 She had compared the press releases that EPA Administrator Christy Whitman wrote with
 1866 statements that the White House finally released, and found key phrases of concern had been
 1867 deleted and other false comfort inserted. Tinsley released her report in August 2003, just a month
 1868 before a major American Chemical Society (ACS) meeting in New York City that included a
 1869 major session on WTC results. The ACS decided to hold its own news conference, and selected
 1870 me and one other colleague to present our work, first on the dust cloud that spread immediately
 1871 upon the collapse of the buildings, then my work on the plume from burning debris that
 1872 continued to smolder throughout the days and weeks following the collapse. This announcement
 1873 generated extensive news coverage.



1874

1875 Figure 8-6. Assessment of very fine dust at the World Trade Center site.

1876 With Sylvia's help we prepared a news release:

ITEM 11.1.

1877 **Trade Center debris pile was a chemical factory, says new study**

1878 *The fuming World Trade Center debris pile was a chemical factory that exhaled toxins in*
 1879 *a particularly dangerous form that could penetrate deep into the lungs of rescue workers*
 1880 *and local residents, says a new study by UC Davis air-quality experts.*

1881 *The new work helps explain the unusual pollutants and extraordinarily high*
 1882 *concentrations found by an earlier UC Davis study, the first to identify very fine metallic*
 1883 *aerosols in unprecedented amounts from Ground Zero. It will be essential to*
 1884 *understanding the growing record of health problems.*

1885 *The conditions would have been “brutal” for people working at Ground Zero without*
 1886 *respirators and slightly less so for those working or living in adjacent buildings, said the*
 1887 *study’s lead author, Thomas Cahill, a UC Davis professor emeritus of physics and*
 1888 *atmospheric science and research professor in engineering.*

1889 *“Now that we have a model of how the debris pile worked, it gives us a much better idea*
 1890 *of what the people working on and near the pile were actually breathing,” Cahill said.*
 1891 *“Our first report was based on particles that we collected one mile away. This report*
 1892 *gives a reasonable estimate of what type of pollutants were actually present at Ground*
 1893 *Zero.*

1894 *“The debris pile acted like a chemical factory. It cooked together the components of the*
 1895 *buildings and their contents, including enormous numbers of computers, and gave off*
 1896 *gases of toxic metals, acids and organics for at least six weeks.”*

1897 Two days later, two of my secret sources independently informed me that a copy of my
 1898 press release from my ACS presentation had arrived on George Bush’s desk, with a yellow
 1899 sticky note saying, “Look what UC is doing to us.” Both of my sources agreed that “Bush had a
 1900 cow” and told the Secretary of Energy to respond appropriately.

1901 So the next Monday, after I had returned to Davis, I was called to a meeting with the vice
 1902 chancellor of research and the dean of engineering, the organization that administered most of
 1903 my grants. I was truly expecting praise, but instead got a scolding. The director of the Lawrence
 1904 Livermore National Laboratory (LLNL), which at that time operated under the management of
 1905 the University of California, had:

ITEM 11.1.

1906 a) terminated all of the grants of my research group (LLNL previously had given us \$16K
1907 for work at the World Trade Center);

1908 b) cut my access to my colleagues at Livermore (permanently lost);

1909 c) My New York colleagues who worked for DOE was suddenly retired, and

1910 d) the building we had used was barred from further studies.

1911 When I got back, Livermore asked UC Davis administrators to order me to pen an
1912 apology because I had not first sent my press release for review at Livermore and for
1913 using data that Livermore had not approved for release.

1914 I was stunned, but responded first by showing the vice chancellor the peer-reviewed and
1915 published article in the journal *Aerosol Science and Technology (AS&T)* giving Livermore credit
1916 for the data and grant, and second by pointing out that because the data was public, we and
1917 Livermore personnel could report and apply the data as we wished. I did at least write an
1918 explanation, but I was pissed and lost all respect for him. Two weeks later, I received through a
1919 roundabout route a note from the director of the Livermore lab indicating that “he really liked the
1920 work.”

1921 In addition,

1922 a) The EPA had contracted with a famous old New York university to refute my data,
1923 (note: their report was never released. My data is in the peer reviewed literature),

1924 Happily, none of the White House pressure reached the National Science Foundation,
1925 which was funding both the large Aerosol Characterization Experiment-Asia (ACE Asia)
1926 program and the new program to measure aerosols on the Greenland ice cap (see Chapter 20,
1927 Global climate change).

1928 My data drew criticism because it was so unlike anything anyone had ever seen before,
1929 especially anomalous levels of vanadium, silicon and other materials in very fine size modes that
1930 would lead deep into the lung. I gained some insight from my old buddy, Professor Ian Kennedy
1931 of the UC Davis Department of Engineering, an expert in ultra-fine metals. He told me that this
1932 was similar to situations seen in the late 1980s hospital incinerator probes in which metals that

ITEM 11.1.

1933 should not be seen at the temperature of combustion were present, and tied to chlorine in the
1934 waste.

1935 A search of scientific literature led me to exactly what I needed. I made a model, and every
1936 toxic element I expected to see, based on the chlorine, was there, in the right ratios, and every
1937 element my model said should not be there was absent. The article I wrote, one of my best,
1938 (Cahill et al, 2005), laid that question about the products of high-temperature combustion to rest.

1939 Lawyers representing first responders contacted me, and I agreed to help them establish a
1940 fund to cover the detrimental health effects I had predicted. As the health effects began to show
1941 up, we gained traction. It took a while, and cost me three days of time for discovery of all my
1942 files at UC Davis by the opposition lawyers, but we won a massive settlement in favor of the first
1943 responders.

1944 When *New York Daily News* investigative reporter Juan Gonzalez published his 2004 book
1945 “Fallout: The Environmental Consequences of the World Trade Center Collapse”, he cited me as
1946 one of three “environmental heroes,” along with Cate Jenkins – my EPA “leak” source protected
1947 by her whistleblower status. I was just lucky to have the ability to respond quickly and
1948 effectively following discovery of the air quality data. Any of my colleagues and all U.S. EPA
1949 scientists would have done the same given the opportunity. In fact, many EPA scientists snuck
1950 up to New York from North Carolina and also made measurements despite the ban.

1951 In response to a massive lobbying effort by the first responders and John Stewart, in
1952 December 2015, Congress indefinitely extended the fund for which we had fought. This is
1953 terribly important because the rate of heart attacks from ischemic heart disease will soon begin to
1954 rise among WTC first responders and demolition workers. While indefinite extension of the fund
1955 is great news, attaining that authorization should not have been so hard. After all, if the City of
1956 New York, the federal OSHA safety people, and the U.S. EPA had done their jobs and followed
1957 laws and regulations, these thousands of people would not be sick today.

1958 At the conclusion of the 10-day rescue phase to find and rescue trapped people, when
1959 survivors were no longer being found, the rescue workers should have been ordered to back
1960 away. At that point, the fire department should have deployed personnel wearing full-face
1961 canister respirators, and the operation should have shifted to concentration on extinguishing the
1962 fires before attempting cleanup. I cringed when I saw firemen with useless paper masks raking

ITEM 11.1.

1963 debris in search of firemen's badges. California firefighters returned from the WTC site suffering
1964 from pneumonia because the caustic fine dust had burned their sensitive nose and throat
1965 membranes.

1966 The story does not end here. As the health effects I had predicted started to appear, Eric
1967 Gillin, a reporter for *Esquire* magazine, became nervous. He had been standing close to the WTC
1968 south tower when it collapsed, and saved the backpack he had been carrying at the time. He had
1969 sealed the dust-covered backpack in a plastic bag, which he had been keeping in a closet for five
1970 years. He asked if I could I learn something from analyzing the particles on the bag. Recall that
1971 we had no aerosol data from the monster collapse clouds.

1972 So I agreed to help, and designed an instrument to gently vacuum dust off fabrics at about
1973 the same wind velocity at which they had been deposited. Gillin came out to Davis, camera crew
1974 in tow, and we did the work. The bag's contents included a book, some papers, a transit
1975 schedule, and the debris-caked shirt he had been wearing that day as he had been enveloped in
1976 the furiously virulent cloud of dark grit that cloaked lower Manhattan.

1977 When we called Gillin after completing our analysis of the results, he was really nervous,
1978 but then we told him most of the collapse dust that had coated him and his bag was harmless
1979 gypsum from the drywall used in the center walls of the WTC. His relief was palpable.

1980 Gillin's resultant article, titled "The Bag," was published in the April 2007 issue of
1981 *Esquire*. It begins on page 133, immediately following a photo of Hilary Swank's feet. I
1982 recommend you read the article yourself – it is an accurate representation and well written. Upon
1983 my request, *Esquire* published an accompanying sidebar article on the smolder fumes, showing
1984 how toxic they were. Good work on all sides.

1985 Amazingly, the story still does not end there. About a month after publication of the
1986 *Esquire* article, I received a furious and insulting phone call from someone asking who had paid
1987 me off to cover up the WTC conspiracy. Without realizing it, my data showed that there was no
1988 trace of thermite (or thermate) in the south tower collapse, driving a garlic-coated stake through
1989 the center of their ridiculous hypothesis. I still received nasty emails with similar accusations
1990 about twice a month. But I also get praise from my physics colleagues at meetings for sticking
1991 my neck out when the EPA-White house cover-up of the dangers the dust posed to workers was
1992 in full play.

ITEM 11.1.

1993 **References**

1994 The best summary:

1995 Gonzales, Juan, **Fallout**, The New Press, New York (2002)

1996 The best read:

1997 Gillin, Eric **The Bag**, Esquire magazine, April 2007

1998 And then for the masochists....

1999 Cahill, Thomas A., Steven S. Cliff, Kevin D. Perry, Michael Jimenez-Cruz, Graham Bench,

2000 Patrick Grant, Dawn Ueda, James F. Shackelford, Michael Dunlap, Michael Meier, Peter B.

2001 Kelly, Sarah Riddle, Jodye Selco, and Robert Leifer. 2004. **“Analysis of Aerosols From the**2002 **World Trade Center Collapse Site, New York, October 2 to October 30, 2001.”** *Aerosol*2003 *Science and Technology* 38: 165–183. doi: 10.1080/02786820490250836.

2004 • Cahill, T.A., S.S. Cliff, J.F. Shackelford, M.L. Meier, M.R. Dunlap, K.D. Perry, G.S. Bench,

2005 and R.Z. Leifer. 2005. **“Very Fine Aerosols from the World Trade Center Collapse Piles:**2006 **Anaerobic Incineration?”** *American Chemical Society Symposium Series*, 919: 152–163.

2007 doi:10.1021/bk-2006-0919.ch009.

2008 **Tales from the Field: Our essential volunteers**

2009 This is a good time to celebrate the volunteer experts that again and again have set me on

2010 the right path. I have learned to stop and listen to those people living within the problem. In the

2011 last chapter, we talked about Arden Middle School right downwind from the Watt Avenue stop

2012 lights. The Principal asked us to measure because of her concerns and being fully aware of how a

2013 bad result could harm her school’s reputation. . We did it as a favor to her, not expecting much.

2014 Well, she was right, I was wrong, and the Watt data at Arden Middle School helped unlock the

2015 mystery of the excess heart attacked deaths all over California. Later in Chapter 14, we will meet

2016 a rancher near Moneo Lake who was worried enough about the dust that he volunteered his ranch

2017 as a location for our (unauthorized) air sampler. I can think of cores of other examples, including

2018 right now a high school in China where students are collecting samples for us. Now we always

2019 go to the site, sit down with locals over coffee or a beer, and listen.

2020

ITEM 11.1.

2021

2022

Section C

2023

Mitigation – Yes, You Can Do Better

2024

2025

2026

2027

2028

2029

The threats outlined in the Chapters 7 and 8, diesel carcinogens and ultra-fine metals, impact the population as a whole most severely for people who live near heavily traveled roadways. In Chapter 9, we address how you can evaluate the degree to which you are at risk from local roadways, and Chapter 10 starts the discussion of how you can make your indoor are essentially free from these threats. Detailed instructions of how to build an inexpensive but highly effective indoor air filtration system are given step by step in Appendix B.

2030

2031

Chapter 9

2032

Outdoor Air Quality – My Way or the Highway

2033

2034

Living with heavily trafficked roadways

2035

Introduction

2036

2037

2038

2039

2040

2041

2042

2043

2044

2045

My students and I had done very detailed study of pollution from Los Angeles freeways, data that caused Ronald Reagan's Air Resources Board to try to shut me down. (Chapter 11) But with the election of Jerry Brown 1.0 as California's governor in 1976, pretty much everybody thought that our troubles were over. Abundant data showed that only with the catalytic converter on cars could Los Angeles lower its appalling ozone impacts, which also required the removal of lead from gasoline. I also helped remove the sulfur from gasoline. California was the only state that could set standards more stringent than those of the U.S. EPA because California had initiated pollution control measures 20 years before the federal Clean Air Act was written. The stunning success that these anti-pollution measures caused many of us to assume that our problems were over, and we left for other tasks.

ITEM 11.1.

But starting around 1995, studies of Los Angeles children came up with an unexpected result. Children growing up near freeways were losing lung function at the rate of about 5% /year in the ages from 10 years to 18 years. This left them with the lungs of an aged person. California and the US EPA returned to the question of freeways, clueless as to what was causing the problems. In the next 15 years, things only got worse. By 2010, the peer reviewed medical literature was awash with data on health impacts in people living within about 1,000 feet of a freeway.

There were standard models of impact based on excess cancer from diesel soot. First, there were studies showing that pollutants fell off quickly as one went downwind. Below I show both my data published in 1974 and more recent data from a research scientist in Los Angeles, showing that by the time you are 500 ft (150 meters) downwind, freeway influence is reduced to only about 10% of what it was at the freeway edge.

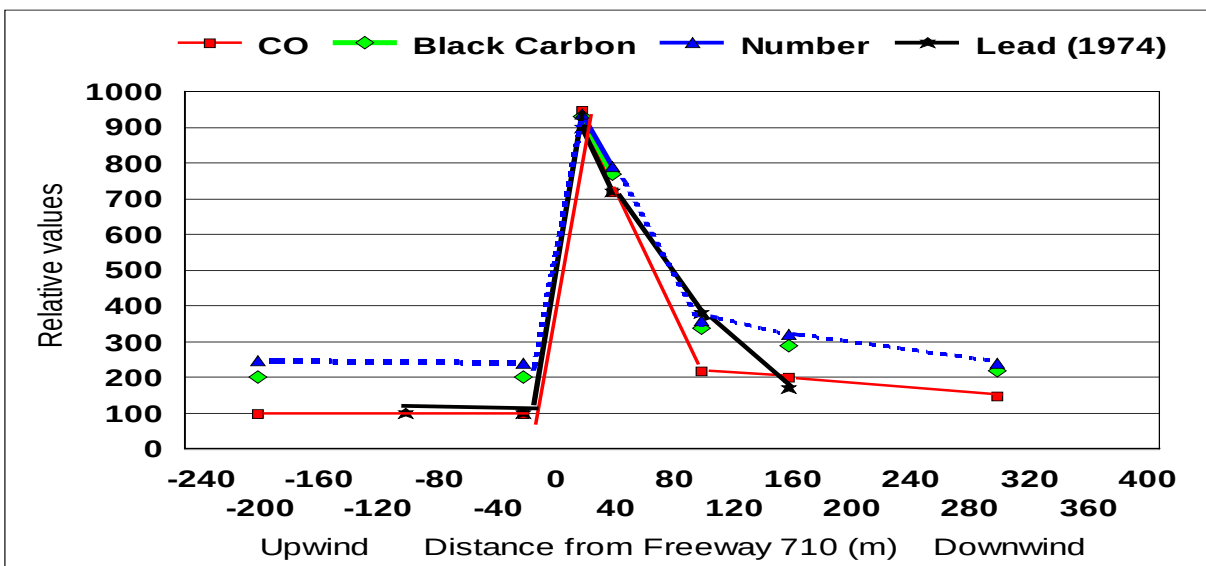


Figure 9 -1. Transects across an at-grade roadway (Zhu et al., 2002), with the data of Cahill et al., 1973 for lead (Cahill et al., 1973, Feeney et al., 1975, Zhu et al 2002 a,b).

The next parameter is how many vehicles are involved. Finally, this is then turned into a model of the health impacts versus distance in terms of excess cancer deaths/million, both downwind and upwind of the freeway, with the esoteric name Emfac2007

ITEM 11.1.

2065 The data below are in excess of deaths per 70-year lifespan, and the worst listed is 1,488
 2066 deaths per million. To put this in perspective, since roughly 20 percent of all deaths are from
 2067 cancer (~ 200,000 per million), this is a 0.7 percent increase in the cancer death rate.

PROJECTS NORTH AND SOUTH OF AN EAST-WEST ROADWAY								
Distances in feet	Receptor distance from edge of nearest travel lane (feet)							
	10	25	50	100	200	300	400	500
Distances in meters	3	8	15	30	61	91	121	152
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: north (downwind)								
4,000	210	186	153	114	75	57	45	39
8,000	420	372	309	228	150	114	90	75
12,000	630	558	462	339	222	168	135	114
16,000	837	741	615	453	297	225	180	153
20,000	1047	927	768	567	372	279	228	192
24,000	1257	1113	924	681	447	336	273	228
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: south (upwind)								
4,000	117	96	75	54	36	27	21	18
8,000	234	192	153	108	69	51	42	36
12,000	351	291	228	165	105	78	63	54
16,000	468	387	306	219	138	105	84	69
20,000	582	486	381	273	177	132	105	87
24,000	699	582	459	327	210	159	126	105

PROJECTS EAST AND WEST OF A NORTH-SOUTH ROADWAY								
Distances in feet	Receptor distance from edge of nearest travel lane (feet)							
	10	25	50	100	200	300	400	500
Distances in meters	3	8	15	30	61	91	121	152
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: east (downwind)								
4,000	249	213	168	117	75	57	45	36
8,000	495	423	336	237	150	111	90	72
12,000	744	636	504	354	225	168	132	111
16,000	990	849	672	474	303	222	177	147
20,000	1239	1062	840	591	378	279	222	183
24,000	1488	1272	1008	711	453	336	267	219
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: west (upwind)								
4,000	159	123	93	63	39	27	21	18

ITEM 11.1.

8,000	315	249	183	126	78	57	45	36
12,000	474	375	276	189	117	87	69	54
16,000	633	501	369	252	156	114	90	75
20,000	792	627	459	315	198	144	114	93
24,000	948	750	552	378	237	174	135	111

2068 Table 9 -1. Emfac2007. The shaded areas are roughly set at 400/millions, which is close to a 0.5
 2069 percent increase in the cancer death rate, or a 0.1 percent increase in the total death rate.

2070 For comparison, the worst death rate in California, roughly 2,500 per million, occurs
 2071 downwind of the BNSF San Bernardino rail yard/intermodal facility. That constitutes a 1.35
 2072 percent increase in the cancer death rate, but it affects only a few thousand people.

2073 However, recent data from epidemiological studies of illness and death, plus data from 10
 2074 massive EPA research programs, 2000 to 2010, one of which was at UC Davis, shows health
 2075 impacts far greater than the diesel soot model. From these studies, we were starting to gain some
 2076 insights into impacts and causes (in italics for each case):

- 2077 1. ~ **doubling of early heart attacks from ischemic heart disease** (*ultra-fine metals from brakes*),
- 2078 2. **permanent loss of lung function in children at ~ 5 %/year**, (*probably very fine metals*)
- 2079 3. **exacerbation of asthma**, (*a variety of vehicular sources*)
- 2080 4. **increased cancer rates from diesel exhaust**, (*benzo[a]pyrene and other PAHs*)
- 2081 5. **86% increased chances for having an autistic baby**, (*ultra-fine metals?*), and other impacts.

2082 There is another factor. As part of the lead studies we did in Los Angeles, we also
 2083 considered freeways that were not flat but either depressed (cut section) or elevated on a berm
 2084 (raised section). These data changed everything!

ITEM 11.1.

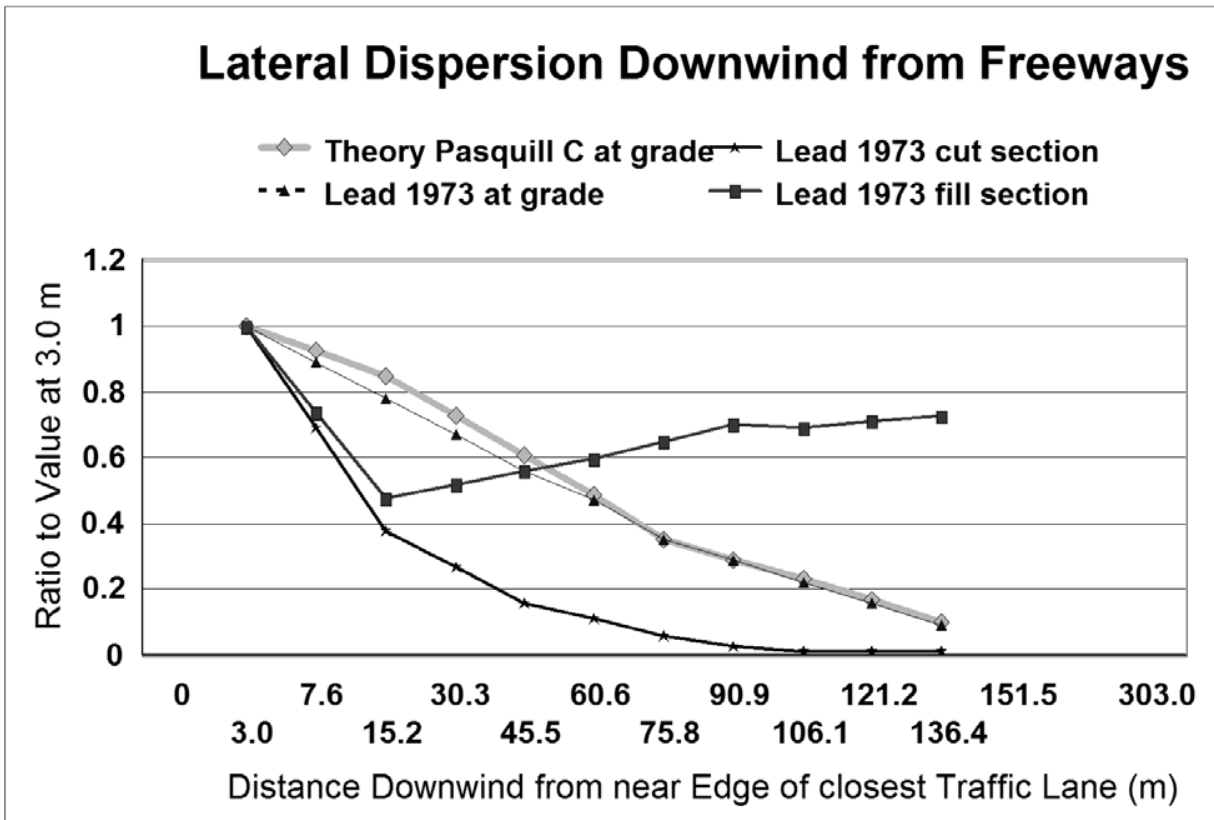


Figure 9 -2. Lead values as a function of freeway configuration, 1972.

Most important, our data showed that freeway were pitching pollutants (in this case, lead) far downwind and into residential neighborhoods. (This was the result got all my ARB research funds cut off.)

In Appendix A, we give a much more detailed way to evaluate your risk, but here we can summarize all of the data.

How can I protect myself?

- **Distance.** No mitigation is better than being far from the source(s).

But staying distant is difficult to do in suburban and urban situations, in which highways and heavily traveled roadways generate the major pollutant load.

First of all, we must rely on state and federal agencies to continue to clean up the exhaust from trucks. However, they have done essentially nothing about other pollutants from roadways. These other or “wear” aerosols from brakes, brake drums, roadbeds erosion, resuspended

ITEM 11.1.

2099 roadway dust, and other sources soon will be roughly equal to tailpipe emissions, according to a
2100 recent European study.

2101 So what can you do? Begin by analyzing the potential problem:

2102 1. From a map, locate all the heavily traveled roadways.

2103 2. From state records, find the traffic volumes for cars and trucks, usually in the form AADT
2104 (annual average daily travel).

2105 a. Is traffic on the road subject to heavy braking and acceleration? (If so, see Chapter 7,
2106 “Black, Black, Black Is the Color of My True Love’s ...” Exhaust.)

2107 b. Does the traffic move freely and a constant speed? Our recent data near Detroit show that
2108 freely moving freeways are only lightly polluting.

2109 3. From web sources on meteorology, including the NOAA National Weather Service and the
2110 very useful Weather Underground site (www.wunderground.com), identify wind direction
2111 from the roadway to your house.

2112 4. From these data, identify the most important potential upwind sources. Go to the sites and
2113 evaluate the roadway:

2114 a. Flat, elevated, or below grade?

2115 a. Vegetation screen or barren land at the edges of the road?

2116 5. Use Table 9-1 to establish the impact on your house.

2117 6. Evaluate the terrain between the roadway and your house. Specifically, is your house
2118 protected by a heavy tree canopy? If so, our measurements and those of the EPA show that
2119 the roadway impact will be cut roughly in half.

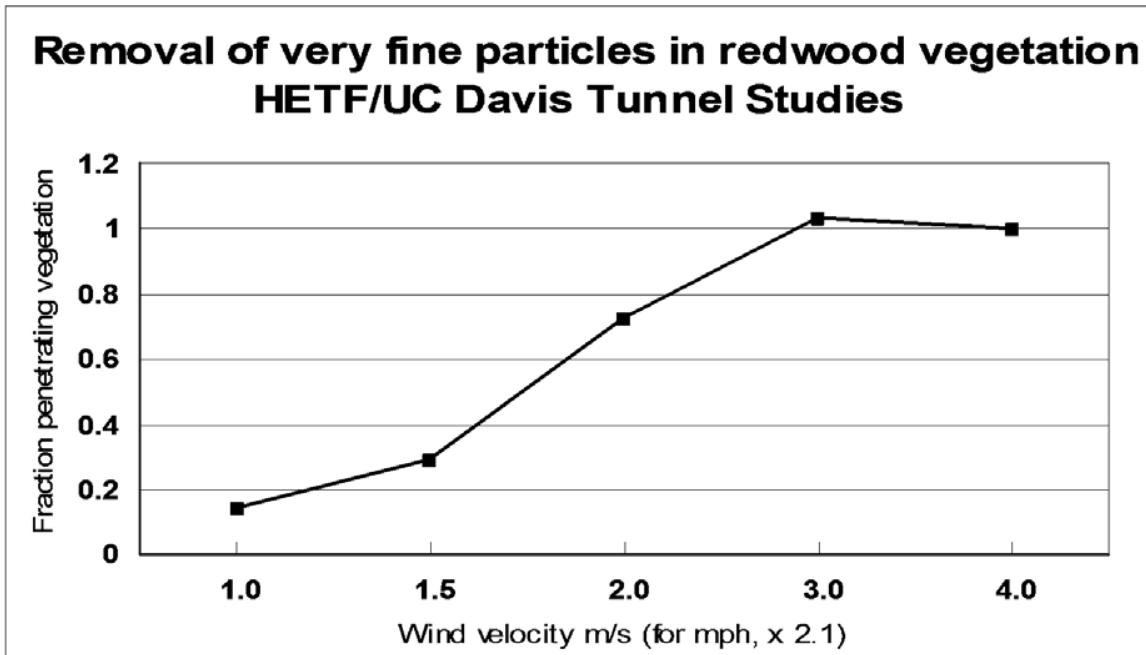
2120 7. Is the freeway below grade? That results in air quality that is twice as good, or even better,
2121 than it would have been otherwise.

2122 Mitigation by vegetation is under study, and good data show that it can be very helpful
2123 without being a panacea. If a highway has large and continuous vegetation barriers of both sides,
2124 often placed there for sound reduction and privacy protection, it can have major benefits as a
2125 function of wind velocity:

ITEM 11.1.

- 2126 1. For strong winds, a vegetation barrier results in increased vertical turbulence, diluting the
2127 freeway pollution with air from higher in the atmosphere.
- 2128 2. For medium wind velocities, the same effect occurs, but less strongly. An additional factor
2129 arises, however.
- 2130 • The waste heat of the cars and trucks tends to rise, pulling in clean air from the margins.
2131 This was the reason the below-grade freeway results for the 1973 Los Angeles study were
2132 so much better than those for an at-grade freeway.
- 2133 3. At very low wind velocity, in stagnation or inversion events, the pollution diffuses through
2134 the vegetation, which then tends to strip out the finest and most dangerous particles
2135 (specifically, diesel pollutants and ultra-fine metals).
- 2136 Figure 9-1 shows the effects of very fine (0.26 to 0.09 μm) particle removal through
2137 redwood branches as a function of wind velocity.
- 2138 Mitigation by vegetation also works at your home. Measurements that my colleagues and I
2139 made in Sacramento for very fine and ultra-fine metals, and that the EPA did in North Carolina,
2140 showed that a moderately continuous tree canopy cut pollutant impacts in half.
- 2141 Any tree helps, but the types we tested that worked best were not deciduous and had
2142 numerous fine needles. Redwood (Figure 9-1) and deodar both tested well, and our analysis
2143 shows that the California pepper is also excellent. Canary Island pines are good for pollution
2144 reduction also, but they should be grown a safe distance from dwellings because they tend to
2145 drop large limbs.

ITEM 11.1.



2146

2147 Figure 9-1. Removal of very fine aerosols through redwood branches. For ultra-fine
 2148 particles, the removal approaches 99 percent.

2149 **Nitty-gritty details**

PROJECTS NORTH AND SOUTH OF AN EAST-WEST ROADWAY								
Peak-hour traffic (vehicles/hr)	Receptor distance from edge of nearest travel lane (in feet)							
	10	25	50	100	200	300	400	500
Incremental cancer risk per million: north (downwind)								
4,000	210	186	153	114	75	57	45	39
8,000	420	372	309	228	150	114	90	75
12,000	630	558	462	339	222	168	135	114
16,000	837	741	615	453	297	225	180	153
20,000	1047	927	768	567	372	279	228	192
24,000	1257	1113	924	681	447	336	273	228
Incremental Cancer Risk Per Million: South (upwind)								
4,000	117	96	75	54	36	27	21	18
8,000	234	192	153	108	69	51	42	36
12,000	351	291	228	165	105	78	63	54
16,000	468	387	306	219	138	105	84	69
20,000	582	486	381	273	177	132	105	87

ITEM 11.1.

24,000	699	582	459	327	210	159	126	105
--------	-----	-----	-----	-----	-----	-----	-----	-----

2150 Table 9-1a. Projects north and south of an east-west roadway.

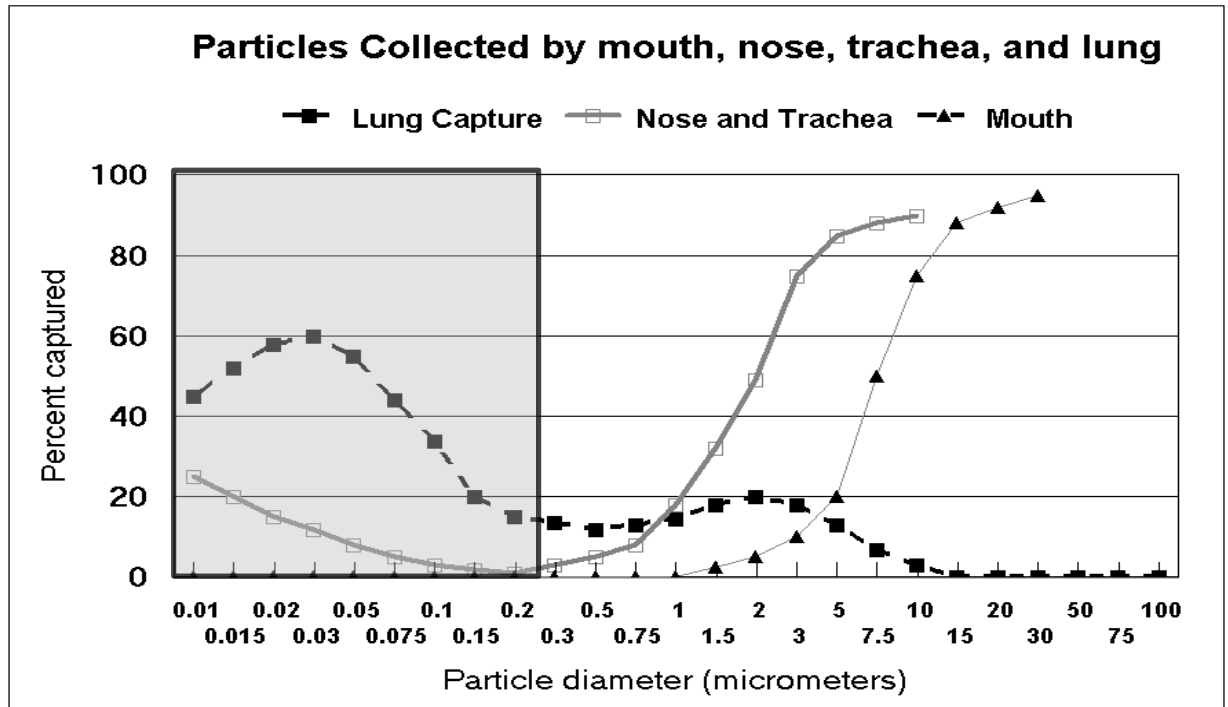
2151

PROJECTS EAST AND WEST OF A NORTH-SOUTH ROADWAY								
Peak-hour traffic (vehicles/hr)	Receptor distance from edge of nearest travel lane (in feet)							
	10	25	50	100	200	300	400	500
Incremental Cancer Risk Per Million: East (downwind)								
4,000	249	213	168	117	75	57	45	36
8,000	495	423	336	237	150	111	90	72
12,000	744	636	504	354	225	168	132	111
16,000	990	849	672	474	303	222	177	147
20,000	1239	1062	840	591	378	279	222	183
24,000	1488	1272	1008	711	453	336	267	219
Incremental cancer risk per million: west (upwind)								
4,000	159	123	93	63	39	27	21	18
8,000	315	249	183	126	78	57	45	36
12,000	474	375	276	189	117	87	69	54
16,000	633	501	369	252	156	114	90	75
20,000	792	627	459	315	198	144	114	93
24,000	948	750	552	378	237	174	135	111

New worst case scenario = 1,488/million

2152 Table 9-1b. Projects east and west of a north-south roadway.

ITEM 11.1.



2153

2154 Figure 9-2. The gray shaded area shows the size range and lung deposition for very
 2155 fine and ultra-fine metals, which are the most dangerous emissions from freeways with
 2156 persistent vehicle braking.

2157 Special cases:

- 2158 1. Are you near an upwind freeway that is significantly (circa 30 feet) below ground?
- 2159 • Then you benefit enormously from enhanced removal of particles (as Figure 9-3 shows).
- 2160 2. Are you near an upwind freeway that is significantly (circa 20 feet) raised above ground on a
 2161 solid berm?
- 2162 • In this case, the freeway impact extends much farther downwind than the models and
 2163 tables predict. This was shown as early as 1973 when measuring lead (as shown in Figure
 2164 9-3) and confirmed and extended in 2012 at I-5 in Sacramento as described in the
 2165 Appendix A , “Outdoor Air Mitigation: Threats from living near freeways and
 2166 roadways.”

ITEM 11.1.

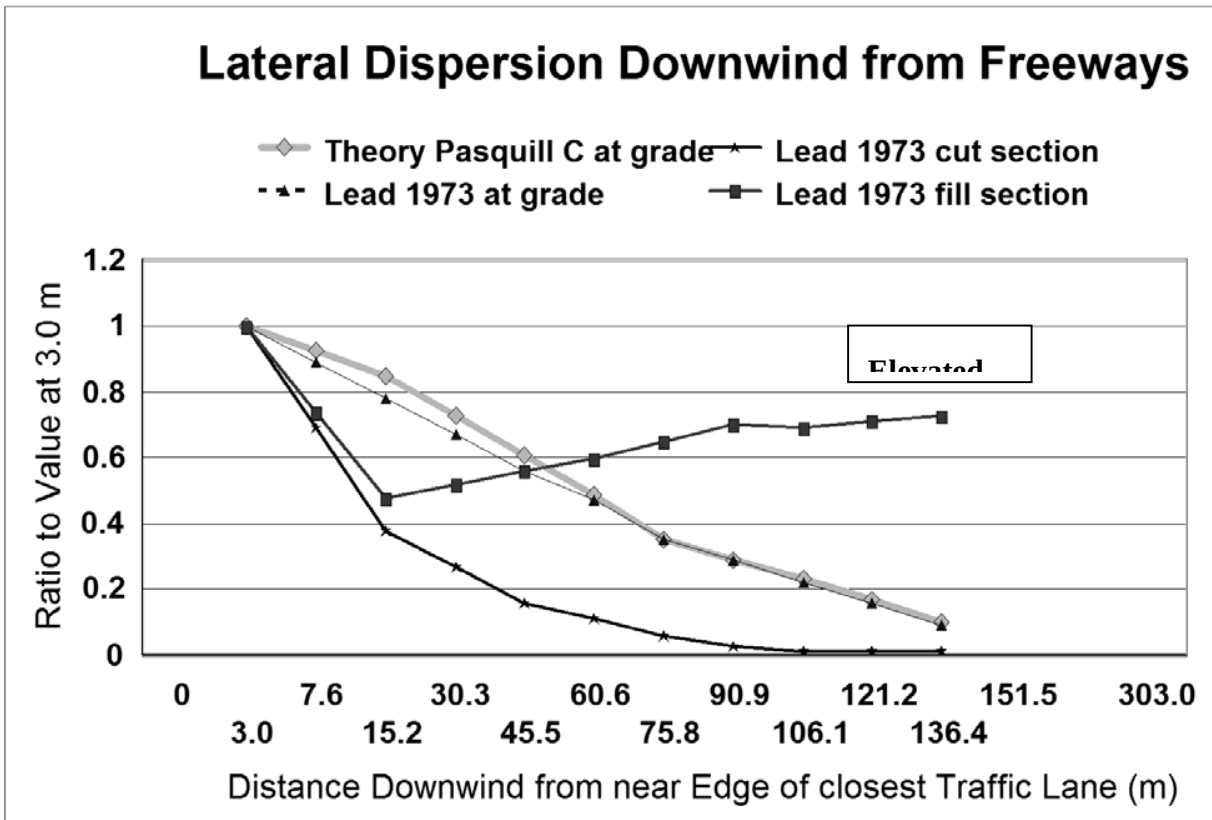


Figure 9 -3. Lead values as a function of freeway configuration, 1972.

Thus, you must be very aware of upwind freeways on berms, especially if a lot of braking occurs there.

LEARN MORE: See the Appendix A. for a detailed analysis of threats from living near freeways.

References

- Baldauf, Richard, Greg McPherson, Linda Wheaton, Max Zhabg, Tom Cahill, Chad Bailey, Christina Hemphill-Fuller, Earl Withycombe, and Kori Titus. 2013. **“Integrating Vegetation and Green Infrastructure Into Sustainable Transportation Planning.”** *Transportation Research Bulletin, National Academy of Sciences.*
- Cahill, T.A., and P.J. Feeney. June 15, 1973. **“Final report to the California Air Resources Board on Contract ARB-502, Contributions of Freeway Traffic to Airborne Particulate Matter.”**

ITEM 11.1.

- 2181 • Feeney, P.J., T.A. Cahill, R.G. Flocchini, R.A. Eldred, D.J. Shadoan, and T. Dunn. 1975.
2182 **“Effect of Roadbed Configuration on Traffic Derived Aerosols.”** *Journal of the Air*
2183 *Pollution Control Association* 25: 1145–1147.
- 2184 Fujii, Erin, Jonathan Lawton, Thomas A. Cahill, David E. Barnes, Chui Hayes (IASTE intern),
2185 Nick Spada, and Greg McPherson, and the active collaboration of The Health Effects Task
2186 Force (HETF) – Jan Sharpless, Chair. February 24, 2008. **“Removal Rates of Particulate**
2187 **Matter Onto Vegetation as a Function of Particle Size: Final Report to the Breathe**
2188 **California of Sacramento Emigrant Trails Health Effects Task Force (HETF) and**
2189 **Sacramento Metropolitan AQMD.”**
- 2190
- 2191

ITEM 11.1.

Chapter 10

Indoor Air Quality – as Clean as You Want it!***Indoor mitigation: potentially the most effective line of defense******Indoor sources of air pollution***

Indoor sources of air pollution can be far more important than external sources in many cases. In terms of health impacts, two stand out:

1. Cigarette and cigar smoke, and
2. Carbon monoxide from poor combustion of natural gas, charcoal grills, improper use of fireplaces, and other sources

Probably more common but with somewhat less serious health impacts:

3. Re-suspension of household dust, allergens, pet dander, and other sources
4. Dust from vacuuming carpets and additional dust-catchers

In terms of indoor air pollution, the first step must be a thorough and professional cleaning of ducts. Hot air systems have a long, long memory. I saw chalk dust in a school in Detroit every weekday years after teachers stopped using chalk.

In terms of mitigation, the same techniques recommended in this chapter for outdoor pollutants work on indoor pollution, with the additional component of good household cleaning techniques. I worked with the American Lung Association in New York evaluating ways to rid apartments of the dust of the WTC collapse. The key was throwing away all fabrics when possible, and scrubbing rugs with generous amounts of water. Doing so glued the very fine aerosols into larger forms that could be removed by workers using simple face masks.

Not all ultra-fine particles are hazardous. Candles, for instance, generate enormous numbers of ultra-fine particles that appear harmless, as opposed to traffic on roadways, which can belch out ultra-fine metals that can be lethal in the long term. This is an excellent reason why

ITEM 11.1.

2217 we cannot rely only on numerical counts of ultra-fine particles, which are cheap and easy to
2218 measure, but irrelevant to health impacts.

2219 Outdoor sources of air pollution

2220 All the techniques and strategies described in the previous chapters are relevant here,
2221 especially:

- 2222 1. maintaining distance from known sources
- 2223 2. cultivation of a canopy of vegetation
- 2224 3. using abundant lawns and shrubs as “particle sinks”

2225 After all that can be done is in place, the last and often most effective line of defense is
2226 indoor mitigation.

2227 This effort was started as a result of the work at Arden Middle School, especially the ultra-
2228 fine metals seen in Chapter 8 but also the diesel exhaust of Chapter 7. Our data indicated that
2229 both these pollutants were tiny in size, very fine and ultra-fine particles less than 0.25 micrometer
2230 (μm) in diameter. As we saw earlier, these go deep into the lung and some translocate into the
2231 blood stream, with dire results.

2232 So in an effort to help the students and staff of Arden Middle School, we proposed and
2233 they implemented better air filters in their recirculating heater in the teacher’s ready room, the
2234 room closet to Watt Avenue. First, we ran models to see how much very fine and ultra-fine mass
2235 we would expect at the school. From two separate peer reviewed papers, we obtained two
2236 estimates, $6.7 \mu\text{g}/\text{m}^3$ and $5.4 \mu\text{g}/\text{m}^3$. We measured on the roof of the ready room slightly more,
2237 $7.0 \mu\text{g}/\text{m}^3$. The ready rooms had been using this outdoor air, and we closed this window and
2238 added better filters to their recirculating heater. With this one modest change, we reduced the
2239 very fine and ultra-fine mass from $7.0 \mu\text{g}/\text{m}^3$ to $1.8 \mu\text{g}/\text{m}^3$. This was then extended to all rooms
2240 in the school.

2241 But we can do better now. These very fine and ultra-fine particles that are so dangerous
2242 also tend to diffuse to and stick to surfaces, if you provide a surface and give them enough time.
2243 Based on this insight, we stated detailed theoretical and experimental methods to utilize this fact

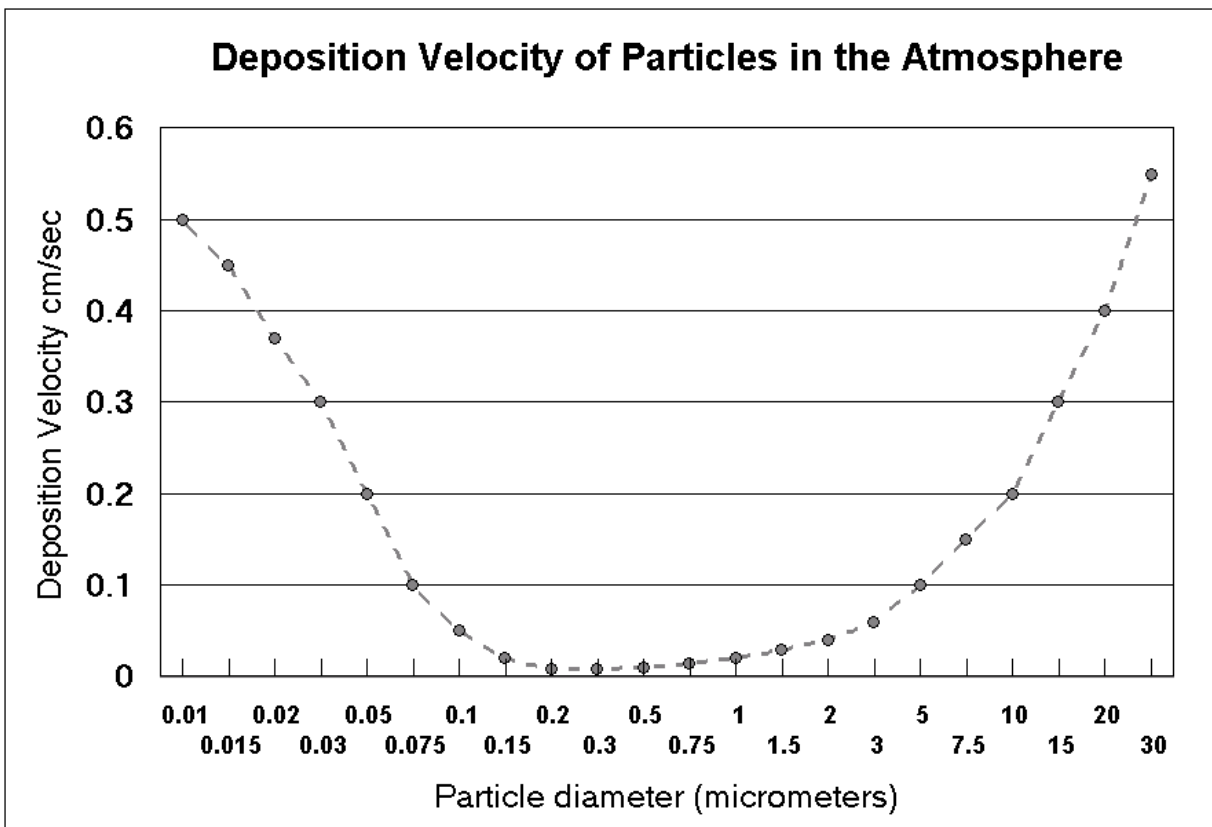
ITEM 11.1.

2244 to really, really clean indoor air. We present our insights in this Chapter and in Appendix, where
 2245 we actually build such systems.

2246 How can I protect myself?

2247 Answer: by mitigation of indoor pollutants

2248 Keeping windows and doors closed effectively screens out coarse mass materials from any
 2249 modern house or apartment. The problem comes from fine PM_{2.5} particles. These penetrate
 2250 easily into the average house or apartment, and their indoor levels typically are half to as much
 2251 as three-quarters of outdoor levels. Thus, the realistic course of action is removal from the air,
 2252 since we can do little about curtailing sources. Figure 10-1 illustrates removal from the
 2253 atmosphere. The horizontal scale of particle size goes up to 40 micrometers, about the diameter
 2254 of a fine human hair.



2255

2256 Figure 10-1. Removal of particles from the atmosphere as shown by the velocity with
 2257 which they settle or diffuse to surfaces.

ITEM 11.1.

Now take a look at “bimodal distribution,” shown in Figure 10-2. On the right side of the plot are coarse and very coarse particles – easily made from dust, sea salt spray, and agricultural operations, among other sources. Coarse particles are produced abundantly in dust storms, but then settle to the ground rapidly, the so called “mechanical mode.” Indoors with still air, these particles settle to surfaces as dust, but can be re-suspended by any disturbance, such as vacuuming without adequate air filters on the vacuum cleaner.

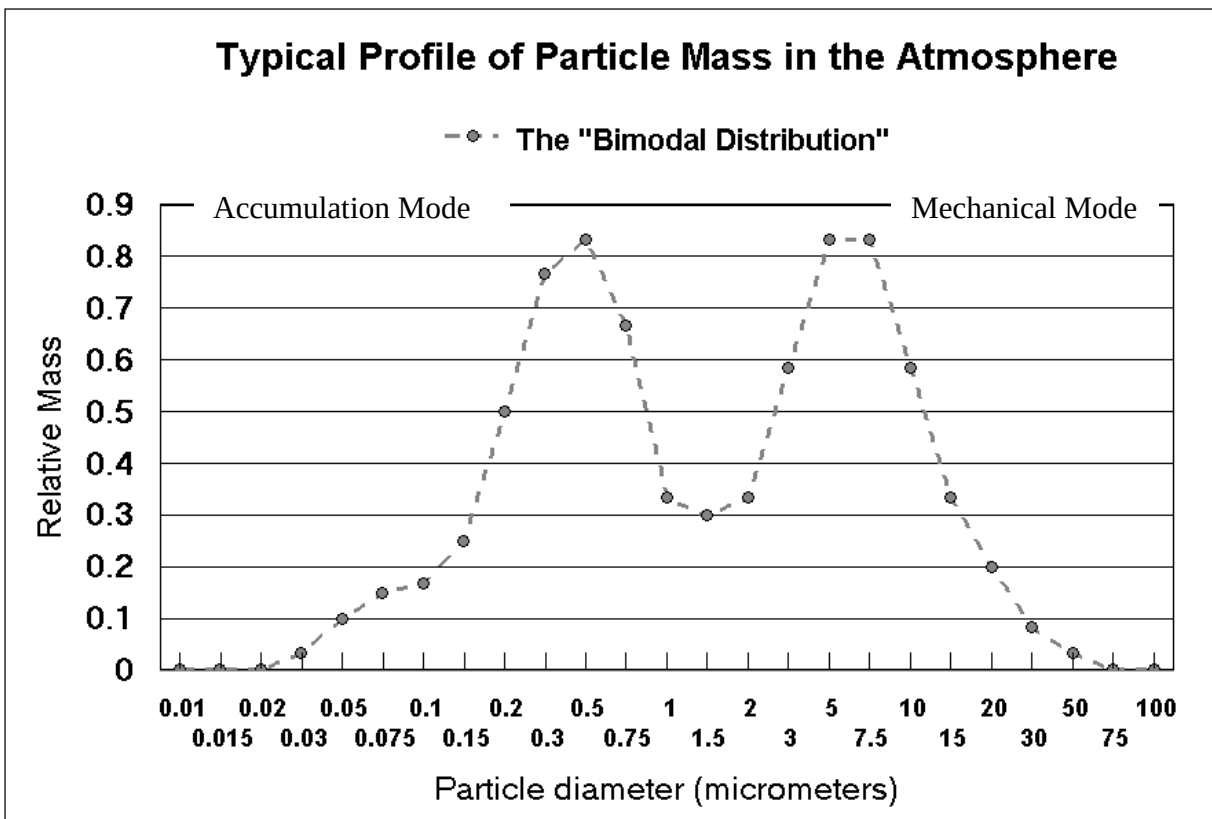


Figure 10-2. The “bimodal distribution” of mass in the atmosphere, with the mechanical mode and accumulation mode represented. A small “combustion mode” shoulder, dominated by diesel exhaust, also occurs around 0.1 μm .

The left side of the graphic presents particles that grow from gases, nitrates, and sulfates, plus particles made in the fine mode by high-temperature sources, such as diesel exhaust and some industrial processes. The first type grows by picking up gases, including water, and eventually swelling to the left-hand bump – the “accumulation mode,” in which they are too

ITEM 11.1.

small to settle by gravity but too big to grow further. These particles tend to grow in size from gases to very fine particles, in many cases picking up water (SO_2 gas $\rightarrow$ sulfates, NO_2 gas $\rightarrow$ nitrates, HC gases $\rightarrow$ low mass organics). Some particles, such as those composing wood smoke (which picks up water during combustion and ends up around $0.4\ \mu\text{m}$), naturally occur in the “accumulation mode” maximum. That is why forest fire smoke as seen from a distance is usually white – condensed water.

This “bi-modal Distribution” was discovered in Southern California smog studies in the early 1970s, and is universal around the world. These particles are relatively difficult to filter out. Normal furnace filters are almost useless. Light scatters from the accumulation mode, and that haze you see is a mixture of scattering from aerosols and absorption from soot.

Particles between $0.1\ \mu\text{m}$ and $1.0\ \mu\text{m}$ exhibit a very slow rate of removal from the air, which allows them to accumulate in this region, even if sources are fairly weak. An exception is wood smoke (as shown in Chapter 11). Particles greater than $1.0\ \mu\text{m}$ are made readily by mechanical processes, wind-blown soil, and sea salt – and are rapidly removed by settling.

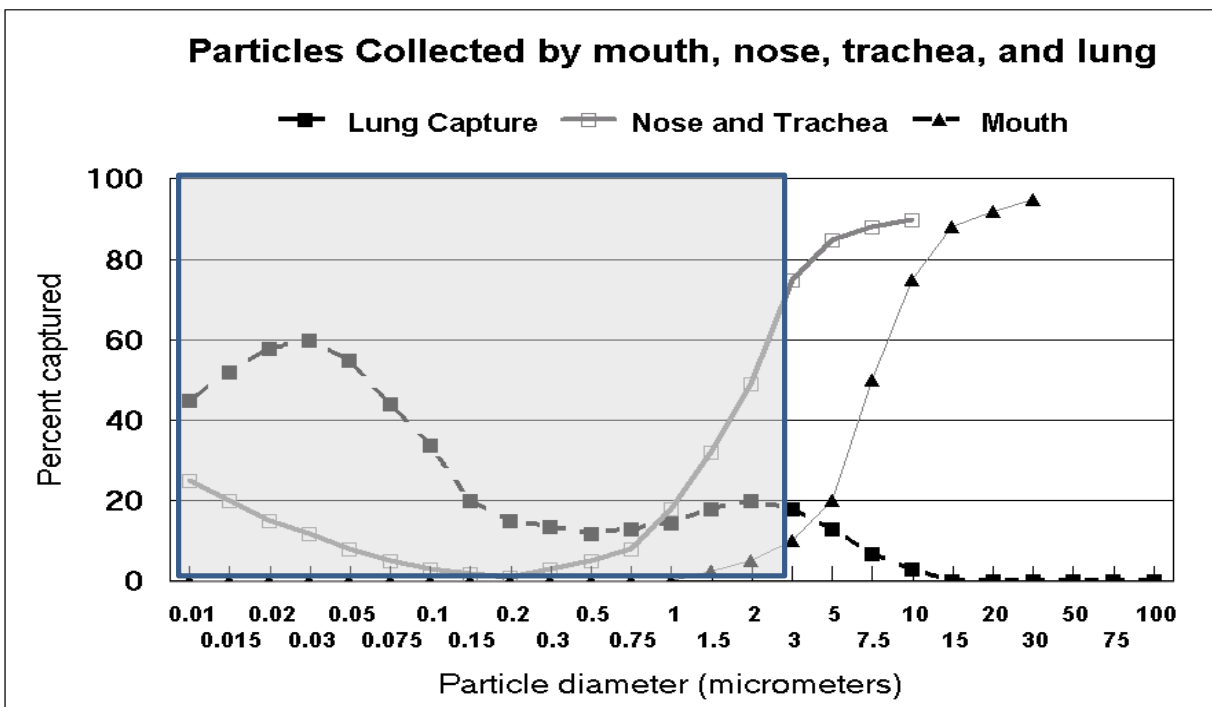


Figure 10 -3. Aerosol capture by the human body versus the EPA $\text{PM}_{2.5}$ mass standard.

ITEM 11.1.

2289 The finest modes are captured by the lung, and removal is mostly through the bloodstream
2290 – a much more dangerous route, perhaps 10 times worse than swallowing particles.

2291 **Particle removal strategies**

2292 The old high volume air sample (Hi-Vol) was essentially a vacuum cleaner with a filter,
2293 and collected basically everything in the air. The term used for the mass collected was Total
2294 Suspended Particulates (TSP). In 1987, this was superseded by more modern samples that threw
2295 away the coarsest particles since they were too big to be inhaled. It limited particles to only
2296 those less than 10 µm in diameter, PM₁₀, and called inhalable mass, to better match human
2297 collection. New research, and consideration of Figure 10-3, resulted in the current standard of
2298 PM_{2.5}, particles < 2.5 micrometers in diameter, set at 35 µg/m³ for 24 hr, 15 µg/m³- annual
2299 average.

2300 It is clear that PM_{2.5} includes a lot of mass that, in most cases, is relatively harmless.
2301 With this in mind, we must efficiently remove the very finest particles from the air to foster
2302 human health. Regretfully, that is not easy. Next, we examine the methods.

2303 One of the key factors to discuss is ACH – air changes per hour – in a house or
2304 apartment. An apartment cannot be hermetically sealed, or people inside would run out of
2305 oxygen. If the house or apartment is leaky, say 2 ACH, then new pollution is being constantly
2306 introduced indoors, and removal must be vigorous. An apartment or house that is tight, with a
2307 value such as ½ ACH, has a better chance of sustaining clean air after particle removal.

2308 Various means touted to purify indoor air include:

2309 **1. Removal by electrostatic devices**

2310 Avoid at all cost! They don't work well, and they produce ozone. (One such device was
2311 the Sharper Image's late and un-lamented unit.)

2312 **2. HEPA filters (high-efficiency particulate absorption)**

2313 Air filters meeting the HEPA standard must remove 99.97 percent of particles that have a
2314 size greater than 0.3 µm (micrometers). They are excellent for small volumes of air (a
2315 single room) in a low ACH apartment.

ITEM 11.1.

2316 The problem with HEPA units is the 99.97 percent requirement. This is really overkill –
 2317 95 percent would be more than adequate for most purposes. Because HEPA units remove
 2318 particulate materials so efficiently, they require a lot of energy to push air through the
 2319 filter, measured by a high “pressure drop”. A commercial unit might clean the air twice
 2320 per hour in a 700-square-foot room at the highest setting, which could consume about 50
 2321 watts. Some HEPA filters coat the fibers to trap biological aerosols better. Consequently,
 2322 room volume capacities are limited for typical single-room units.

2323 3. High-volume filters

2324 These are used as furnace filters, and while they can filter an enormous volume of air,
 2325 they are hopelessly inefficient for any but the coarsest particles. Improvements are being
 2326 made (the 3M Filtrete Series, for example) but because they have to have low pressure
 2327 drops, their ability to handle the finest particles is poor.

2328 Thus, the problem we face is how to remove the finest particles from the atmosphere –
 2329 those that have the highest toxicity and pose the greatest risk for lung capture – and still handle
 2330 large volumes of air for a full apartment or house.

2331 Fortunately, a solution exists.

2332 4. High-volume low pressure drop HEPA-like filters

2333 The solution is implicit in Figure 10-1. The ultra-fine and very fine particles are so small
 2334 that they can easily diffuse to surfaces, if a surface is provided. That is why the removal
 2335 rate increases as the particles get smaller, in the ultra-fine range. That effect is shown for
 2336 vegetation in Figure 10-4, and the same effect was seen for air filters. This is the
 2337 foundation for the contaminant removal techniques that my research colleagues and I
 2338 have developed.

2339 Our approach is to pass the full volume of air in a central house or apartment air system
 2340 through filters at such a slow velocity that the particles can strike the filters. Because they are
 2341 mostly sticky, there they stay.

2342 We built and tested a similar capability near the BNSF rail yard in San Bernardino, an
 2343 area with very high predicted cancer rates associated with the diesel exhaust from trains and

ITEM 11.1.

2344 trucks. We were able to decontaminate the air in old houses adjacent to the rail yard by injecting
2345 super-clean air inside in our “green air box” tests. It worked very well when it was in use.
2346 Because we conducted the test in winter, and the incoming air was unheated, our research study
2347 participants, local residents in their homes, tended to turn the system off when the weather was
2348 cool.

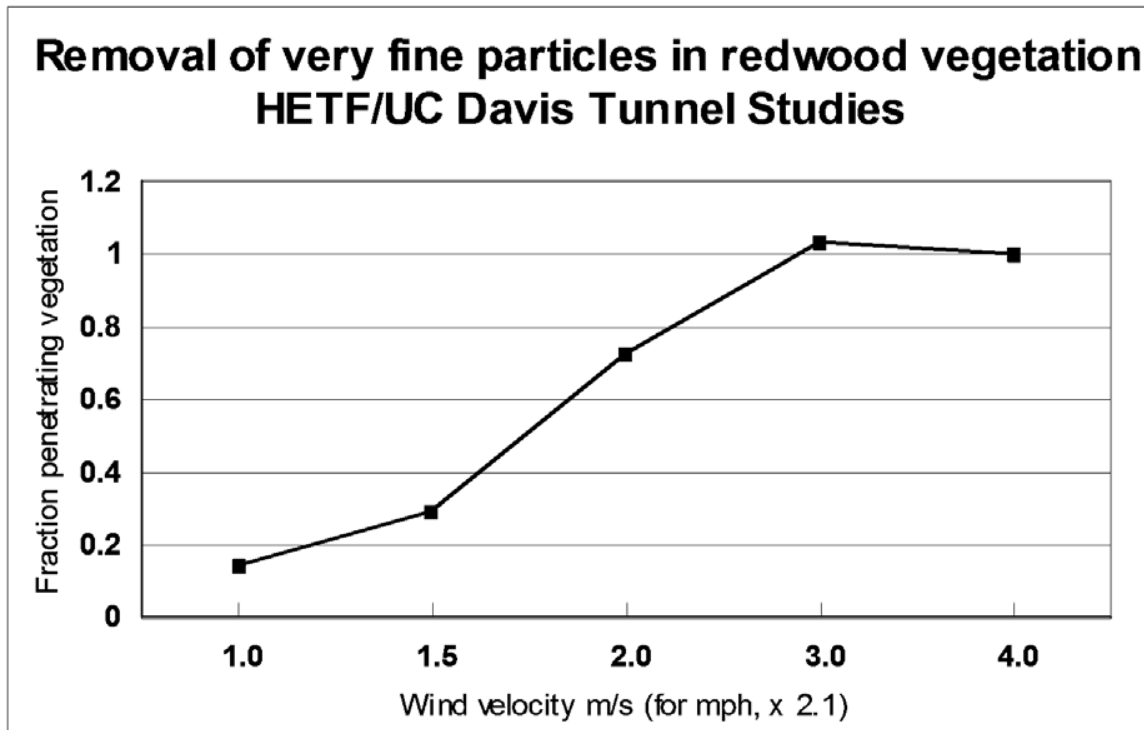
2349 How to make your own air filtration system:

2350 The details of several configurations, parts list, and plans are in Appendix B, but here we
2351 shown just one option.

2352 First, let’s be clear on what we are trying to do. The previous sections abundantly
2353 demonstrated that the greatest threat to health comes from very fine ($0.25 > D_p > 0.1 \mu\text{m}$) and
2354 especially ultra-fine ($D_p < 0.1 \mu\text{m}$) insoluble toxic particles that reach the lung and penetrate into
2355 the bloodstream. The most dangerous are diesel exhaust (associated with heavy PAHs and
2356 cancer); very fine reduced transition metals, especially iron and copper (capable of causing free
2357 radicals in lung fluid and loss of lung capacity, especially in children); and very fine to ultra-fine
2358 insoluble particles that pass into the bloodstream (associated with arteriosclerosis and ischemic
2359 heart disease). Recent work has shown that these particles are largely hydrophobic and don’t
2360 easily pick up water, so they stay small in the atmosphere.

2361 Figure 10-1 verifies that diffusion to a surface is essentially the only way to remove such
2362 particles. Our tests in wind tunnels (Figure 10-3) allowed us to quantify this effect, including
2363 tests on standard high-quality (3M Filtrete) furnace filters.

ITEM 11.1.



2364

2365 Figure 10-4. Removal of very fine aerosols through redwood branches. For ultra-fine particles,
 2366 the removal approaches 99 percent, caused by didduisng aprtlces to the branch surfaces. .

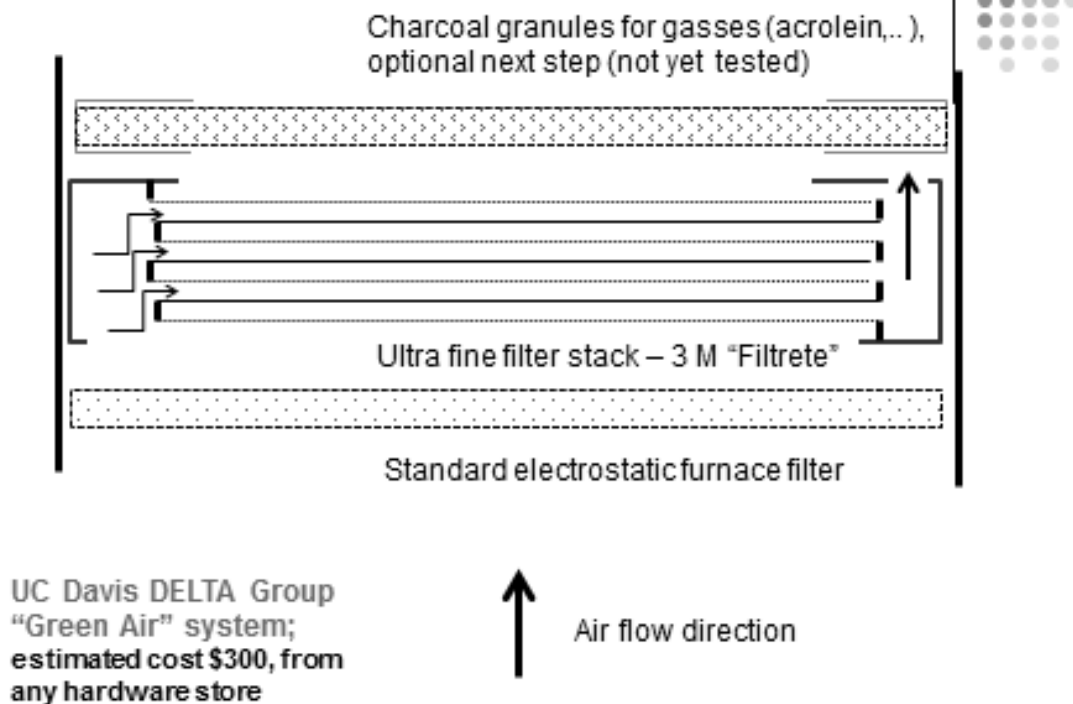
2367 The velocity of the air at thr front of the filter, called “face velocity”, must be slowed
 2368 through filters to 20 to 25 percent of normal in order to give the particles time to stick. Any of
 2369 several designs can accomplish that task.

2370 **Design 1: A “drop-in” addition to a standard furnace filter**

2371 If sufficient space is available above the existing furnace filter, we can design a pack that
 2372 slows the air by a factor of 4 (an 80 percent reduction in speed). We use a stack of four standard
 2373 3M Filtrete electrostatic filters (combined cost about \$120) run in parallel in a flat pack that sits
 2374 on top of the usual furnace filter.

ITEM 11.1.

And for the retrofits....4 filters in parallel



2375

2376 Figure 10-5. One design of the high-volume, high-efficiency air filtration system that the
 2377 UC Davis DELTA Group developed. This unit is designed to drop on top of a standard
 2378 furnace filter.

2379 The key to the effectiveness of the drop-in unit is a series of carefully designed baffles that
 2380 force the air to go through the filters **in parallel**, thus slowing the air speed. Some additional
 2381 pressure drop (about 30 percent) occurs, so the whole-house air turnover is slightly slowed. The
 2382 ultra-fine removal stack should last for years because so little mass exists in this size mode.

2383 A configuration like this has been tested, and achieved greater than 90 percent removal for
 2384 very fine particles (0.26 to 0.09 μm) and a predicted greater than 95 percent efficiency for all
 2385 ultra-fines. This was the design used in the "green air box" tests at the San Bernardino rail yard.
 2386

ITEM 11.1.

2387

Section D

2388

Potentially Devastating, But Limited in Space or Time

2389

ITEM 11.1.

Chapter 11

“Get the Lead Out!”***Automotive lead, about the worst idea ever***

Major impacts: Developmental disabilities including mental retardation in children, nerve damage, anemia, stillbirths, scores more

Introduction

Twenty-five feet below me the westbound lanes of the Santa Monica Freeway in Los Angeles, which in 1973 was the most heavily traveled road in the world, had come to a complete stop. As far as I could see, it had turned into a mammoth parking lot, right in the height of rush hour. And it was all my fault. Thank God there were no cell phones in those days or I would have been “outed” immediately, with consequences I shudder to consider. And it was all because of lead.

I had been asked and funded by the California Air Resources Board to study lead emissions and patterns of dispersion away from freeways. And the first freeway we chose was the Santa Monica (Interstate 10). We had placed an air sampler on the middle of a pedestrian bridge across the freeway, but to access it, I had to climb up onto the top of a wire cage that was built to prevent pedestrians from falling or jumping onto the road. Thus, for the 5 p.m. air sampler change, I was silhouetted against the setting sun, and people thought I was going to jump. The traffic jam that I unwittingly caused took hours to clear (later we found a way to change the filters without the acrobatics). So why were we studying lead?

A growing body of evidence indicated that lead is very toxic in several ways, associated with damage to bones and blood, and even with mental retardation. We chose Los Angeles because so many cars were driven there, and they all emitted lead. The question was – did lead emitted from automotive exhaust on freeways travel far enough into surrounding areas to harm people?

ITEM 11.1.

2415 We did a very complete study of freeway emissions, and our measurements showed vast
2416 violations of the lead standard, with concentrations of up to four times the allowable state
2417 standard at homes downwind of the San Diego Freeway (Interstate 405), which intersects I-10.
2418 However, as our Final Report was being written in early 1974, Ronald Reagan canned the entire
2419 Air Resources Board for their position on nitrate pollution from cars, and brought in a new group
2420 designed to keep things quiet in his last year as governor. This new group greeted the arrival of
2421 our Final Report like a smoking turd. The ARB quietly dumped it on a shelf.

2422 (See “Shut down Tom – attempt No. 1” below.)

2423 So I did what any aggrieved environmentalist would do: I joined Jerry Brown’s campaign
2424 for governor! With his campaign manager and later head of the ARB, Tom Quinn, we added all
2425 the good stuff to his campaign. Thus, his victory led to mandating the catalytic converter,
2426 removing lead from gasoline, enacting controls on sulfur in fuel (I helped write that part) and
2427 other steps that put California ahead of the rest of the nation and world. And these steps worked,
2428 with a massive reduction of both ozone and lead in the next decade.

2429 But the story does not stop there. As I was starting to make measurements of atmospheric
2430 aerosols all over California, using the techniques I had pioneered for the freeway lead work, our
2431 monitors consistently showed lead concentration numbers in downtown Los Angeles that were
2432 almost three times as high as those that the Los Angeles County Air Pollution Control District
2433 (LAAPCD) was reporting. I naturally assumed I was wrong and desperately tried to find the
2434 source of my error. Well, it turns out that I was right. The LAAPCD had been measuring lead by
2435 ashing paper filters at relatively low temperature, and then doing elemental analysis on the ash.
2436 About that time, the APCD went to a more modern method of using acids, wet ashing, to remove
2437 the lead, and their results increased by a factor (my recollection) of 2.87. So a memo went out
2438 from APCD management for APCD analysts to divide all lead levels by that factor to “maintain
2439 historical continuity.” The surrounding districts consequently were all registering lead levels
2440 higher than those in downtown L.A., which likely influenced the California ARB’s consolidation
2441 of the historic LAAPCD into the new South Coast Air Quality Management District, including
2442 all of Orange County and urban portions of Los Angeles, Riverside and San Bernardino counties.

2443 Why were the LAAPCD lead levels wrong when they ashed the filters? I didn’t learn why
2444 until the Word Trade Center studies, during which I showed that if any chlorine was present on

ITEM 11.1.

2445 the filters, lead would form gaseous PbCl_4 (lead tetrachloride) at very low temperatures. This
2446 compound would then evaporate from the filters, deceptively lowering discernable lead levels.
2447 The marine air that keeps L.A. so cool in summer is loaded with sea salt – sodium chloride.

2448 These episodes convinced me that by using solid physics and good experimental
2449 techniques, we could successfully confront a “conventional wisdom” that was not very wise.
2450 That continues to be my mantra, and one important reason for writing this book.

2451 When I lived in Los Angeles, the entire city was subject to lead levels close to 10 times the
2452 presently allowed upper limit, and many areas downwind of freeways were being smothered with
2453 air saturated with lead up to 70 times the amount permissible under current regulations. Spewing
2454 out bone-seeking, mind-eroding toxic ultra-fine particles throughout every major metropolitan
2455 area in the world – just to attain somewhat better gas mileage and a few more gallons of gasoline
2456 from crude oil – was a really bad idea.

2457 This was the reason I opposed electric cars with lead batteries. That would have required a
2458 vast increase in the mining, smelting, manufacturing and disposing of lead, a threat we should
2459 not take. Waiting for development of better, nontoxic batteries is a far better idea. Now we have
2460 much more efficient and lighter nontoxic batteries, in hybrid, extended-range vehicles (such as
2461 my Chevrolet Volt), and all-electric cars.

ITEM 11.1.

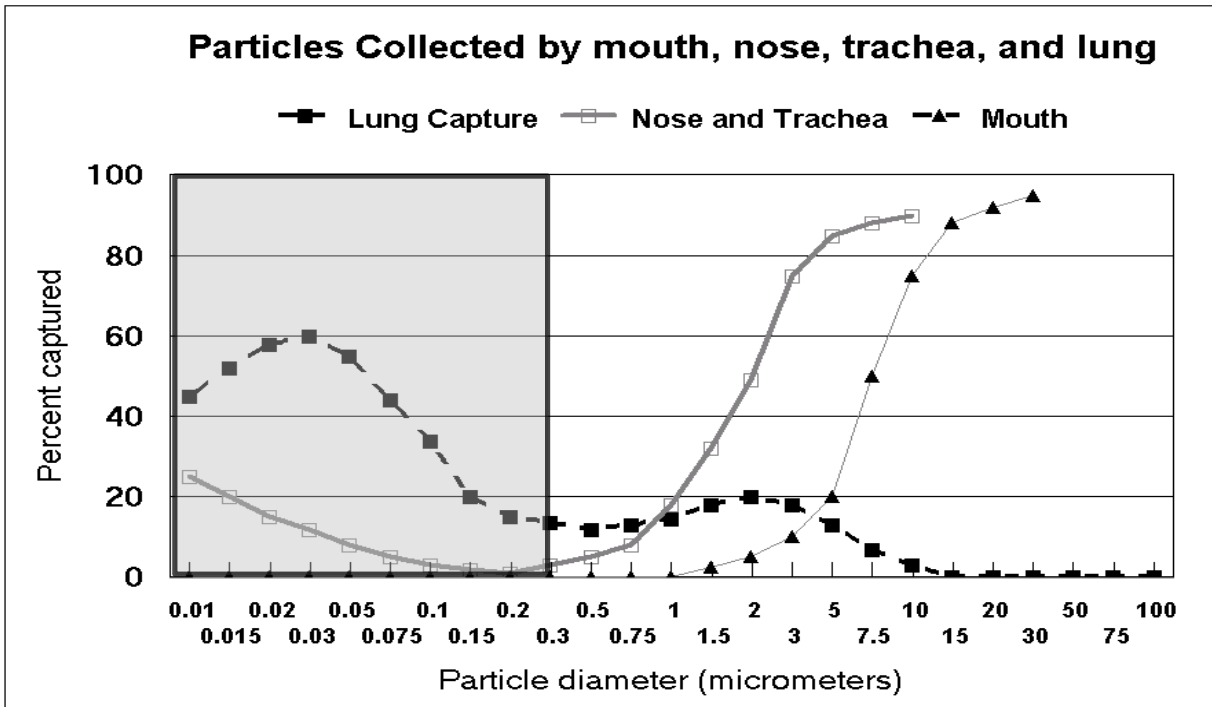


Figure 11-1. The gray shaded area shows the size range and lung deposition for very fine and ultra-fine lead.

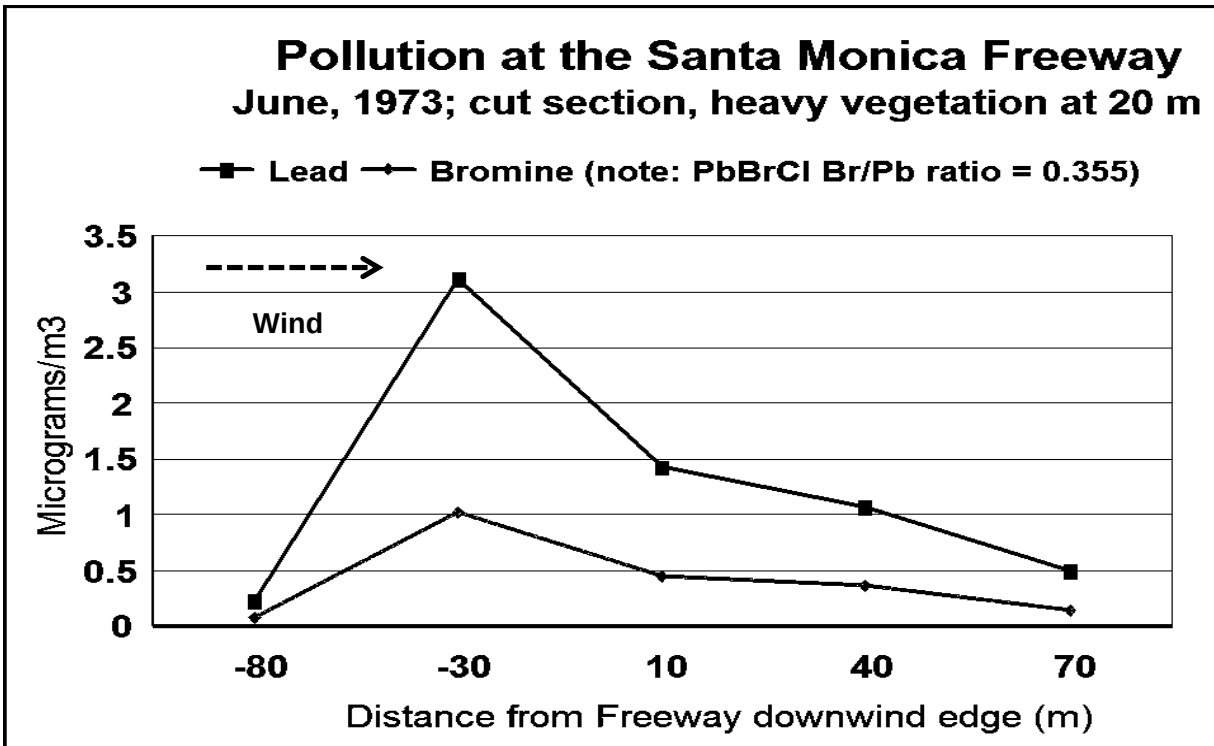
One last point about lead: Adding lead to gasoline in the form of tetra-ethyl lead (a potent neurotoxin) smoothed out the combustion, avoided spikes in pressure and temperature, and thus raised the octane level of gasoline (and the fraction of a barrel of crude oil that could be turned into the high-profit gasoline). The problem was that as lead cooled, it plated onto the cylinders and choked the engine and exhaust hardware.

The solution was to put two molecules into the gasoline as ethyl – the lead scavengers 1,2-dibromoethane and 1,2-dichloroethane, which converted lead into lead chloro-bromine, PbBrCl . The key thing about PbBrCl was that it had no liquid phase, so the lead came out of the tailpipe as an ultra-fine particle destined for the deep lung and the bloodstream (Figure 9-1). Addition of those two molecules was a really, really bad idea. Gasoline-powered vehicles were belching out these toxics at knee height for adults – and face height for children – in all the most heavily populated regions of California, the nation, and the rest of the world.

Addition of those two molecules yielded one unintended benefit for our research: it made automotive lead easily distinguishable from all other sources of lead. Because my research team

ITEM 11.1.

members and I were using PIXE technology and could see essentially any element from sodium to uranium, we automatically detected the bromine (Figure 11-2). I didn't plan that – it was just the result of my acknowledgment that because I was clueless about emissions from cars, I had to make the best, most comprehensive measurements possible.



2483

Figure 11-2. Lead and bromine (as PbBrCl) across the Santa Monica Freeway.

Current sources of lead

2485

Lead in soil

2486

The largest current source of airborne lead to which most of us are exposed is the “legacy lead” left over in soil from the decades of gasoline lead emissions.

2488

Industrial sources

2489

Any high-temperature industrial activity has the potential of generating very fine and ultra-fine particles. Because lead volatilizes at such a low temperature, it is emitted easily in such processes. Figure 9-3 shows both the impact of the Exide battery recycling facility in Vernon,

2492

ITEM 11.1.

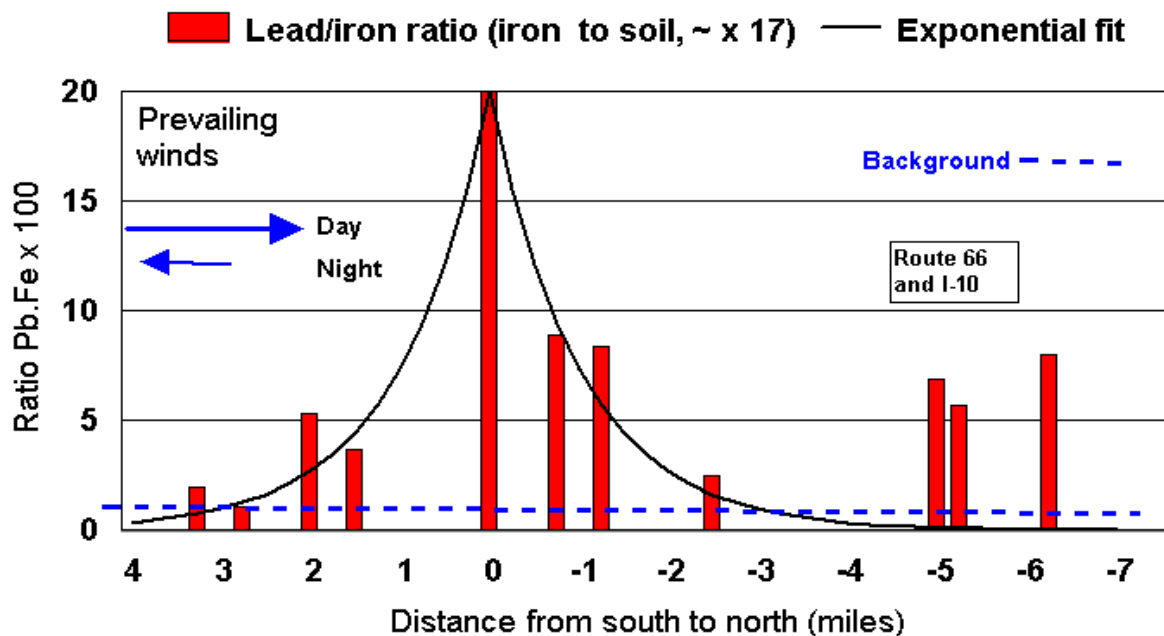
southeast of downtown L.A., and the Los Angeles background lead levels, plus “legacy lead” from U.S. 66 and Interstate 10.

Exide contamination and cleanup

Exide Technologies operated a lead-acid battery recycling facility in Vernon, an industrial city a few miles southeast of downtown Los Angeles. The smelting facility began operation in 1922, melting down used batteries and capturing lead to manufacture new ones. The process emitted arsenic and lead particles into the air. Exide did not acquire the plant until the year 2000. Under intense pressure from regulators, Exide shut down the plant in March 2015.

The California Department of Toxic Substances Control (DTSC) is testing for lead in soil that may have been contaminated by Exide Technologies facility operations in Vernon. DTSC is testing soil at residential properties, schools, daycare centers, and parks in areas of Boyle Heights, East Los Angeles, Commerce, Huntington Park, Bell, Vernon, and Maywood. Properties with high levels of lead in soil, and high risk for exposure, will be cleaned up by removing contaminated soil, backfilling with clean soil, and re-landscaping.

Lead to soil (iron tracer) versus Distance from Exide



2507

ITEM 11.1.

2508 Figure 11-3. The natural behavior of particles in the atmosphere is that they fall off
2509 exponentially versus distance. We apply an exponential fit north and south of the Exide
2510 battery recycling plant. The basin background lead level is about 150 ppm in surface
2511 soil. The high levels of lead found in soil at Alhambra and Monterey Park 5 to 6 miles
2512 north of Exide are associated with transport from downtown Los Angeles and decades
2513 of traffic on U.S. 66 and I-10.

2514 When operating, the Exide facility recycled approximately 11 million batteries per year,
2515 processing an average of 120,000 tons of lead annually. Soil testing that DTSC is conducting
2516 likely will reveal that Exide's contamination may have reached up to 1.7 miles away from the
2517 facility, which would encompass about 10,000 properties. DTSC is working with Exide to safely
2518 decontaminate the facility and soil.

2519 **DTSC's plan to expedite testing and cleanup**

2520 Governor Brown proposed a \$176 million plan to fund testing of all residential properties,
2521 schools, daycare centers, and parks within a 1.7-mile radius of the Exide battery recycling
2522 facility. Properties with high levels of lead in soil and high risk for exposure will be cleaned up.
2523 About 10,000 properties would be tested and about 2,500 properties would be cleaned.

ITEM 11.1.

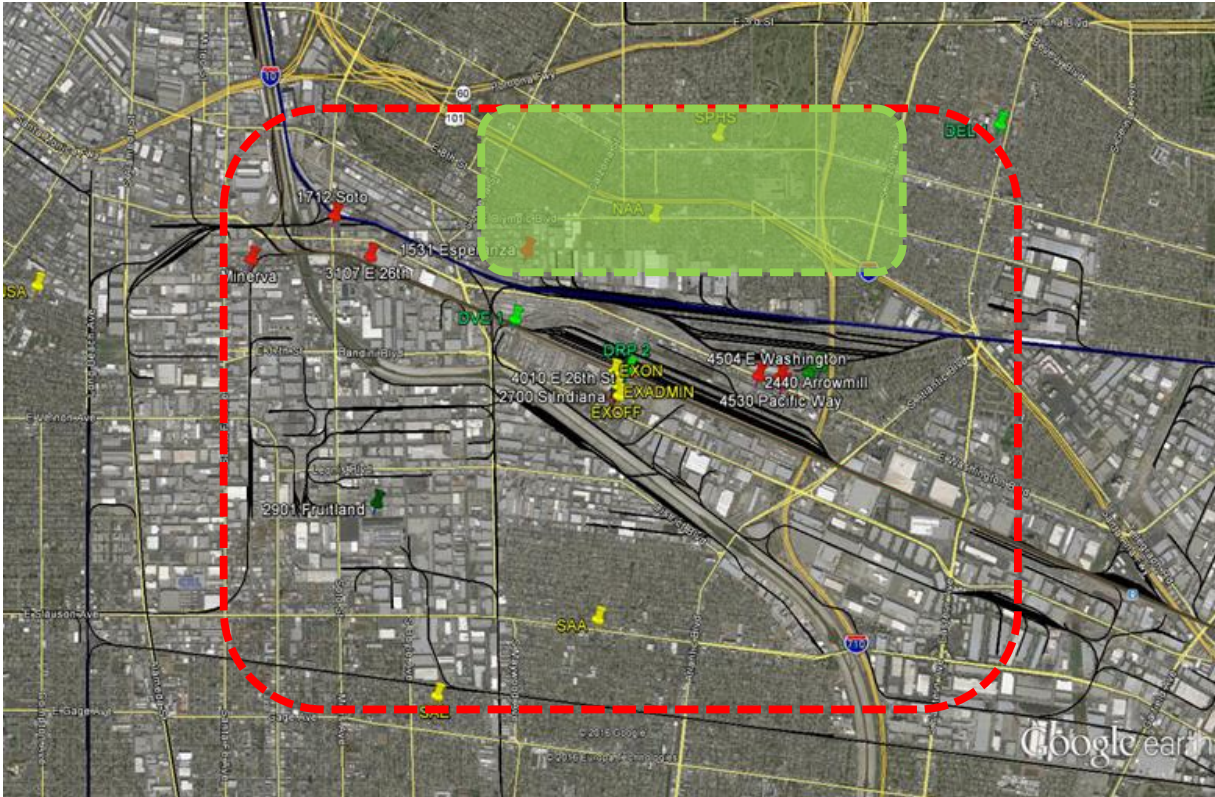
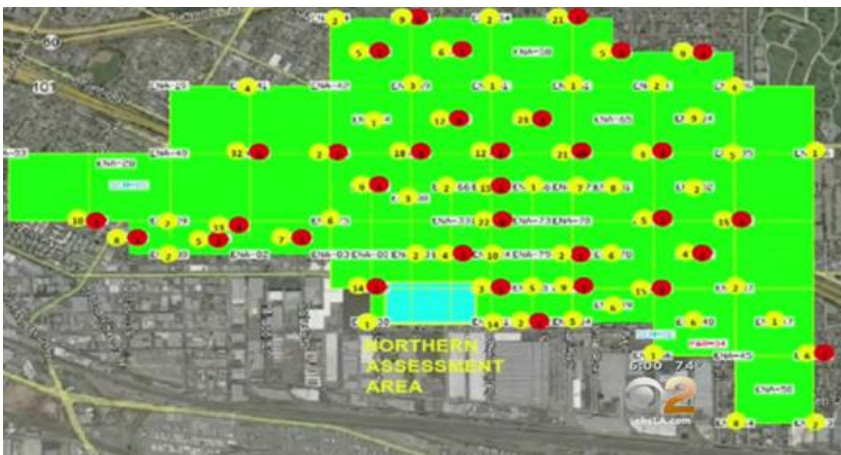


Figure 11- 4. Map showing the approximate area slated as of February 2016 for lead mitigation. Residential properties, schools, daycare centers, and parks within this 1.7-mile radius of the Exide facility are eligible for DTSC lead soil testing.

A *Los Angeles Times* article headlined “Lead contamination near Exide plant may be worse than previously thought,” published July 8, 2016, included a map (Figure 9-5) of the affected area.



ITEM 11.1.

Figure 11-5. Approximate map of area slated as of February 2016 for lead mitigation. The red dots represent testing sites that registered values greater than 1,000 ppm lead; the yellow dots indicate greater than 400 ppm lead. These data are derived from hundreds of measurements.

• For more information, visit www.ExideCleanup.org or call 844-225-3887.

Other sources

Figure 11-6 shows lead as high as 10,000 ppm from a now-closed car shredding plant on Terminal Island at the Los Angeles Harbor. It was the second largest source of airborne lead in the Los Angeles basin after the Exide plant.

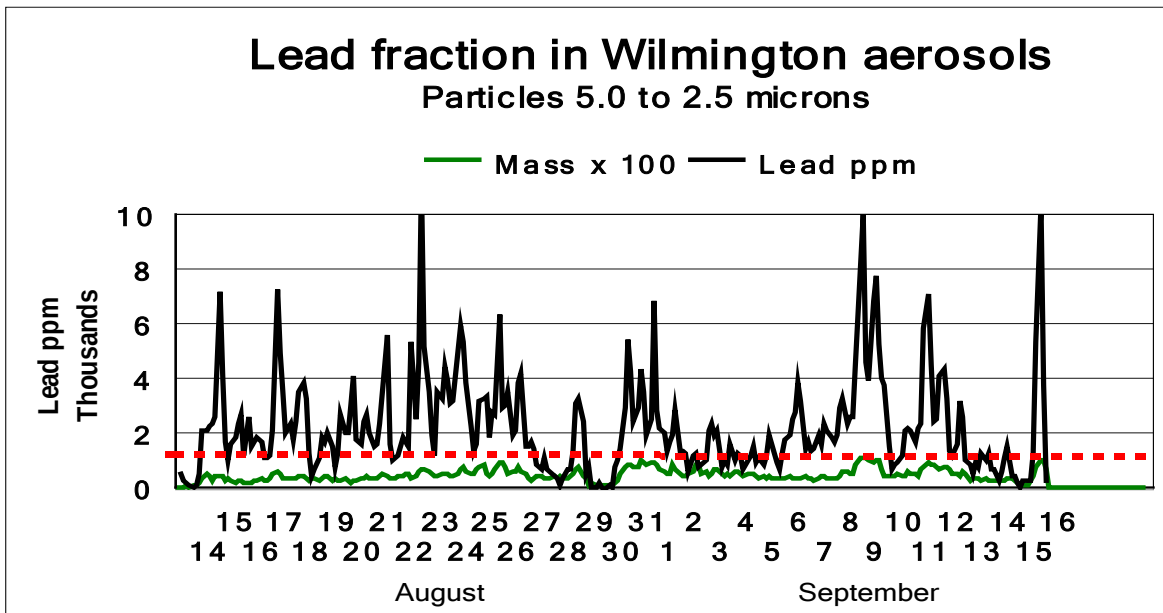


Figure 11-6. Lead and mass (shown in ppm) downwind of a car shredding operation, Los Angeles Harbor.

The World Trade Center smolder pile emitted lead for months following the September 11, 2001, attack and collapse. The lead came from a variety of sources, including lead additives in power cords manufactured from certain foreign countries (see Chapter 8, Ultra-fine metals).

How can I protect myself?

ITEM 11.1.

2548 The federal government has done an excellent job in reducing lead emissions from
 2549 vehicles, (although it took 20 years for the U.S. EPA to fully accept California's standards), but
 2550 many stationary sources still must be considered because current sources of lead pollution in the
 2551 United States and Western Europe are almost entirely industrial.

2552 1. Inventories are available in air quality agencies. In most cases, the emissions are minor, but if
 2553 they are serious, then don't live close downwind.

2554 • Current sources include metal and lead recycling operations.

2555 2. Consider having local soil tested, because in many cases while present emissions are minor,
 2556 past emissions were much more serious and residue may remain embedded in your soil.

2557 3. If lead is detected in your dust, clean surfaces with water or steam to reduce re-suspension.

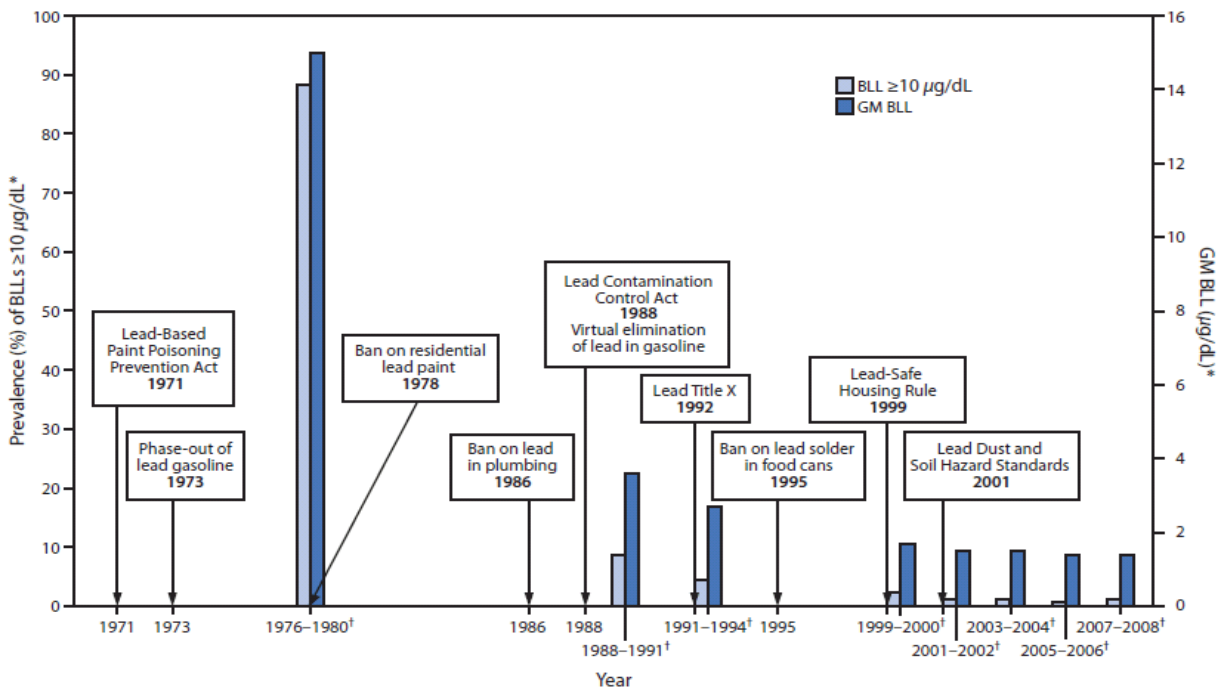
2558 4. If you have any doubts, ultra-filter your indoor air.

2559 Nitty-gritty details

2560 • Lead standard, California, 1973: $2.5 \mu\text{g}/\text{m}^3$

2561 • Highest 24-hour lead level we measured, 1973 $10 \mu\text{g}/\text{m}^3$

2562 • Lead standard, U.S. EPA, 2015 $0.15 \mu\text{g}/\text{m}^3$



2563

ITEM 11.1.

2564 Figure 11–7. Reduction in lead levels in blood after lead was removed from gasoline.

2565 Health impacts

2566 Lead entering the respiratory and digestive systems is released to the blood and distributed
2567 throughout the body. More than 90 percent of the total body burden of lead is accumulated in the
2568 bones, where it is stored. Lead in bones may be released into the blood, re-exposing organ
2569 systems long after the original exposure. The toxic nature of lead is well documented. Lead
2570 affects all organs and functions of the body to varying degrees. The frequency and severity of
2571 symptoms among exposed individuals depends upon the amount of exposure. Key lead-induced
2572 health effects include:

- 2573 • Neurological effects: mental retardation (especially in children), peripheral neuropathy, and
2574 more
- 2575 • Gastrointestinal effects: nausea, gingival tissue damage, and more
- 2576 • Reproductive effects (miscarriages, stillbirths, reduced sperm count and motility, and
2577 abnormal sperm), anemia, chronic nephropathy with proximal tubular damage, hypertension,
2578 arthralgia and myalgia

2579 Shut down Tom – attempt No. 1

- 2580 • **Governor Ronald Reagan, 1973. My offense? Reporting that lead from cars infiltrates**
2581 **California houses.**

2582 I had learned how to use my applied physics to analyze particles collected from air
2583 samples, atmospheric aerosols, by size, time and composition. I was hoping to simply remain the
2584 administrator of a “well-funded” analytical laboratory at the UC Davis Crocker Nuclear
2585 Laboratory cyclotron and to help keep it afloat after withdrawal of the U.S. Atomic Energy
2586 Commission grant in 1971. Thus, I was totally unprepared when the California Air Resources
2587 Board asked (and funded) me and my students to study lead from California freeways. One thing
2588 I was sure of: I was clueless about contamination from freeways, so I did what any physicist
2589 would do.

2590 I measured everything I could:

- 2591 1. both upwind and downwind to establish a background

ITEM 11.1.

- 2592 2. near and far to see transport
- 2593 3. in five different size modes to see transport and human impact
- 2594 4. day and night, every two hours, because I had no idea how traffic and meteorology could
- 2595 interact, and
- 2596 5. lead and every element from sodium through heavier substances, because I had no idea what
- 2597 else might be important

2598 Our data showed high amounts of lead, 400 percent of the California maximum standard,

2599 (which itself was 17 times the current U.S. EPA standard) downwind of the type of freeway

2600 topography that the U.S. EPA claimed to be the cleanest – an elevated section on a solid berm.

2601 For various reasons, my results arrived on the ARB and soon disappeared into the archives.

2602 When a lawsuit was filed on the proposed Century Freeway in L.A. based on impacts on local

2603 homes, the court became aware of my report. Finally the press demanded an explanation, and

2604 The ARB held a news conference in Sacramento. I was told to come and keep my mouth shut.

2605 Good luck on that, but in this case, my input was not needed. The key question came from a

2606 reporter of the *Los Angeles Times*, and it was phrased something like, “Did you know about these

2607 high lead levels prior to Dr. Cahill’s report?” Think about it. There is no good answer. But they

2608 chose the worst of the lot, “Oh, yes, we saw much higher levels in Riverside, and....” Next day’s

2609 headline: “ARB Suppressing Dangerous Lead Levels” or something like that.

2610 Immediately, all my ARB research funding was cut off.

2611 But even after Jerry Brown was elected governor of California, succeeding Ronald Reagan,

2612 our problems were not over. The U.S. EPA did not — repeat *not* — want California to have its

2613 own standard different from the rest of the states. However, because California had begun

2614 imposing air quality regulations before the EPA was formed, the state was “grandfathered” in to

2615 allow it to have standards more stringent than the rest of the country. This provision, however,

2616 required a sign-off by the EPA administrator, and he balked. The problem (or at least the

2617 scientific excuse the federal EPA used) was sulfur. Gasoline contained a lot of sulfur in 1973,

2618 and a high-level chemist, using data collected on Los Angeles freeways, stated that catalytic

2619 converters would produce so much sulfuric acid that (a close paraphrase) “it would melt the

2620 Nylon stockings off the women of Los Angeles.”

ITEM 11.1.

2621 EPA officials based their estimates on models, not measurements, because they had spent
2622 so much money on their single mobile laboratory they could not afford more than one, and thus
2623 could not make measurements upwind of the freeway at the same time they made measurements
2624 downwind of the freeway. Also, it took so much electrical power to run it that it was hooked to
2625 electrical circuits was not really mobile.

2626 . Hence, they assigned the sulfur values they saw to areas downwind of the freeways. We,
2627 however, measured just as much sulfur upwind of the freeway as downwind – meaning that the
2628 freeway couldn't be the source! When in addition their freeway transport models failed
2629 miserably (see previous discussion about lead in homes), they caved. However, just to be sure, I
2630 proposed a law to phase out sulfur in gasoline as the catalytic converter became established. We
2631 thought this proposal would induce massive opposition from the oil industry, because it would
2632 cost them millions of dollars. So I went ready to testify at the hearings in Sacramento, and waited
2633 for the firestorm. A General Motors representative spoke first – and declared the catalytic
2634 converter the best thing since sliced bread! (General Motors held a key patent on the catalytic
2635 converter.) The Ford representative said that this would destroy the car industry! (Ford would
2636 have to pay GM for using the patents.) The Chrysler representative collared me in the hallway
2637 and asked “What is going on in there?” I responded truthfully: “I am clueless!”

2638 Then after lunch it was the turn of the oil companies. Chevron: “We take no position on
2639 this bill.” My jaw dropped – they had just signed in for many millions of upgrades for their
2640 refineries. Before I could recover, the Union Oil rep said: “We take no position on this bill.”
2641 Now I was floored. Then came a string of small refiners: “This will force us out of business
2642 because we can't afford the upgrades.” Ah *ha*! Now all became clear, and the bill requiring
2643 removal of sulfur from gasoline in California soon became law without me opening my mouth.

2644 The U.S. EPA finally followed California's sulfur initiative circa late 1990s. Thus, this
2645 victory led to the adoption of the catalytic converter, removing lead from gasoline, controls on
2646 sulfur in gasoline, and other steps, including development of internal combustion engines that
2647 could use low (87) octane gasoline, thereby putting California ahead of the rest of the nation and
2648 world. And these steps worked, with a massive reduction of both ozone and lead in the next
2649 decade. Having left my silver bullet, I moved on to see what I could do to help reduce haze in my
2650 beloved deserts and national parks.

ITEM 11.1.

2651 **References**

- 2652 • Cahill, Thomas A., and Patrick J. Feeney. June 15, 1973. "Final Report to the California Air
2653 Resources Board on Contract ARB-502: Contributions of Freeway Traffic to Airborne
2654 Particulate Matter."
- 2655 • Courtney, W.J., S. Rheingrover, J. Pilotte, H.C. Kaufmann, T.A. Cahill, and J.W. Nelson.
2656 1978. "Continuous Observation of Particulates During the General Motors Sulfate Dispersion
2657 Experiment." *Journal of the Air Pollution Control Association* 28: 225–228.
2658

Chapter 12

The Mad Hatter Had a Point

Mercury and other toxic metals

Detrimental health effects on: the neurological system, development of the infant brain, tremors, insomnia, and a variety of other impacts

Introduction

How often have you heard a sound that you had never heard before? I was sitting at my desk when I heard an extremely powerful sound of very, very low frequency, and felt it as my chair and the desk at which I was sitting vibrated. I had no idea what could be causing it, but it was so powerful that I feared something awful was about to happen.

Because I was sitting in a Chinese Atmospheric Physics Laboratory in North Beijing in winter 2001, I had no prior knowledge to draw upon. But I was only a few hundred feet from the base of the tallest atmospheric physics diagnostic tower in China, rising almost 1,000 feet into the sky. I went outside, and the sky to the northeast was a beige wall. It was the beginning of the infamous north Chinese dust storms, which often resulted in scores of deaths in the countryside. The growing wind was making the entire tower hum like a giant tuning fork.

Within minutes, I was enveloped in a beige world with visibility cut to a few hundred feet. Fleeing indoors provided no relief from the fine dust that I could taste in my mouth and feel in my nose. Surprisingly, no special odor seemed to accompany the dust. And the tower hummed its unique tune and continued for hours until the wind started to drop. Even then, the city was a beige monochrome landscape as a pall of dust hung in the air and covered every surface.

Actually, as a scientist, I was not unhappy to experience this, because my instrumentation was recording it all as part of a massive American-Chinese-Japanese-Korean-Taiwanese research study called ACE Asia. My portion was 22 ground stations, from western China to Oregon, Alaska and Hawaii, each raking data every three hours in either 3 of 8 particle size modes depending on the DRUM sampler used. I would have been desolate if I had not experienced a

ITEM 11.1.

dust storm during the six weeks I was in Asia. The problem was that it required me to stay several weeks in Beijing and Qingdao. A handkerchief placed on a white table by my bedside in the evening would have a neat outline in black soot by morning.

After the six-week study, I returned with all of my samples, and my colleagues and I began analyzing what was in that soot. Table 10-1 shows what the data from our measurements revealed.

Yes, the lead levels are surprising, because China said that it had pulled lead out of gasoline in 2000 – yet the levels are about twice the worst ever seen in Los Angeles. Many of the other toxic elements are clearly industrial.

Of all the values in those data, the level of mercury is probably the most startling and deleterious to health. The mercury is almost certainly coming from coal combustion, which is globally the largest source of mercury in the world.

Aerosol Data		Washington, D.C.		Beijing, China
PM ₁₀ mass	July 2008	25.5 µg/m ³	IMPROVE 1992	129.4µg/m ³
PM _{2.5}	IMPROVE 1992 4 weeks		ACE Asia 2001 5 weeks	
Mass	“	19.2 µg/m ³	“	51.5µg/m ³
Ammonium sulfate	“	10.1 µg/m ³	“	11.0 µg/m ³
Ammonium nitrate	“	2,2µg/m ³	“	Not available
Organic matter	“	4.8 µg/m ³	“	Not available
Soot	“	1.2 µg/m ³	“	Not available
Soil	“	0.7 µg/m ³	“	40.5µg/m ³
Soil (dust storms)	“	Not available	6 storms	129.2µg/m ³
PM _{2.5} toxics ng/m ³ (= 0.001 µg/m ³)				
Vanadium (fuel oil)	“	4.5 ng/m ³	“	4.2 ng/m ³

ITEM 11.1.

Copper	“	3.9 ng/m ³	“	110.5 ng/m ³
Zinc	“	21.0 ng/m ³	“	429.3 ng/m ³
Arsenic	“	0.3 ng/m ³	“	24.9 ng/m ³
Selenium (coal combustion)	“	2.2 ng/m ³	“	27.1 ng/m ³
Mercury (coal combustion)	“	< 1.0 ng/m ³	“	232.5 ng/m ³
Lead (automobiles?)	“	12.6 ng/m ³	“	4,323.6 ng/m ³

2697 Table 12-1. Comparative aerosol results from two capital cities, Washington and Beijing.

2698 Mercury, which has been known from antiquity, was commonly used to make mirrors.

2699 Mercury in the form of vermilion from the mines of Spain was used to make the beautiful red
2700 colors in manuscript and printed documents, including the Gutenberg Bible.

2701 Regretfully, we know an awful lot about the impacts of mercury on human health. In *Alice*
2702 *in Wonderland*, the Mad Hatter was “mad” because he was using mercury to turn cheap local
2703 rabbit fur into fake beaver hats – good for the beavers, bad for the hatters. Also in the 19th
2704 century, an awful lot of mercury was distilled in the coastal mountains of California to aid
2705 extraction of gold in the Sierra Nevada. Much of this has ended up in silt, where it converts into
2706 the most dangerous form, methyl mercury.

2707 Currently, most airborne mercury is from coal burning in the middle latitudes, especially in
2708 China. The U.S. EPA is attempting to promulgate rules to limit mercury emissions. One reason is
2709 that mercury emitted into the air from coal-fired power plants tends to move north into the
2710 Arctic, where it ends up in the breast milk of natives via a process called “global distillation” (D.
2711 MacKay, Ontario Canada). A lot of mercury also is used in industry, from manufacture of
2712 fluorescent bulbs and mercury-containing batteries (which should be kept out of landfills,
2713 please!) to mercury vapor street lamps. Use of mercury as a fungicide for grains finally began
2714 decreasing, after a major mercury poisoning event occurred in Iraq some years back when
2715 someone sold grain infused with mercury for seeding (dyed a color as a warning against eating)
2716 as dietary wheat, with disastrous consequences.

2717 In Japan, mercury from a battery plant was dumped into shallow Minamata Bay for about
2718 35 years. This material entered shellfish and the food chain and caused probably the worst
2719 modern mercury poisoning in modern times, forever infamous as “Minamata Disease.” The
2720 contamination resulted in well more than 1,500 deaths, and more than 10,000 people developed

ITEM 11.1.

2721 serious illness. Finally, in 2004, which was 70 years after dumping began, the government forced
 2722 the battery manufacturer to clean up the bay.

2723 Interestingly, the same sort of deformities seen in the Minamata Disease were also seen in
 2724 aquatic birds nesting in the marshes of the Kesterson National Wildlife Refuge, used as a
 2725 dumping area for agricultural runoff in California's San Joaquin Valley. The culprit in that case
 2726 was selenium.

2727 An industrial source in northern Japan bled cadmium into a river, and the people
 2728 downstream developed an awful condition called the "Ouch Ouch" disease because of muscle
 2729 and joint pain. Too many other examples of metal poisoning exist to list here.

2730 **Cautionary tale not yet learned:**
 2731 **Cadmium, the toxic live-in roommate of lead**

2732 Major impacts: Muscle pain, renal failure, cancer, and others.

2733 I used to raise horses, and when I first came to Davis in 1967, I was entranced by the
 2734 campus livestock, including a major program rehabilitating Thoroughbred race horses (I trained
 2735 horses to jump fences, and had owned a cousin of Seabiscuit on our New England farm).
 2736 However, the horses in the field near our laboratory were not in good shape. They were skinny,
 2737 and their coats were dull. They seemed listless. It turns out that they were part of a veterinary
 2738 medicine study of horses raised on pastures near the Selby lead smelter on the east shore of San
 2739 Pablo Bay. It was, I recall, a three-year study, but as it was concluding, someone decided to run
 2740 some tests for cadmium. The cadmium levels in the horses were far more toxic than the lead. So
 2741 the whole study was thrown into doubt because in those days they could not go back and re-
 2742 analyze samples as we do routinely today. They went into the study with blinders on, they saw
 2743 exactly what they expected to see, and looked no further.

2744 One of the four worst environmental diseases in Japan in the 20th century was cadmium
 2745 poisoning of a river from mining activities. We still see cadmium in California in residential
 2746 areas. When Chinese manufacturers of children's toys were told to get the lead out, they simply
 2747 changed to cadmium.

2748 In 2015, Exide agreed to permanently close its battery recycling plant in Los Angeles, and
 2749 fund a program to clean lead from local soils. That sounds like good news for Los Angeles, but I

ITEM 11.1.

worry about where these batteries will now be recycled, almost surely with far fewer environmental safeguards than in California. While I was in India a few years back, I saw big open heated vats that were being used to melt the batteries, surrounded by the houses of workers.

The current problem is the continued presence of toxic metals that are in lesser amounts but widely distributed in the environment and absorbed in people's bodies. Combustion of coal at mid-latitudes, the largest current source of airborne mercury, generates gaseous mercury that then migrates north into the Arctic, cools and coverts to particles, and falls to the ground, a process called "Global Distillation". It the ends up in the biosphere, including the breast milk of native populations to then deposits in a process called "Global Distillation," ending up in the breast milk of native populations.

How can I protect myself?

Fortunately, I know of no place in the United States where airborne mercury is currently a concern. Anyone who is planning to travel and stay for an extended time in some of the industrialized areas of the developing world should try to ascertain whether mercury (or any number of other toxics) is present there at appreciable levels.

Nitty-gritty details

The California Department of Toxic Substances Control (DTSC) has as its mission under California law the prevention of dumping of toxic materials into the environment. A list of the elements that DTSC must control is given below. The amounts allowed give some idea of the relative toxicity of many elements. The list also includes out ability at UC Davis to detect each element when we analyze at Stanford (SSRL) on the analytical system we helped develop.

2771

Metals and compounds	STLC ppm	TTLC ppm soils	SSRL, Stanford SLAC, 38 keV (ppm)
Antimony	15	500	0.2
Arsenic	5.0	500	1.6
Barium	100	10,000	0.8
Beryllium	0.75	75	na
Cadmium	1.0	100	0.6
Chromium VI	5	500	na

137

ITEM 11.1.

Chromium, Cr III	5	2500	0.2
Cobalt	80	8,000	0.6
Copper	25	2,500	0.4
Fluoride salts	180	18,000	na
Lead	5.0	1,000	1.6
Mercury	0.2	20	0.2
Molybdenum	350	3,500	0.4
Nickel	20	2,000	0.2
Selenium	1.0	100	0.2
Silver	5.0	500	0.2
Thallium	7.0	700	0.2
Vanadium	24	2,400	0.3
Zinc	250	5,000	0.6

2772 Table 12-2. Title 22 elements of concern, regulatory thresholds and S-XRF capability.

2773

ITEM 11.1.

Chapter 13

*Wood Smoke Is Good Smoke?**The controversy continues*

Major impacts: asthma exacerbation, some toxic PAHs, acrolein irritant.

Introduction

Alert! This topic is wildly controversial, so I will present facts and let you decide (I regret that the slogan “fair and balanced” has been pre-empted).

First the bad news:

1. 2.6 million deaths per year are due to use of wood stoves for cooking. The greatest number of deaths occurs in developing countries in Western Pacific and South-East Asia regions.
2. The highest level of the carcinogen benzo[a]pyrene seen in the California Central Valley was in the town of Chico, infamous for high levels of wood smoke each winter.
3. Wood smoke can exacerbate asthma and other pre-existing respiratory conditions.
4. Wildfires can result in 24-hour smoke masses that are 20 or more times greater than the current EPA 24-hour standard.
5. Wood smoke is highly visible, even in small concentrations. What you see is what gets you.
6. Wood smoke smells and your nose picks it up, even in very low concentrations.

Then the good news:

1. The size of smoke particles from wildfires peaks at the location where lung efficiency for capture is only around 10 percent. About 90 percent of what you breathe in is expelled when you exhale.
2. Despite the high smoke and benzo[a]pyrene smoke mass every winter in Chico, no indications of any directly linked detrimental health effects (e.g., cancer, COPD) have been documented.

ITEM 11.1.

2797 3. Massive wildfire in the region of Fairbanks, Alaska, in the summer of 2004 generated smoke
 2798 levels 22 times the EPA 24-hour standard, and persisted for weeks at an average level 700
 2799 percent that of the acceptable standards. Despite this, essentially no health impacts occurred
 2800 beyond a small increase in the purchase of asthma inhalers.

2801 4. Even though you can see and smell wood smoke, the concentrations are usually far below
 2802 EPA threshold standards.

2803 Here are two summaries from studies of wildfire smoke:

- 2804 • *“Exposure measurement is a key challenge in current literature on wildfire and human*
 2805 *health. A limitation is the difficulty of estimating pollution specific to wildfires. New*
 2806 *methods are needed to separate air pollution levels of wildfires from those from ambient*
 2807 *sources, such as transportation. The majority of studies found that wildfire smoke was*
 2808 *associated with increased risk of respiratory and cardiovascular diseases. Children, the*
 2809 *elderly and those with underlying chronic diseases appear to be susceptible. More*
 2810 *studies on mortality and cardiovascular morbidity are needed. Further exploration with*
 2811 *new methods could help ascertain the public health impacts of wildfires under climate*
 2812 *change and guide mitigation policies.”*
 2813 – Liu, J.C., G. Pereira, S.A. Uhl, M.A. Bravo, and M.L. Bell. February 2011. “A
 2814 Systematic Review of the Physical Health Impacts From Non-occupational Exposure to
 2815 Wildfire Smoke.” *Respirology* 16(2): 198–209.
- 2816 • *“Smoke events were associated with an immediate increase in presentations for*
 2817 *respiratory conditions and a lagged increase in attendances for ischemic heart disease*
 2818 *and heart failure. Respiratory impacts were either absent or considerably attenuated in*
 2819 *those <15 years. Similar to previous studies, we found inconsistent associations between*
 2820 *fire smoke and cardiovascular diseases. Better characterization of the spectrum of*
 2821 *population health risks is needed to guide public health responses to severe smoke events*
 2822 *as this exposure becomes increasingly common with global climate change.”*
 2823 – Johnston, F.H., S. Purdie, B. Jalaludin, K.L. Martin, S.B. Henderson, and G.G. Morgan.
 2824 January 2015. “Air Pollution Events From Forest Fires and Emergency Department
 2825 Attendances in Sydney, Australia 1996–2007: a Case-crossover Analysis.”
 2826 *Environmental Health* 136: 120–132.

ITEM 11.1.

Additional complexities come from the fact that wildfire smoke and fireplace smoke have variable emission rates and compositions. For wildfires, work at Lake Tahoe showed much more nutrient impact on algae from chaparral smoke than from pine smoke, and we expect eucalyptus to be different yet. The key in forest fires is that most of the material that burns consists of needles and small branches, with heavy water content. That is why most forest fires seen from a distance appear white or light gray. The water increases the size of the particles and reduces deep lung capture. Wood smoke from fireplaces and stoves is much hotter, especially if charcoal is used as in many developing countries, and has much less water. Pine wood is distinctly different from dried hardwood, and it emits far more toxics and creosote. These considerations are almost never considered in health impact studies, and make me very cautious in accepting their results.

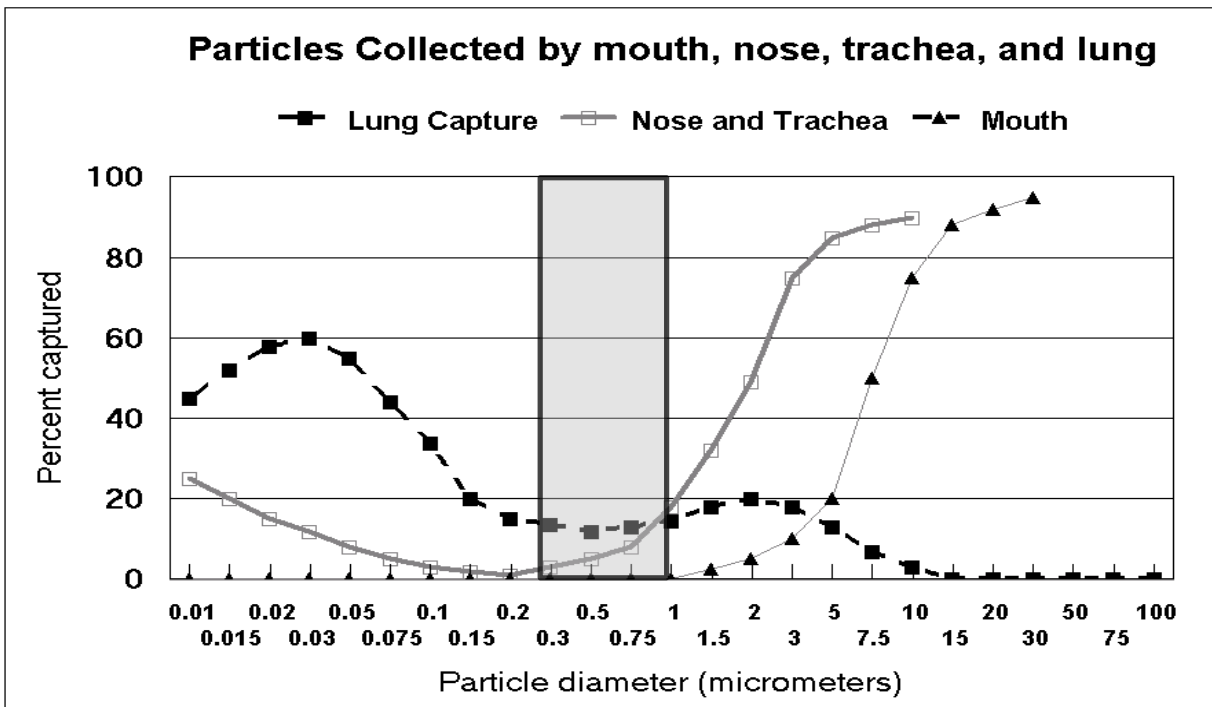


Figure 13-1. The shaded area shows the size profiles and lung deposition for wildfire smoke. **Note how little is collected by the lung.**

Wood smoke from fires is highly visible, because light scattering maximizes when the size of the particle is about the same length to about double the wavelength of light. Thus smoke in the size range from about 0.3 μm to 1.0 μm diameter exactly overlaps visible light, from blue to red (as shown in Table 13-1).

ITEM 11.1.

2843 I helped design and for 20 years ran visibility projects for Interagency Monitoring of
 2844 Protected Visual Environments (IMPROVE, a collaboration between the EPA and the National
 2845 Park Service). From the aerosol component of IMPROVE, we were able to discern visibility
 2846 versus forest fire wood smoke mass relationships. See Figure 3-1, AQI index.

2847

Visibility	Mass PM _{2.5}	Other information
Est. 0.6 miles (1 km)	200 µg/m ³	Maroon on PM _{2.5} color chart
1.9 miles (3.0 km)	150 µg/m ³	U.S. EPA 24 hr PM ₁₀ standard
5.7 miles (9.1 km)	50 µg/m ³	Orange on PM _{2.5} color chart
Est. 6.8 miles (11.3 km)	35 µg/m ³	U.S. EPA 24 hr PM _{2.5} standard
Est. 12.0 miles (20 km)	17.5 µg/m ³	Green on PM _{2.5} color chart

2848 Table 13-1. The inverse relationship between mass PM_{2.5} and visibility.

2849 How can I protect myself?

- 2850 1. Do your homework. Smoke is easy to see and smell, and occasionally a major factor in PM_{2.5}.
- 2851 2. If your local air quality agency has burn–no burn days, observe them.
- 2852 3. Those little paper masks are useless for such fine particles.
- 2853 4. Smoke in this size range penetrates into houses with ~ 70 percent to 85 percent efficiency.
- 2854 Sheltering indoors does not help much.
- 2855 5. Be concerned if someone near you uses an older style EPA-approved wood stove for home
- 2856 heating.
- 2857 6. If you believe you are subject to serious threats, ultra-filter your indoor air.

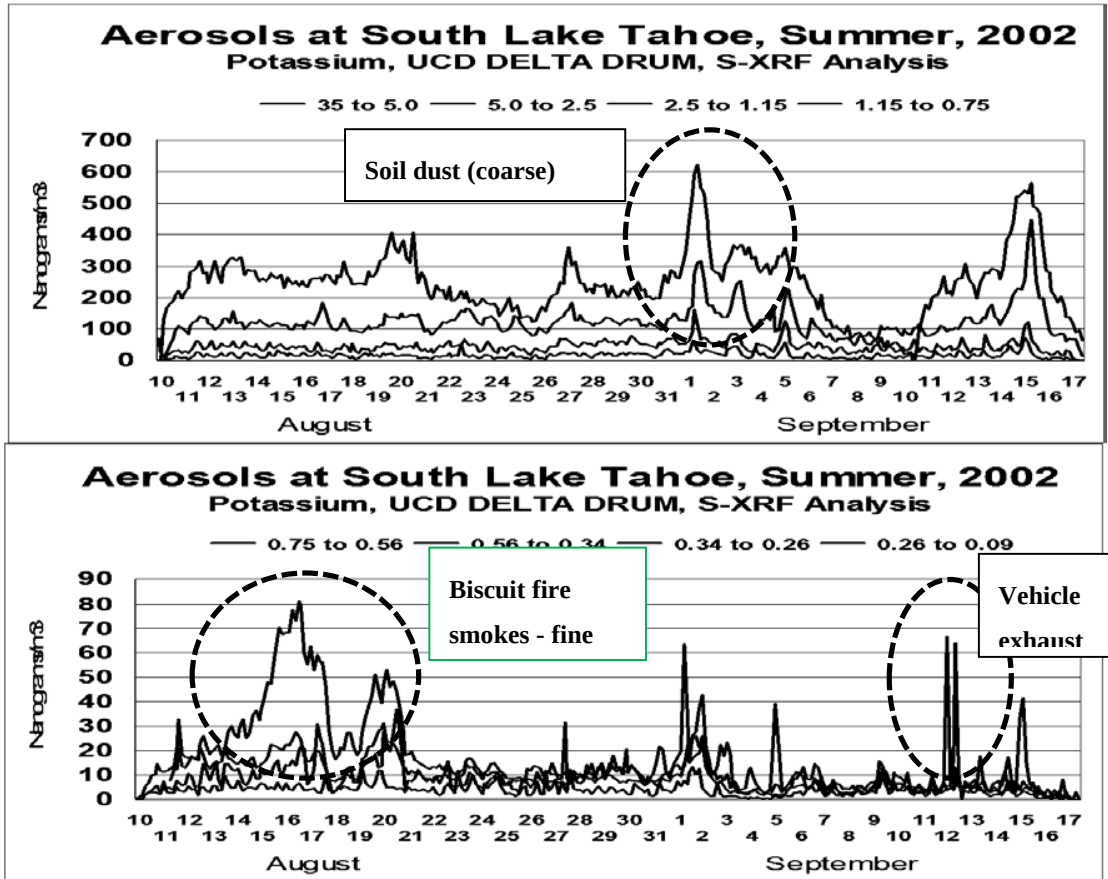
2858 The cool pollutants from older wood stoves hang close to the ground, unlike open
 2859 fireplaces, and can infiltrate the homes of nearest neighbors. We did an extensive study of this in
 2860 Davis, and identified about a half-dozen houses that were the source of almost all complaints.

2861 But recall that there are many reasons to believe that ambient levels of wood smoke are not
 2862 very harmful to health.

2863 Nitty-gritty details

ITEM 11.1.

2864 Figure 13-2 shows the size mode of wildfire smoke, taken from the data at Lake Tahoe
 2865 measuring particulate matter from the mammoth Biscuit Fire in 2002. Almost all the wildfire
 2866 smoke measured 0.56 to 0.74 μm diameter). Note the ultra-fine diesel smoke (in black).

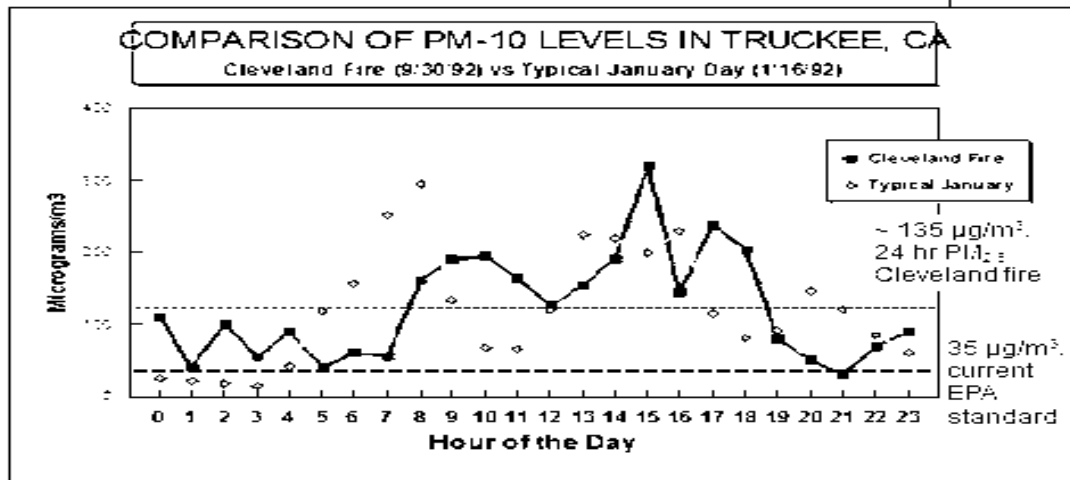


2867

2868 Figure 13-2. Size profiles of potassium, a tracer of soil dust, wildfire smoke, and vehicle
 2869 exhaust at Lake Tahoe.

ITEM 11.1.

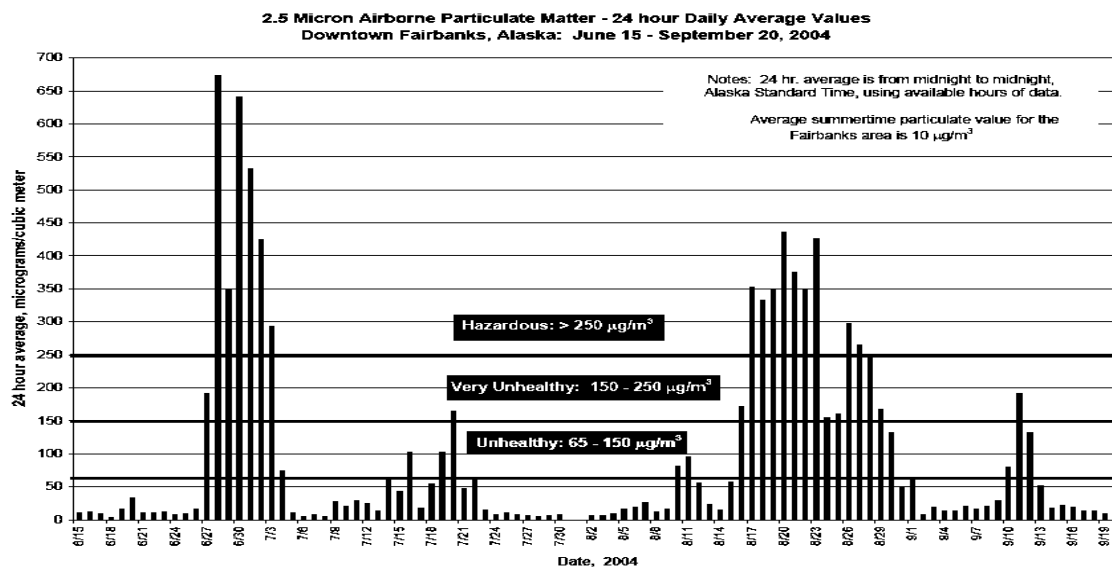
Cleveland fire – 14,000 acres burned on Sept. 30, 1992; Truckee was 35 miles downwind.



2870

2871 Figure 13-3. Relative concentrations of forest fire smoke and wood stove smoke.

2872 The results of the medical impact showed that over a 24 hr period, smoke amounts averaging
 2873 670 µg/m³ of smoke mass had essentially no impact on the residents of Fairbanks. Recall that
 2874 the EPA standard for health impacts is 35 µg/m³. A null result for health was also seen when
 2875 smoke persisted at ~ 250 µg/m³ for 2 weeks.



2876

2877 Figure 13-4. Wildfire smoke in Fairbanks, Alaska.

ITEM 11.1.

Smoke from wood-burning stoves and fireplaces

In many areas, wood smoke exposure is mostly from stoves and fireplaces. Open fireplaces are about twice as bad as wood stoves per kilogram of wood burned, but the amount of wood burned and the duration of burning is 20 times higher for wood stoves than fireplaces. In addition, switching to dried hardwoods reduces fireplace smoke nearly in half.

PM₁₀ Emission Factors	Grams smoke/kg of wood burned	Use factor
Open hearth fireplaces	17.3	95% are rarely used
Wood stoves		
Conventional	15.3	heavily used
Non catalytic	9.8	heavily used
Catalytic	10.2	heavily used
Pellet stoves – certified	2.1	heavily used
Pellet stoves - exempt	4.1	heavily used

Table 13-2. Wood stoves and open-hearth fireplaces

Because the differences in emission rates among wood-burning methods are relatively modest, something between 2.5 (more recent studies) and 1.7 (EPA AP 42) emissions per mass of wood burned, we can now turn to the duration during which the wood was burned.

Category	Fireplace: open hearth	Wood stoves: conventional	Wood stoves: non-catalytic	Wood stoves: catalytic	Pellet stoves: certified	Pellet stoves: exempt	Masonry heaters
Pre-phase 1		15.3	12.9	12.1			
Phase 1			10.0	9.8			
Phase 2			7.3	8.1	2.1		
All	17.3	15.3	9.8	10.2	2.1	4.1	2.8
Use factor	Very low (5%)	high	high	high	high	high	high

Table 13-3. PM₁₀ emission rates (other data show that this is almost all PM_{2.5}).

ITEM 11.1.

2890 The vast majority of open-hearth fireplaces (EPA estimates 95 percent) are used for
2891 aesthetic reasons, with fires only of short duration. This contrasts starkly to wood-burning stoves
2892 used for space heating, which are in more continuous use during cold weather.

2893 Models used in a recent city of Davis (California) study show that the local ground level
2894 impact is enhanced for wood stoves because its cooler smoke tends to hang closer to the ground,
2895 compared to the generally hotter and more buoyant smoke from an open-hearth fireplace.

2896 **References**

- 2897 • Cahill, T.A, J. J. Carroll, D. Campbell, and T. E. Gill. 1996. "Air Quality, Chapter 48. Sierra
2898 Nevada Ecosystem Project (SNEP), Report to Congress." UC Davis Centers for Water and
2899 Wildlife Resources.
- 2900 • Washington State Department of Ecology. August 2004. Health Effects of Wood Smoke.
2901 Retrieved from: <https://fortress.wa.gov/ecy/publications/publications/92046.pdf>

2902

2903

ITEM 11.1.

Chapter 14

The Pollutants That Can Shut Down a Freeway***Soil dust and PM₁₀*****Major impact: Loss of lung function****Introduction****Extreme events**

On August 27, 1972, a low-pressure weather system coming in from the Pacific Ocean ran into a high-pressure front over the Mojave Desert, setting up a large pressure gradient. Ferocious winds blew from the high desert, through the Tehachapi Pass, and into the San Joaquin Valley, stripping the vegetation and soil off hillsides that faced the wind and raising an enormous dust storm, reportedly with aerosol masses averaging about 2,000 micrograms per cubic meter, versus the coarse particle standard of 150 micrograms per cubic meter. Visibility dropped to a few hundred feet, and at least seven people were killed and as many as 100 were injured in multiple car and truck crashes. Interstate 5, the main north-south freeway in the Central Valley, was shut down for hours. Much of the dust was re-suspended from agriculturally disturbed soil – dust that would not have been present if the natural vegetation and grasslands had been intact. In this case, it had eerie similarities to the 1930s Great Plains “Dust Bowl” – many refugees from which ironically had settled in the lower San Joaquin Valley. Regretfully, climate models predict deeper and longer droughts in the southwest, partially due to climate change, so such dust storms may become more common – if humans do not intervene.

Two factors are vital in the evaluation of potential aerosol sources:

1. The friability and particle size profiles of the materials, which provides an estimate of the nature of the materials that might be suspended into the ambient atmosphere; and

ITEM 11.1.

2. The wind shear present on the materials, a combination of the strength of the wind and the ground level, the friction velocity, and momentum transfer, that gives the effective wind profile as it approaches the ground (Seinfeld and Pandis, 1997, pg. 873).

Thus a highly friable (easily crumbled) soil under a vegetative cover that effectively reduces the wind velocity to zero at and just above the ground will not be emitted into the atmosphere, while a less friable soil exposed to the full wind velocity will be re-suspended.

The nature of the sources of the materials and the mode of re-suspension can be further clarified by classification of source type and mechanisms. Because airborne dust comes from a variety of sources, subdividing the material into categories is helpful. Each category has its own characteristics that allow source identification.

Materials		Mechanisms: Wind	Mechanisms: Human activities
Natural – unmodified by humans		Category 1: Natural background	Category 2: Re-suspended dust
Human-made – tailing piles, dirt roads		Category 3: Fugitive dust	Category 4: Primary pollutant emissions

Table 14-1. Characterization of ambient dust sources.

Categories 1 and 4 are the easiest, but the second and third are the most important.

The first category, **natural background**, represents unmodified soil surfaces eroded by natural winds. Because soils over time protect themselves with physical and biological crusts, vegetation, and the like, these dusts are usually low in concentration except in high wind events (such as Sahara dust storms, and some Chinese storms). Exceptions may occur for dry lake playas and vegetative free beach zones.

Materials in the fourth category, **primary pollutant emissions**, are also easy to identify because both the particle size and composition differ from natural dusts. In many cases, the source itself is known – a tall stack, a cement plant, and in this case, vehicles.

The second category, **re-suspended dust**, represents a natural material that has been raised into the air by human activity. Cars on dirt roads, construction activities, and farming operations

ITEM 11.1.

all are major sources of this material. Chemically, it may constitute the same material as natural background, but in the course of human operations, modification in particle size as well as lack of correlation to wind velocity may occur. In addition, soils on a farm field stripped of vegetation and thereby becoming susceptible to being picked up by natural winds fall into this category, because chemically the materials remain soil, as in the 1930s Dust Bowl.

The third, **fugitive dust**, would be represented by a human-created material capable of being picked up and transported by natural winds. Industrial tailing piles, the composition of which is chemically different from the soils, constitute a prime example. Cattle feed lots fall into both categories – cattle can raise dust, re-suspended, and the area is also subject to fugitive dust that is rich in organics, but absent in natural soils. Roadway dusts are also polluted with metals from brakes and other parts of cars. Thus, compositional analysis aids in their identification.

The dust storms that closed the highways were composed of **fugitive dust**. If the natural soils had not been modified by agricultural practices, no dust storm would have occurred.

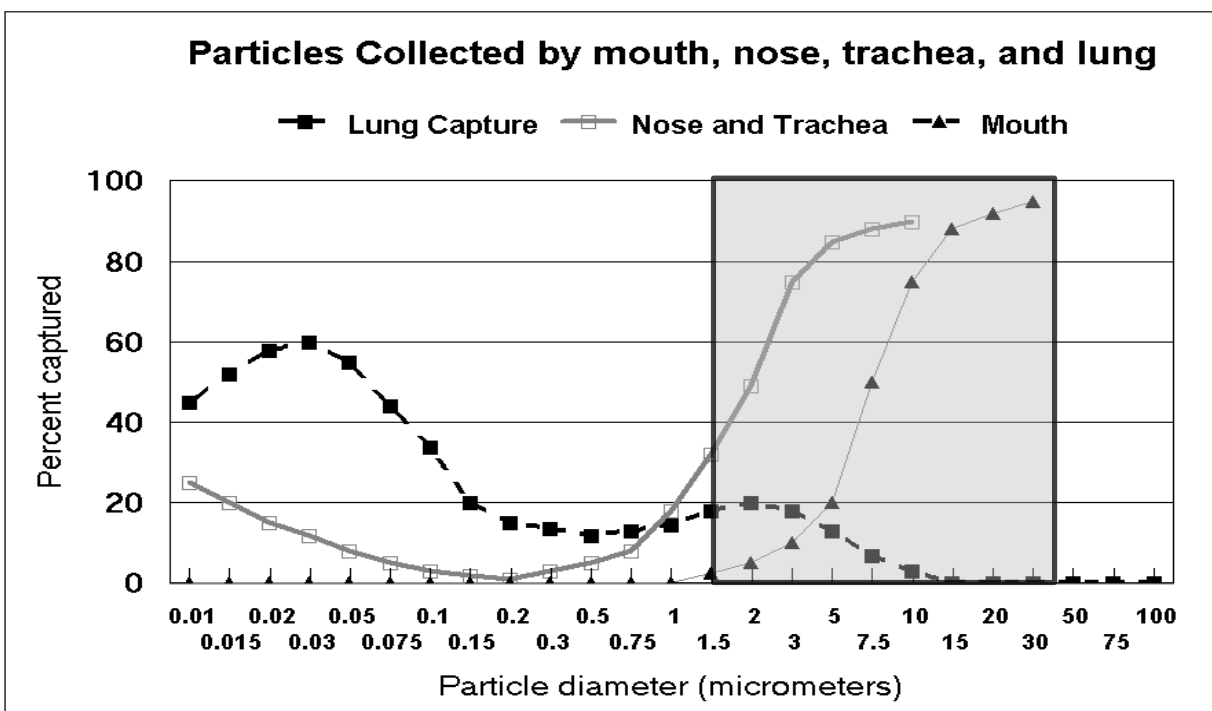


Figure 14 -1. Size range and lung deposition for dust storms, with most particles greater than 15 μm (micrometers).

ITEM 11.1.

2967 **Fugitive dust**2968 **“... dust you are, and to dust you shall return”**

2969 Two California sites at opposite sides of the state routinely violate PM₁₀ mass standards.
 2970 They are Owens Lake, in Inyo County on the eastern side of the Sierra Nevada and Oceano
 2971 Dunes State Vehicular Recreation Area on the coast in San Luis Obispo County.

2972 **The \$1.2 billion debacle at Owens (dry) Lake**

2973 My wife, Ginny, and I had been instrumental in protecting Mono Lake from 1979 to 1994.
 2974 But the collaborative attempts of my UC Davis research group, ARB, and the State Lands
 2975 Commission to halt persistent problems with choking dust from Owens (dryish) Lake were met
 2976 with misguided opposition. Ill-advised mitigation expenditures totaling \$1.2 billion have been
 2977 largely ineffective at Owens Lake, where extreme winds blowing across a very large, flat, dry
 2978 lakebed that has veins of salt brines produce mammoth dust storms. Fifteen years after we
 2979 proposed a more effective, more natural solution that was rejected, we're saying “We told you
 2980 so.”

2981 Unless your car happen to break down in Keeler, California, during an Owen Lake dust
 2982 storm, you can safely ignore this section. But I am including it because I am still ticked at my
 2983 failure to protect the long-suffering people of the lower Owens Valley. So humor me on this one.

2984 Owens Lake was a 110-square-mile lake in the lower Owens Valley in Eastern California.
 2985 During the 19th century, steamships operated on it, transferring ore from Cerro Gordo silver
 2986 mines destined eventually for the tiny pueblo of Los Angeles. But the tiny pueblo grew, and was
 2987 thirsty, and in the 1920s the Los Angeles Department of Water and Power (LADWP) grabbed
 2988 Owens Valley water to quench its thirst, cutting off the water supply to the lake, which within a
 2989 few years dried up.

2990 Vast dust storms ensued throughout the following decades. Finally in 1979, responding to
 2991 complaints from the China Lake U.S. Naval Ordnance Test Station (yes, in the desert) that the
 2992 facility would be relocated to Utah unless the dust was abated, the Air Resources Board funded
 2993 me to find out what was causing the dust. Los Angeles claimed it was natural, but I proved it was
 2994 the bed of the artificially depleted lake, and I worked with the local air quality management
 2995 district to force L.A. to clean it up. So far, so, good, but when the local district proposed

ITEM 11.1.

2996 spreading old tires and appliances on the lake bed to help hold the dusty soil in place, the State
 2997 Lands Commission – which has jurisdiction over the bed – interceded, and declared that only
 2998 natural methods of dust abatement would be acceptable. With an international team of dust
 2999 experts, including 17 UC Davis faculty members, and funding from the ARB, we did the
 3000 research studies, published peer-reviewed papers, and with State Lands Commission funds, built
 3001 a 1 km² dust mitigation array, which worked splendidly.



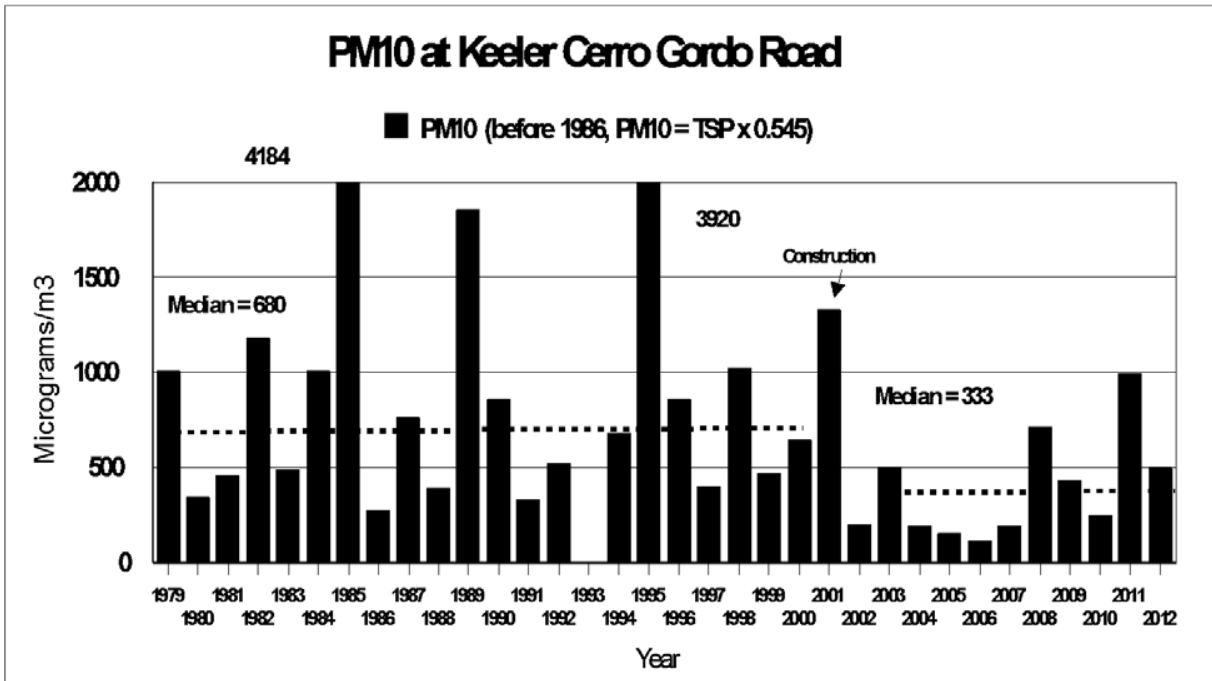
3002
 3003 Figure 14-2. Sand fences (seven sets visible) early in the SLC UC Davis mitigation
 3004 project.

3005 We planned an ecologically based reclamation that would mimic natural processes – fence-
 3006 stabilized dunes, vegetated, with water courses and marshes, all of which already existed at
 3007 places around the lake. It would achieve 90 percent control in 10 years for \$72 million, and leave
 3008 a natural-appearing desert landscape and wildlife habitat.

3009 Well, our concept was rejected in favor of an engineering approach with gravel, sand, and
 3010 shallow ponds. In 1997 I explained in detail why that approach would not work, further
 3011 cementing my persona-non-grata status with the local air district. Beginning in roughly 2000, the
 3012 gravel-and-sand experiment began, including construction of roads with wind-erodible sand

ITEM 11.1.

(which I pointed out would be a tragic mistake!); as a consequence, the dust became much worse. One site had an astounding $16,500 \mu\text{g}/\text{m}^3$ event in 2001 (the standard was $150 \mu\text{g}/\text{m}^3$) Everybody assumed this dust dispersion would be temporary, but look Figure 14-3 and judge the results yourself.



3017

Figure 14-3. Long-term PM₁₀ data on maximum dust storms, 1979–2012.

By roughly 2012, LA had spent about \$1.2 billion for project funding

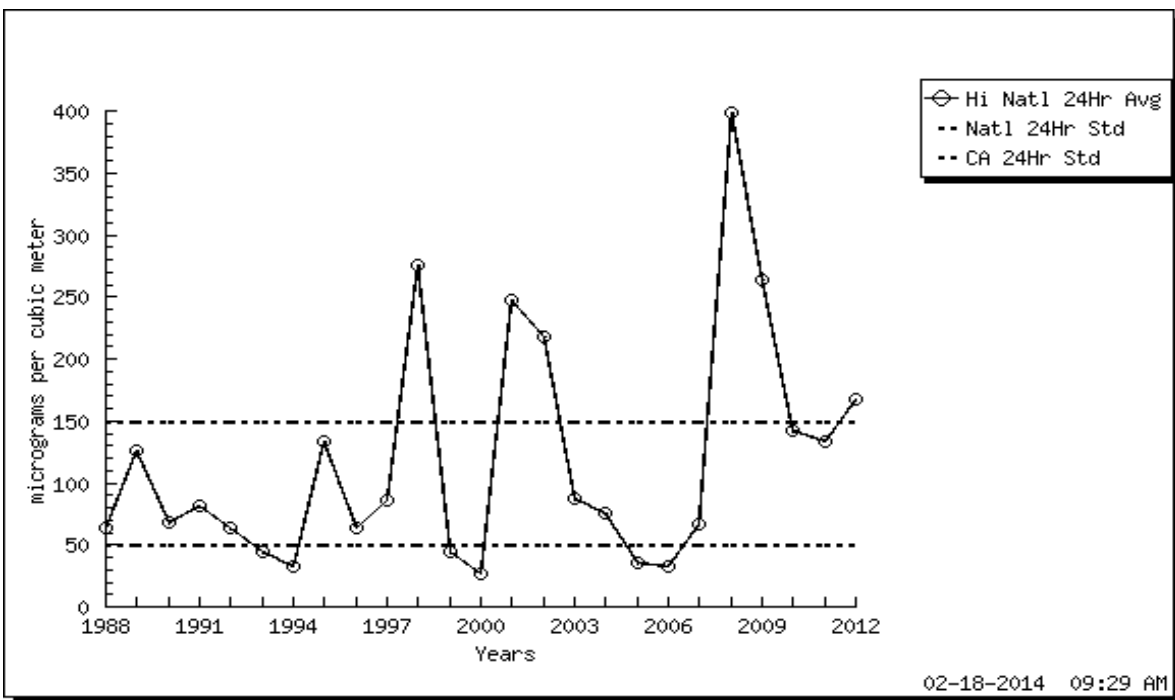
So one can argue a factor of two improvement, but still a far cry from both the state and federal air quality standards and the 98 percent the district required, one reason why our 90 percent effort was rejected. In almost every other metric, the situation has actually worsened, with inhalable fine particles, rich in naturally occurring arsenic, actually increasing. The key problem is that LADWP and the air district are using an engineering approach to an ecological problem. They are fighting Mother Nature, and Mother Nature is kicking their butts.

The sad thing is that this happened once before, and Mother Nature gave us the answer – for free! The 1972 Lone Pine earthquake, magnitude about Richter 7.7, struck just north of Owens Lake, which at that time was full of water. The western edge of the lakebed dropped in elevation by at least 10 feet, perhaps up to 30 feet in places, exposing about 1 mile of shoreline

ITEM 11.1.

3030 on the eastern edge near the small village of Swansea. Like its namesake in Wales, Swansea had
 3031 been a mining port but suddenly there was a mile of salt-laden lake playa between the town and
 3032 the lake.

3033 However, in the next 100 years, vegetated dunes built up and trapped the sand, so that
 3034 when the wind blows, no dust is generated. The same thing happened over centuries east of
 3035 Mono Lake. Thus our use of sand fences and vegetation merely compressed into about 10 years
 3036 the timeline of what would eventually have happened in a century.



3037

3038 Figure 14-4. PM₁₀ aerosols in the nearest town, Lone Pine, about 6 miles north of the
 3039 Owens Lake bed.

3040 A new effort, consisting of deep plowing to make clods to trap the sand, has been under
 3041 way, but these clods will dissolve in the next periodic flooding that occurs. I wish them luck, and
 3042 I will be watching. But as of the most recent data, Owens (dry) Lake remained the largest single
 3043 source of PM₁₀ dust in the United States, \$1.2 billion and counting notwithstanding.

ITEM 11.1.

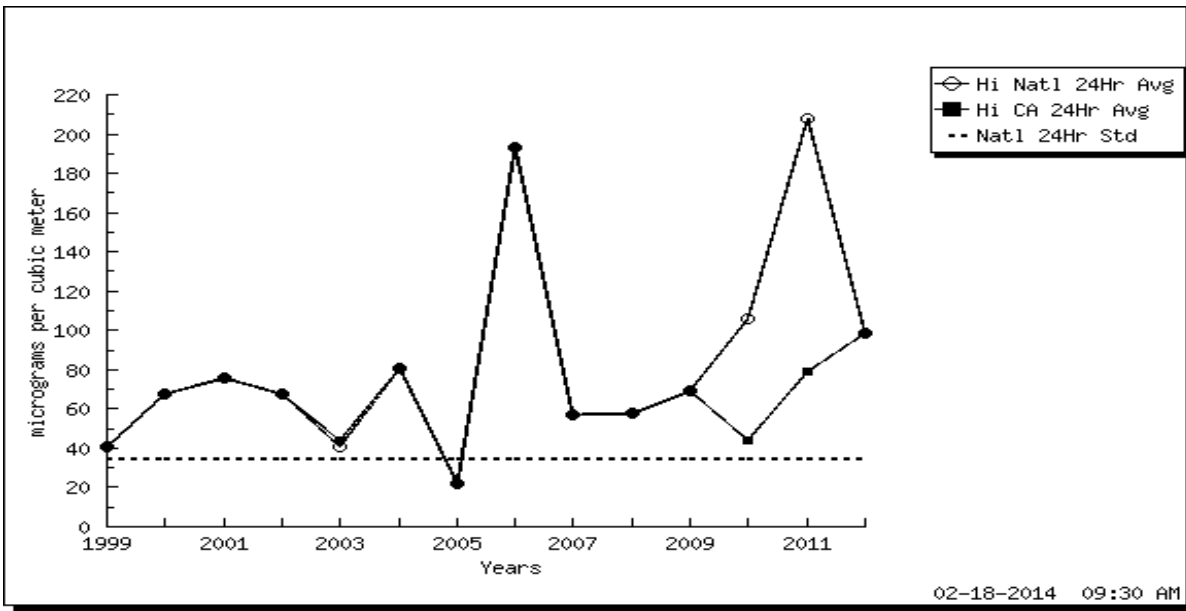


Figure 14-5. PM_{2.5} aerosols in Keeler, next to the heavily mitigated part of the Owens Lake dry bed.

Oceano Dunes State Vehicular Recreation Area

The amount of damage that off-road vehicles have done to coastal sand dunes at Oceano Dunes State Vehicular Recreation Area (SVRA) in San Luis Obispo County, California, is difficult to imagine. There the dust can be very fine, and when it enters the lung, it becomes an urgent health problem – not yet mitigated.

Many people are surprised to learn that considering all the areas of the United States that are dry and have disturbed soils, the only two sites that routinely violate the U.S. EPA PM₁₀ mass standard are both in California. Particularly surprising, the violations at Oceano Dunes, inland of an ocean beach near scenic Pismo Beach, are caused by human activities – in this case, off-road vehicles destroying naturally vegetated sand dunes. Oceano Dunes is the only California State Park where vehicles may be driven on the beach.

The San Luis Obispo County Air Pollution Control District approached my colleagues and me about a problem at their Mesa 2 air sampling site, which was upwind of a major new residential development. (see Figure 12-6). SLO County APCD personnel were recoding routine violations of the EPA PM₁₀ mass standard, and the questions were two-fold: 1) What are the

ITEM 11.1.

3062 source(s), and 2) How can these be mitigated? They also should have inquired about health
3063 impacts.

3064 There were three possible sources:

- 3065 1. Sand blowing off the off-road vehicle areas of Oceano Dunes State Vehicular Recreation Area
3066 (SVRA)
- 3067 2. Dust blowing off agricultural fields upwind of the Mesa 2 site
- 3068 3. Materials from the large petroleum coke piles from the ConocoPhillips oil refinery directly
3069 upwind of Mesa 2.

3070 The staff of Oceano Dunes SVRA argued that its sand, as defined as particles 50 μm to
3071 2,000 μm diameter, could not be the source of the PM_{10} violations, which included only particles
3072 smaller than 10 μm in diameter. They argued that agricultural soils and their silt, 2 μm to 50 μm
3073 in diameter, were more likely sources.

3074 Our analytical approach consisted of several components:

- 3075 1. Routine monitoring at Mesa 2 measuring aerosols every three hours and analyzing for mass
3076 and elemental constituents.
- 3077 2. Intensive measurements for a few weeks at times of predicted dust events, from Grover Beach
3078 in the north to Ten Commandments at the south (actually Guadalupe Dunes State Park, but
3079 known for being the site of a massive old set for Cecil B. DeMille's 1923 motion picture *The*
3080 *Ten Commandments*).
- 3081 3. Detailed analysis of the size and composition of potential sources for the PM_{10} mass.

ITEM 11.1.



3082

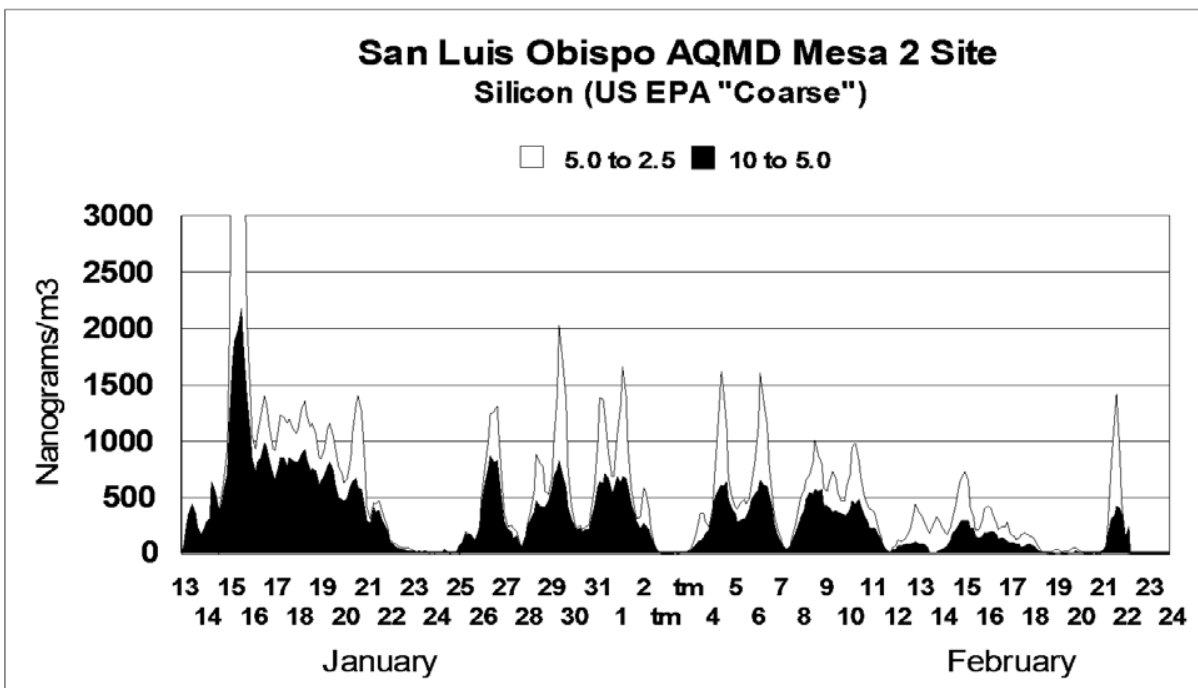
156

Cahill -- 00000161

ITEM 11.1.

3083 Figure 14-6. Aerial photo of aerosol sampling sites, showing prevailing wind direction in
3084 aerosol episodes.

3085 All the evidence, from the chemistry, the wind and sand salt profiles, and Figures 14-9 and
3086 14-10, clearly show that the source of the problem is the disturbed sands at Oceano Dunes
3087 SVRA.



3088

3089 Figure 14-7. Silicon, the major component of soil, in the coarse modes during the winter
3090 2008 deployment.

3091 Studies of the ConocoPhillips slag piles and agricultural soils showed sizes and chemistry
3092 that greatly differed from the observed aerosols that caused the PM₁₀ violations.

ITEM 11.1.

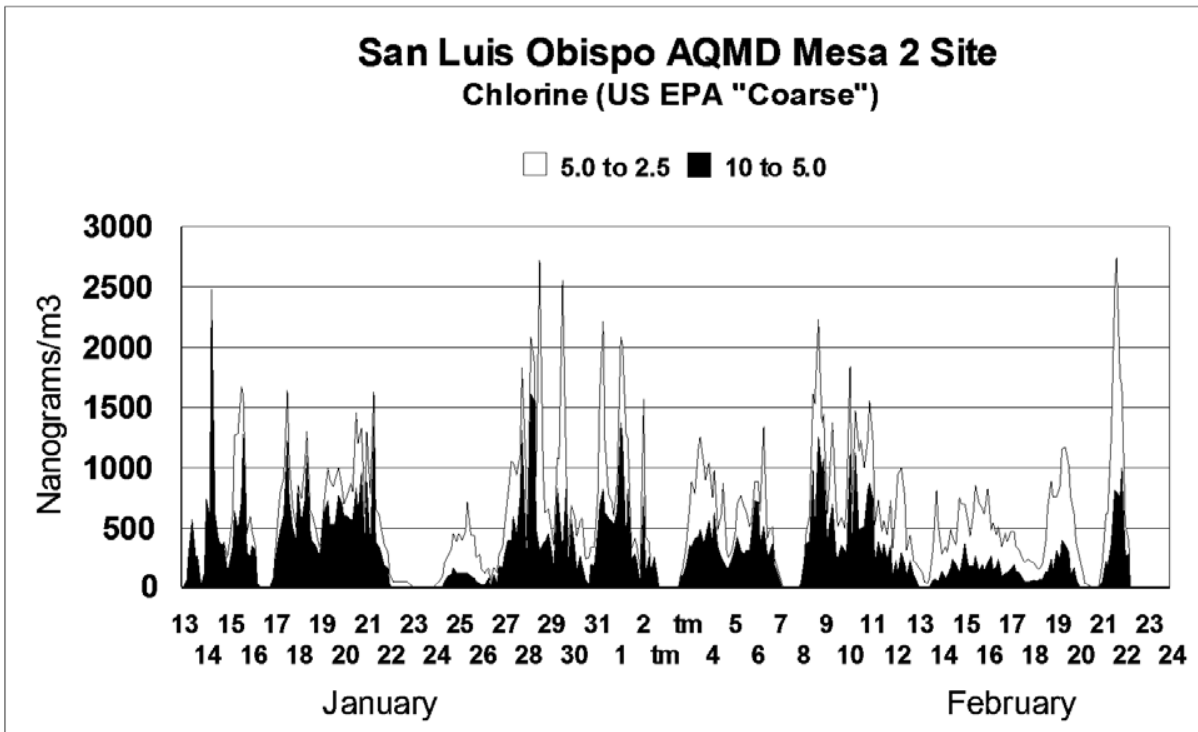


Figure 14-8. Coarse particle chlorine, a sea salt tracer, at Mesa 2, January–February 2008. For the mass of sea salt, multiply by about 1.6.

Finally, just south of the Oceano Dunes site (south of the Oso site in Figure 14-6) is a section of dunes in the Santa Maria oil field that has been off limits to vehicles for decades. The Santa Maria dunes are heavily vegetated, and areas downwind of it have far less dust than at Mesa 12.

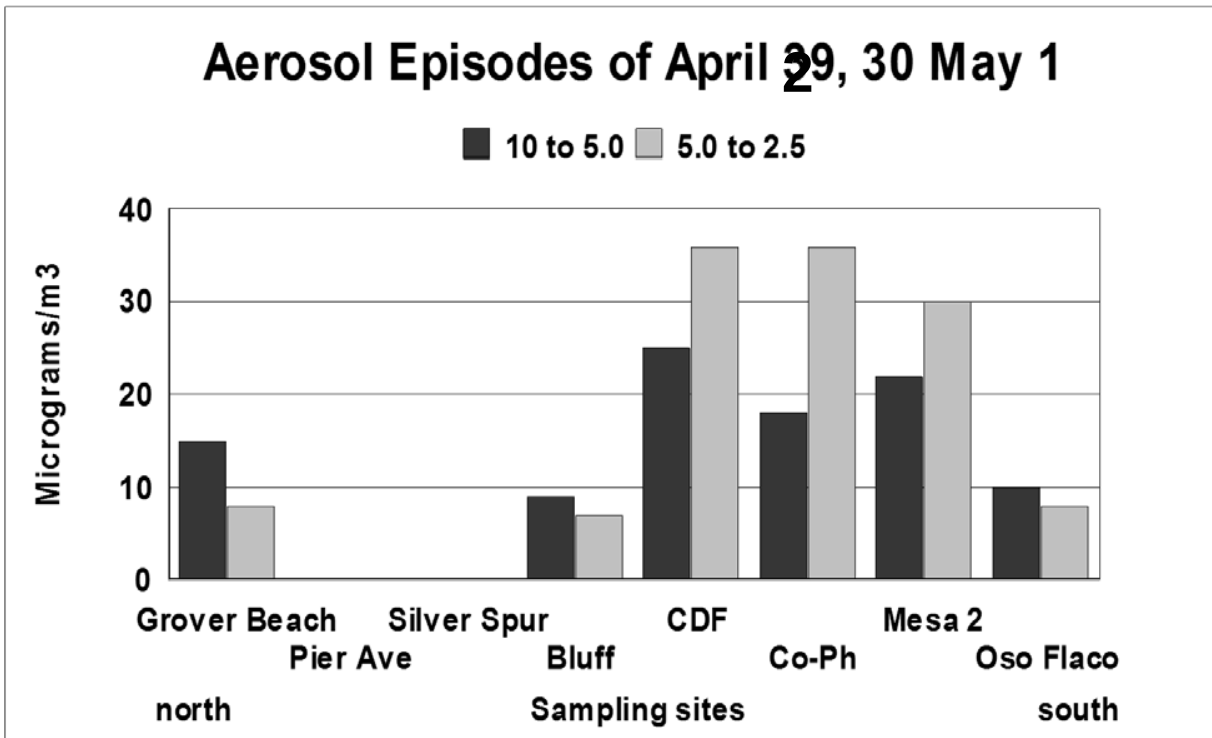
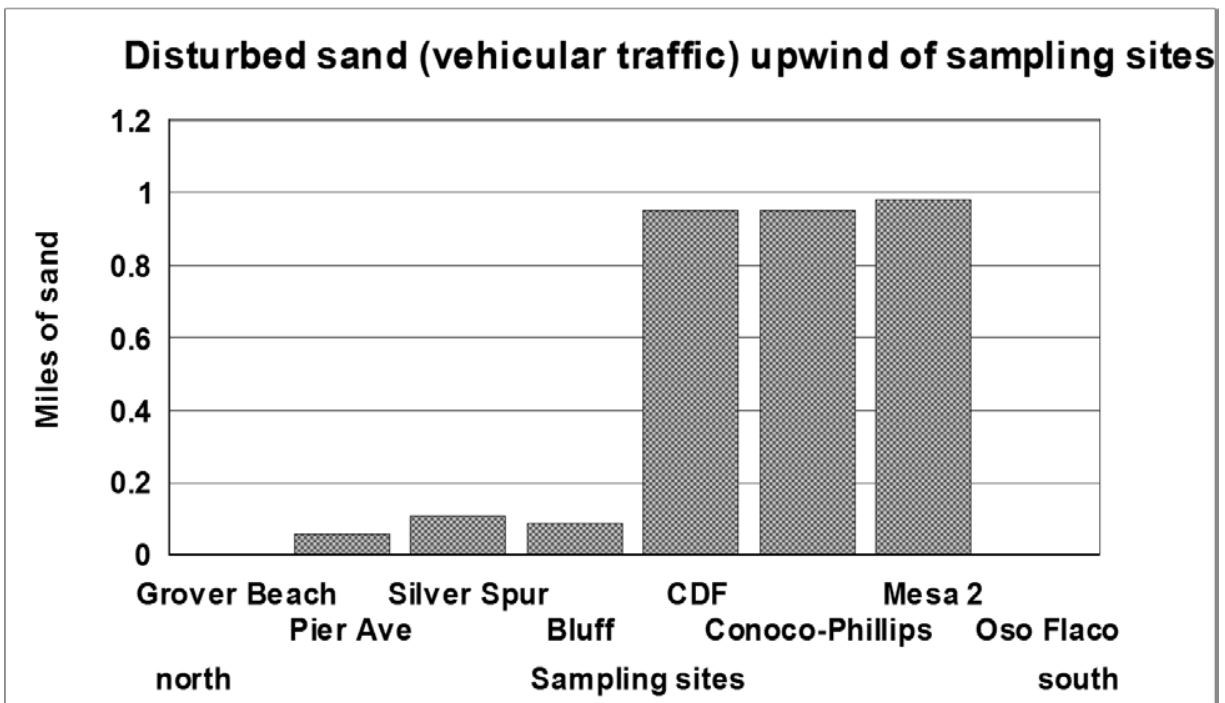


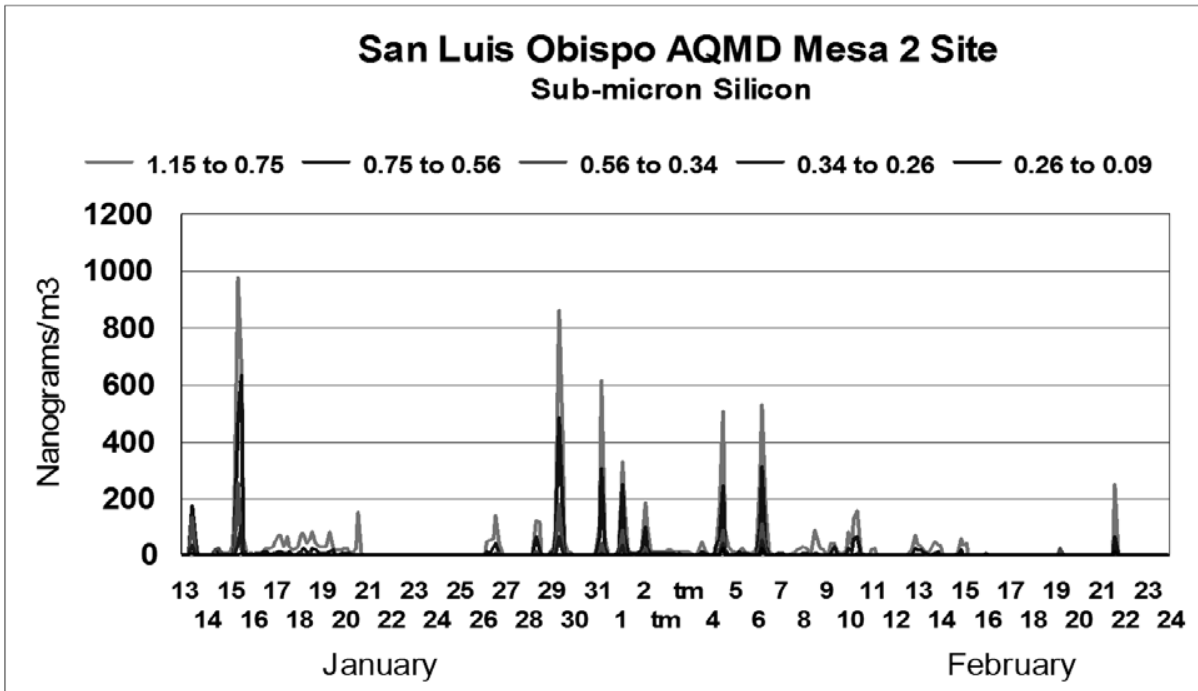
Figure 14-9. Transect across the array for particles between 10 and 5.0, and 5.0 to 2.5 micrometers, averaged over all three daytime episode peaks, April 29 through May 1.



ITEM 11.1.

3104 Figure 14-10. Amount of vehicular disturbed sand upwind of sampling sites.

3105 But unexpectedly, we found that very fine silicon particles, capable of deep lung
 3106 deposition, also were coming from the Oceano Dunes SVRA. The likely source is the abraded
 3107 sand from the intense off-road vehicle activity. This puts the health impact of the off-road
 3108 vehicle activity into an entirely new and more dangerous category, and makes mitigation far
 3109 more urgent.



3110
 3111 Figure 14-11. Silicon in the submicron or highly respirable fraction, PM_{1.0}, which
 3112 penetrates more deeply into the lung.

3113 How can I protect myself?

3114 Dust is dominated by coarse particles, with generally modest health effects. Because dust
 3115 is often of local origin, the most effective mitigations are:

- 3116 1. External controls – anything that will prevent dust from being re-suspended near your
 3117 residence or place of work
- 3118 • Unpaved roads constitute a major threat. Pave your driveway.
 - 3119 • Use vegetative barriers and lawns.

ITEM 11.1.

3120 2. Internal controls

3121 • Install good air filters in your furnace and air conditioner.

3122 • Practice excellent hygiene, wet washing floors often.

3123 • Avoid rugs.

3124 • Maintain a high internal humidity, using plants to trap dust.

3125 3. Take special precautions during dust storms.

3126 • If you must go out, use a face mask (paper types are fine for this purpose).

3127 References

3128 • Barone, J.B., L.L. Ashbaugh, B.H. Kusko, and T.A. Cahill. 1981. "The Effect of Owens Dry
3129 Lake on Air Quality in the Owens Valley with Implications for the Mono Lake Area." In
3130 *Atmospheric Aerosol: Source/Air Quality Relationships*, edited by P. Radke. 18: 327–346.
3131 ACS Symposium Series, No. 167.

3132 •

3133

ITEM 11.1.

3134

Chapter 15

3135

It May Be Organic, But It Still Sucks!

3136

Biologicals, valley fever, and allergens (indoor mitigation)

3137

Major impacts: Death, permanent loss of lung function

3138

Introduction

3139

Ring around a rosie,

3140

Pockets full of posies,

3141

Ashes, ashes

3142

We all fall down

3143

I am amazed that this ditty has survived the centuries, a reflection of the panic and despair of the period of the Black Death. It is a specific reference to pneumonic plague, the most dangerous and contagious kind. (“Ashes” actually symbolizes *achoo*, a sneeze, and the method of aerosol transmission, and the posies are herbs in their pockets and proved useless to ward off the disease. But the last line is accurate.) Current cases of pneumonic plague still crop up (in Colorado, for example, in 2014), but most of the examples are in Africa.

3149

Many of the really dangerous diseases are communicated by aerosols exhaled by sick people – 20 million to 50 million died from the Spanish flu in 1919, tuberculosis is still a killer, measles is making a comeback, and people are dying in New York after being infected with Legionnaires’ disease transmitted by airborne aerosols.

3153

The scientific community is increasingly acknowledging that biological aerosols may be far more important in terms of health impacts than formerly appreciated. Hay fever is caused by pollen, a very coarse particle that can irritate the bronchial tract. The question of the sources of asthma is far beyond the scope of this book, but California Central Valley asthma rates peak in winter, when pollen is low.

3158

Two examples: Valley fever and Legionnaires’ disease

3159

Example 1 – Valley fever

ITEM 11.1.

In terms of ambient atmosphere, one of the most potent biological aerosols in California is the fungus that causes valley fever (also known as San Joaquin Valley fever). Valley fever is caused by *Coccidioides immitis*, a fungus that lives in soil in the southwestern United States and parts of Mexico, Central America, and South America. Inhaling the airborne fungal spores can cause an infection called coccidioidomycosis, which is also known as “cocci” or “valley fever.” Most people who are exposed to the fungus do not get sick, but some people develop flu-like symptoms that may last for weeks to months. In a very small proportion of people who get valley fever, the infection can spread from the lungs, where it can cause permanent fungal masses. It can also cause distress in the rest of the body and can lead to more severe conditions, including meningitis or even death. Valley fever cannot spread from person to person. Estimates are that as many as 150,000 people become infected each year; many feel sick but don’t know the reason, and it goes unreported (CDC 2014).

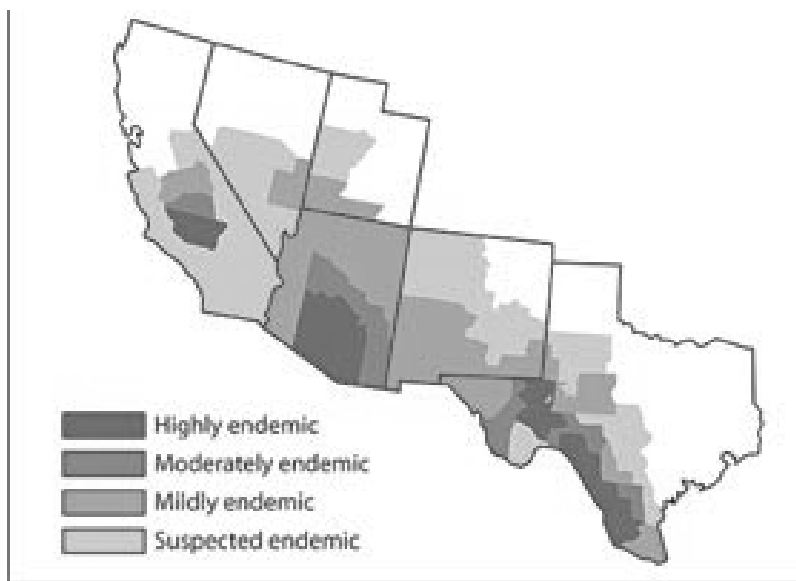


Figure 15-1. Areas with valley fever, which is named after California's San Joaquin Valley.

The annual number of cases of valley fever has been increasing in recent years, possibly because of higher numbers of people exposed to the fungus or due to changes in the way cases are being detected and reported.

Anyone can contract valley fever, including children. However, it is most common among older adults, particularly those 60 and older. People who have recently moved to an area where

ITEM 11.1.

the disease naturally occurs are at higher risk for infection. Several groups of people are at higher risk for developing the severe forms of valley fever, including:

- African Americans
- Asians
- Women in their third trimester of pregnancy
- People with weak immune systems, including those with an organ transplant or HIV/AIDS

Susceptibility to valley fever has become a major problem among inmates who have no resistance to the disease and have been relocated from urban areas to California prisons in the Central Valley. A recent bout of valley fever at Avenal and Pleasant Valley state prisons may have been tied to dust from local construction projects.

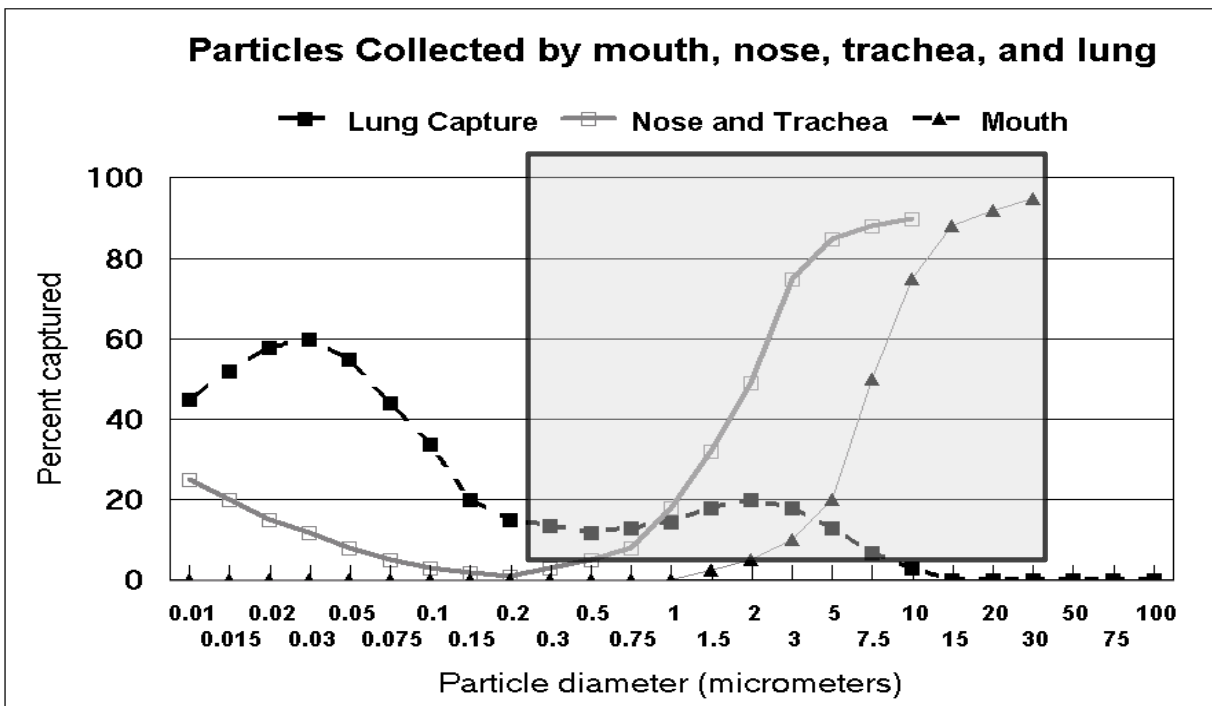


Figure 15- 2. The shaded area shows the size range and lung deposition for re-suspended dust with valley fever spores. Data evaluating the size of the spores is sparse.

How can I protect myself?

ITEM 11.1.

3195 Because valley fever is caused by coarse particles, usually attached to soil dust, the same
 3196 mitigations used for coarse dust (Chapter 12, Soil dust) work here.

3197 1. Live elsewhere. Children who grow up in the area seem to gain immunity when young, but
 3198 older people moving into valley fever areas are at risk.

3199 2. External controls – anything that will prevent dust from being re-suspended near your
 3200 residence or place of work.

3201 • Unpaved roads are a major threat. Pave your driveway.

3202 • Use vegetative barriers and lawns.

3203 3. Internal controls

3204 • Good air filters in your furnace and air conditioner are helpful.

3205 • Practice excellent hygiene, wet washing floors often.

3206 • Avoid rugs.

3207 • Maintain a high internal humidity, using plants to trap dust.

3208 4. Take special precautions during dust storms.

3209 • If you must go out, use a face mask (paper ones are fine for this purpose).

3210 For other biological aerosols, the high air change per hour filtration described in Chapter 16
 3211 (radon) would be highly effective in removing:

3212 • disease aerosols, and

3213 • pollen from the air

3214 **Pollen**

3215 Pollen has a similar size mode as dust, but the biological impact can be severe. However,
 3216 removal of pollen from indoor air is relatively easy, because any high-efficiency modern furnace
 3217 filter (3M Filtrete, for example) can remove these particles while allowing large air flows
 3218 necessary to clean large indoor air volumes.

ITEM 11.1.

3219 I propose, but have no data yet to confirm, that placing a 3M Filtrete filter on the front of a
 3220 box air fan in such a way that air passes through the filter rather than around it could be highly
 3221 effective.

3222 **Example 2 – Legionnaires’ disease**

3223 The second example of a biological aerosol is Legionnaires’ disease. It is associated with
 3224 aerosols and mists of warm water, in the United States often derived from air conditioning units.
 3225 It affects about 13,000 people per year, and has an average mortality rate of about one in four.
 3226 Unlike valley fever, it is a disease of cities, often striking in summer months. A recent
 3227 occurrence in the Bronx borough of New York in 2015 resulted in 119 illness and 12 deaths. It
 3228 was traced to a contaminated air conditioning system on the roof of a hotel.

3229 **How can I protect myself?**

3230 It is almost impossible to protect yourself from this threat. Keeping in touch with health alerts is
 3231 the best that you can do. However, because it is carried on a mist, a simple paper mask, which is
 3232 otherwise useless to stop most air pollution, probably could be effective.

3233 **Smoke from medical lasers**

3234 **Happily, this is irrelevant to almost everybody except surgeons.**

3235 Allen M. was one of the smartest undergraduate physics students who ever worked with
 3236 me in the DELTA Group. As he was graduating, I took him aside and asked how I could help his
 3237 future plans. He allowed that he wanted to go to med school. I was taken aback, but he gave a
 3238 good reason: an M.D. to Ph.D. to research path. So I proposed that he do some medically
 3239 relevant research that used his skills in collecting and analyzing aerosols. Allen went away, and
 3240 came back the next week with a proposal: “I can map bacterially active spray aerosols from
 3241 men’s urinals.” I told him no matter how well you do, people will snicker. Try again. Next week,
 3242 one of us had noticed that there was a problem with doctors using lasers to remove moles;
 3243 occasionally physicians would in turn get moles, probably from the smoke from the laser
 3244 scalpels.

3245 So we designed an experiment: use a laser on infected material and collect the aerosols,
 3246 then culture them and see what grows in the eight size modes. He also came up with the idea of

ITEM 11.1.

3247 putting a standard surgeon's mask on a manikin and measuring how well the mask stopped the
 3248 laser scalpel smoke from passing through. Well, we approached the UC Davis medical school to
 3249 ask for their help (and the laser scalpel) and got nowhere. However, UC Davis also has a world-
 3250 renowned School of Veterinary Medicine, personnel in which were happy to help. They provided
 3251 us with a CO₂ laser scalpel and two sections of tissue from a recently killed horse – the
 3252 bacterially filthy tongue and the bacterially clean liver. So one afternoon, Alan did laser cuts on
 3253 the tongue and then the liver, collecting the aerosols. The entire basement floor of the vet med
 3254 building smelled like burning horse.

3255 Alan then cultured the drum strips and the filter from the manikin, and got all sorts of
 3256 bacterial colonies in sizes much smaller than we had expected. The surgeon's mask was useless
 3257 to stop these biologically active aerosols. So we wrote and published a short paper (Miller and
 3258 Cahill, 2007) pointing out how dangerous was the smoke from laser surgery on infected patients
 3259 (start with AIDS, and then let your imagination plumb the depths).

3260 So Alan applied to many med schools, and reportedly got interviews in all of them. In
 3261 every case, he told me, our paper was on the table. Every medical school to which he applied
 3262 accepted him, but he chose UC Davis. He had great success as a med student (as I had
 3263 anticipated), paying for it by innovative use of eBay, including specialty apparel for a very
 3264 selective niche clientele.

3265 So that is how innovative research gets done. The right people, crazy ideas, good
 3266 technology.

3267 Reference

- 3268 • Miller, Alan E., and Thomas A. Cahill. 2000. "Size and Compositional Analyses of
 3269 Biologically Active Aerosols From a CO₂ and Diode Laser Plume." *International Journal of*
 3270 *PIXE* 9 (3 and 4.5).

3271

ITEM 11.1.

Chapter 16

*On Little Cat's Feet**Pollution-enhanced fogs*

Major impacts: Vehicle accidents and death, asthma exacerbation.

Introduction

They are still dead, but somehow they don't count against the death rate from air pollution.

Late December one year in the early 1970s, my wife, Ginny, and I were driving northbound on California Highway 99, returning home after visiting my parents at their home in Los Angeles. Somewhere near Visalia in the southern San Joaquin Valley, we saw an enormous line of wrecked cars and trucks in the southbound lanes that went on for miles. We learned that the massive pileup occurred earlier that morning when southbound traffic suddenly entered a bank of tule fog, cutting visibility down to a few hundred feet or less. As the vehicles braked, multiple collisions occurred.

Tule fog always formed in the valley in winter, as cold air slid down from the mountains at night and formed a shallow but dense pool of cold air over the extensive tule marshes in the valley. Visibility in tule fog banks usually is often only a few hundred feet or less, and the fog can sometimes be patchy – dense here, nothing a mile away. This causes real problems with high-speed traffic, especially with a mixture of heavy trucks. I have been in fogs so dense that I could barely see the next white dashed marking on the highway lanes, barely 30 feet ahead.

The pileups occur regularly each year, involving scores of cars and usually a few fatalities. Further, the fog occurs in places where historical records never reported tule fogs before. These Central Valley fogs are totally different from the ones I knew in San Francisco. The oceanic fogs are dense, but as soon as the air warms a bit and humidity drops below 100 percent, the fog dissipates to a clear blue sky. In the Central Valley, the fogs start to form well below 100 percent humidity, and the sky goes from light gray to darker gray to fog, and then back again. It makes for a gloomy winter scene.

ITEM 11.1.

The culprit appears to be ammonium nitrate mostly from diesel trucks, as shown in Figure 14-1, based on a multi-day period of stagnant air and fogs. The data from Fresno, California, show that most of the mass is ammonium nitrate, which has a strong tendency to absorb moisture from the air and binds to water. Thus each night the particles hang suspended in the air waiting for the air to cool, and the fog becomes increasingly dense. Unlike oceanic or “wet fogs,” pollution-enhanced or “dry” fog from does not cause water to drip from trees.

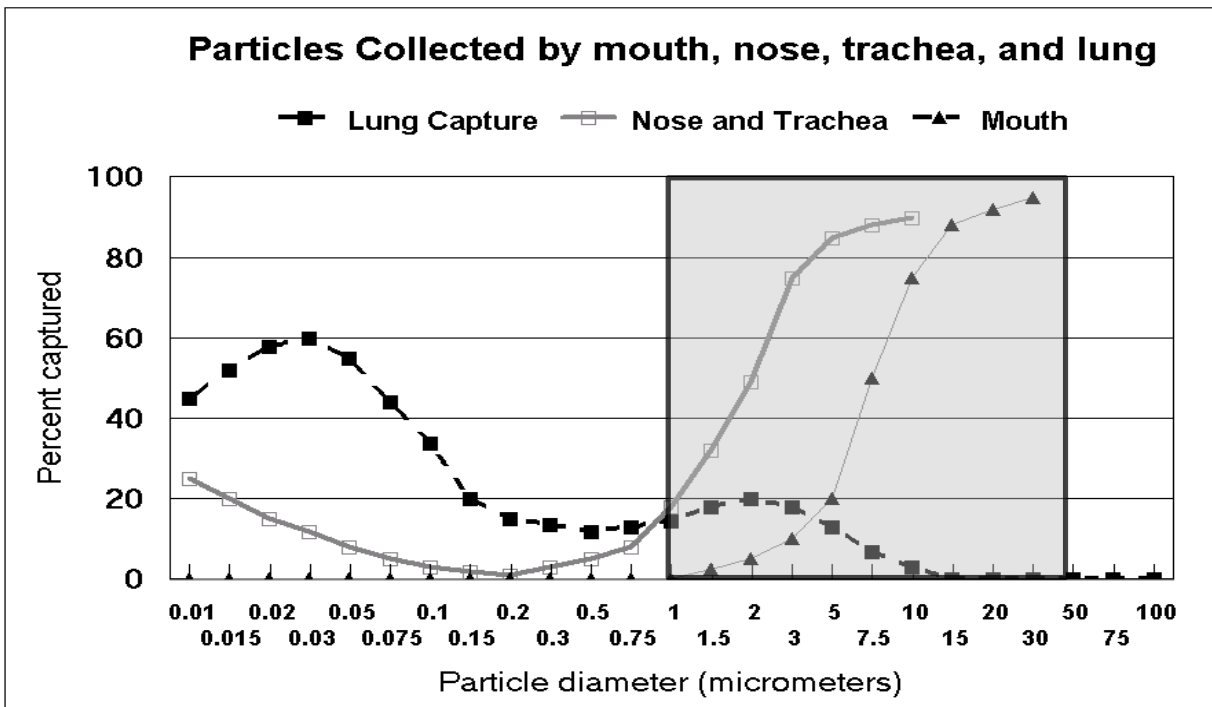


Figure 16-1. Size distribution and lung deposition of fog droplets, with a mode around 10 to 15 μm (micrometers).

How can I protect myself?

The good news is that the fog consists of water and hydrophilic ammonium nitrate, which are relatively harmless by themselves. The same conditions, however, also concentrate hydrophobic ultra-fine metals, which have heavy cardiovascular impacts, and soot, a carcinogenic aerosol.

- Avoid driving in Central Valley fogs. Take Amtrak – especially at night when patchy fogs form.

ITEM 11.1.

Nitty-gritty details

Figure 16-2 illustrates a typical Central Valley stagnation event with nighttime fogs.

Ammonium nitrate, the major component of mass, picks up water (Cahill et al., 2011a). Note that in an attempt to meet mass standards, the local air district is trying to curtail use of fireplaces, which the data show will never work.

Similar data are available in Sacramento, showing again that on most days, the major pollutant is ammonium nitrate.

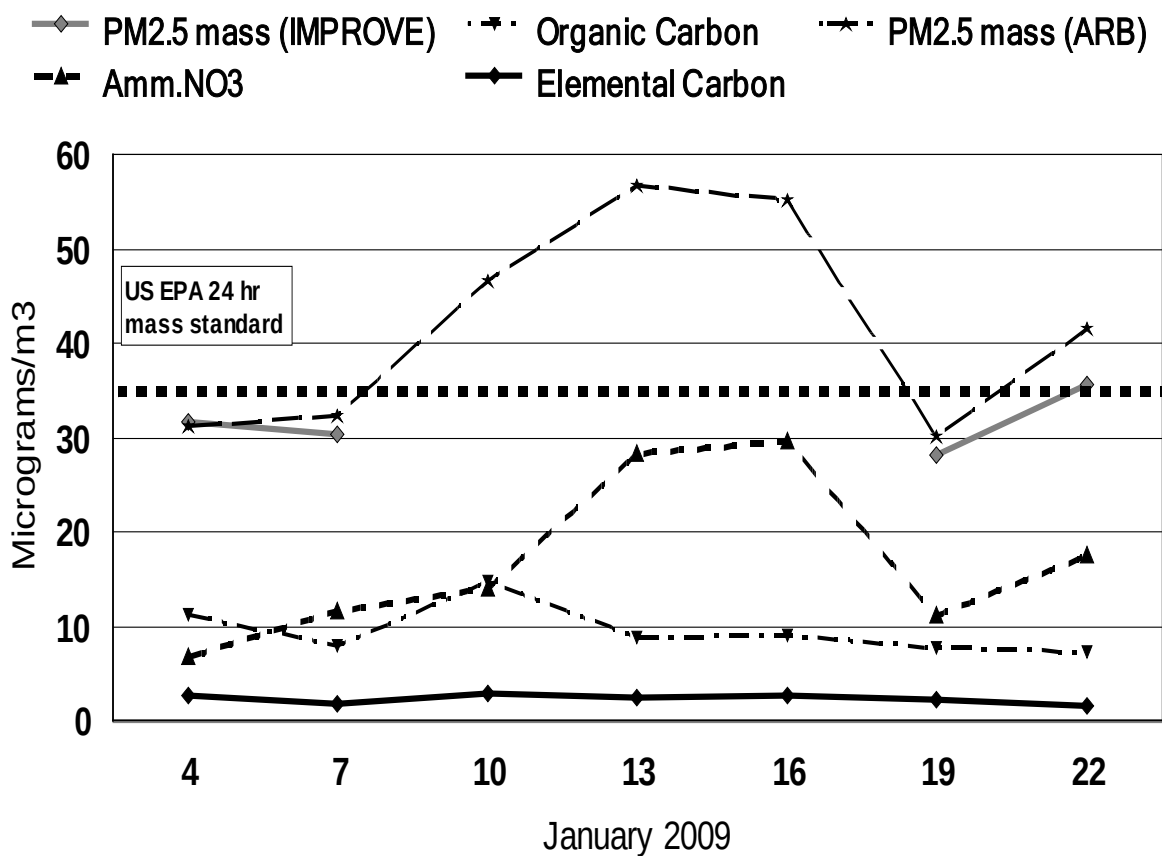


Figure 16-2. Aerosol mass components during extensive stagnation and fog conditions at Fresno, California (Cahill et al., 2011a).

ITEM 11.1.

Chapter 17

*Asbestos**Full employment for ambulance-chasing lawyers***Major impacts: Lung cancer, mesothelioma, asbestosis****Introduction**

Asbestos is the name given to a class of silicate minerals from rocks such as serpentine that tend to form long, flexible fibers. As a mineral, it has several properties that made it useful in industry, especially its ability to withstand high temperatures without burning or melting. Thus it was a natural for insulating steam pipes and making brake pads.

Asbestos is not toxic per se. Its detrimental health effects come from two properties:

1. It forms long, thin fibers that can pass deep into the lung.
2. It is insoluble in lung fluids, so it persists for a lifetime.

The fiber by itself is far too long to invade the deep lung, but because it is so narrow, it aligns with the air stream and thus bypasses the lung's normal defenses. Once in the lung, it is so long that it keeps poking the lining of the alveoli – the tiny air exchange sacs in the lungs. This continually irritates the lung wall, causing cells to continually divide while repairing the damage.

If a mutagen such as cigarette smoke or diesel exhaust is present, these rapidly dividing cells become prime candidates for lung cancer. That is why asbestos plus smoking is an order of magnitude more deadly than either asbestos or smoking alone. Regretfully, the majority of World War II defense workers who installed asbestos wrappings on ships' steam pipes smoked like chimneys. The effects were and are dire.

The most common asbestos-related health effects are all serious:

1. lung cancer
2. mesothelioma, a rare form of cancer that is found in the thin lining of the lung, chest, and the abdomen and heart

ITEM 11.1.

3350 3. asbestosis, a serious progressive, long-term, non-cancer disease of the lung

3351 However, disease symptoms often do not develop until many years following exposure,
 3352 which contributes to making asbestos-related conditions difficult to identify. So while legal
 3353 settlements are absolutely essential and usually well supported by fact, the fringes of the problem
 3354 allow for full employment for ambulance-chasing lawyers.

3355 Asbestos has been used in a variety of building construction materials for insulation and as
 3356 a fire retardant. It also has been a component of building materials (roofing shingles, ceiling and
 3357 floor tiles, paper products, and asbestos cement products), friction products (automobile clutch,
 3358 brake, and transmission parts), heat-resistant fabrics, packaging, gaskets, and coatings.

3359 As the EPA says ominously, “Most uses of asbestos are not banned. A few are banned
 3360 under existing regulations.”

3361 The next step in the problem is identifying how these fibers can migrate from asbestos uses
 3362 into your lung. Fibers from asbestos may be released into the air by the disturbance of asbestos-
 3363 containing material during product use, demolition work, building, or home maintenance, repair,
 3364 and remodeling. In general, exposure may occur only when the asbestos-containing material is
 3365 disturbed or damaged in some way to release particles and fibers into the air.

3366 Scientists became greatly concerned around 1970 that asbestos in brake pads might be a
 3367 major source of fiber dispersal because of the high temperature wear. I was part of a California
 3368 Department of Transportation study on the Santa Monica Freeway in Los Angeles circa 1972–
 3369 1973, studying lead contamination, but another group was studying asbestos. The California
 3370 Department of Transportation investigators told me that very few free fibers were found, and that
 3371 most asbestos was stuck into larger particles of melted drum pad materials and thus did not
 3372 present an inhalation threat. Despite these results, asbestos was banned from brakes on general
 3373 principles (re: the “dark alley” problem), and mandated to be replaced by soft transition metals
 3374 such as copper and zinc (see Chapter 8 to see how that worked out).

3375 **How can I protect myself?**

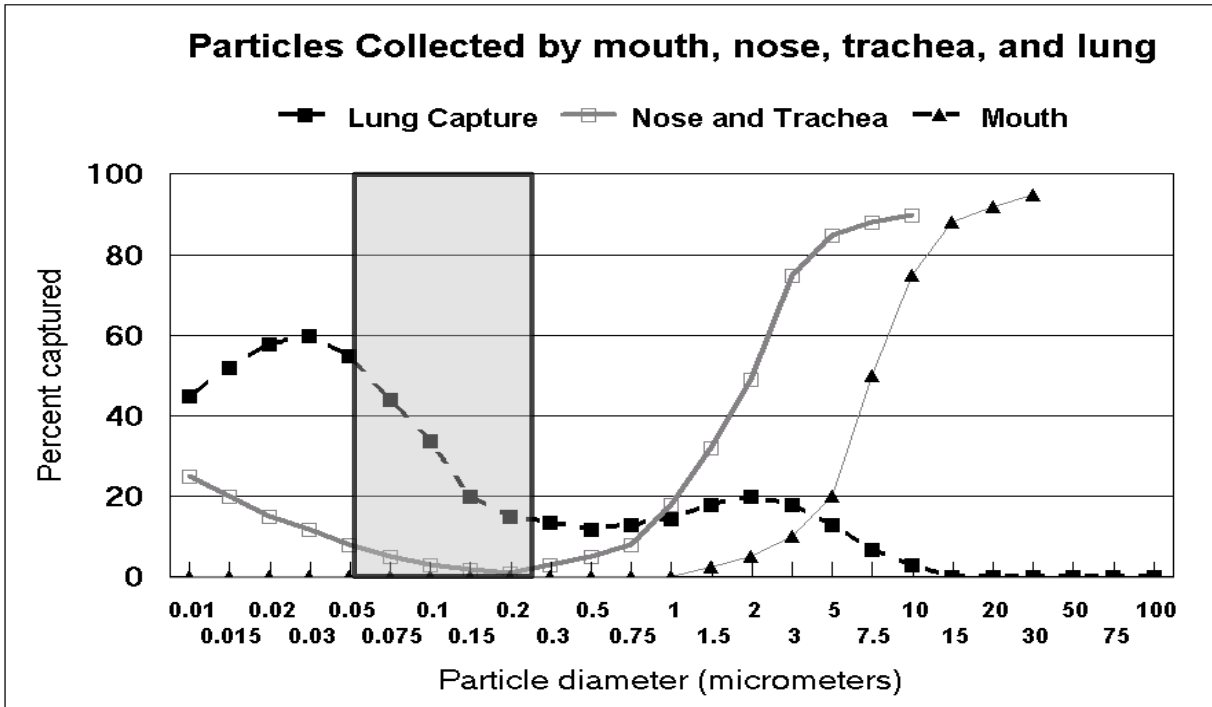
3376 The U.S. Consumer Product Safety Commission (CPSC) states, “Even if asbestos is in
 3377 your home, this is usually **NOT** a serious problem. The mere presence of asbestos in a home or a

ITEM 11.1.

3378 building is not hazardous. The danger is that asbestos materials may become damaged over time.
 3379 Damaged asbestos may release asbestos fibers and become a health hazard.”

3380 Likewise, the CPSC declares, “*the best thing to do with asbestos material in good*
 3381 *condition is to leave it alone!* Disturbing it may create a health hazard where none existed
 3382 before.”

3383 Nitty-gritty details



3384

3385 Figure 17-1. Size range and lung deposition for asbestos fibers by the diameter of
 3386 fibers.

ITEM 11.1.

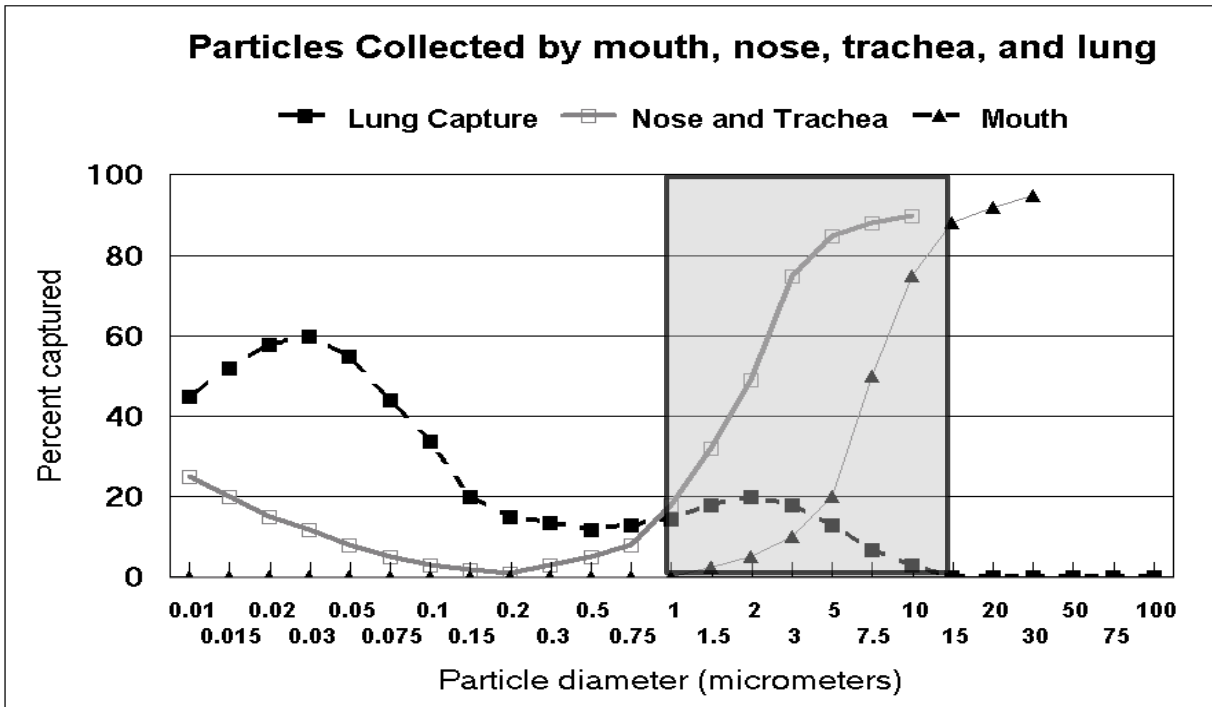


Figure 17-2. Size range and lung deposition for asbestos fibers according to the length of fibers.

The United States Geological Survey (USGS) reports that asbestos has not been mined in the United States since 2002 because of the decline in U.S. asbestos markets due to health and liabilities issues. The United States is dependent on imports to meet manufacturing needs. Asbestos consumption in the United States was estimated to be 400 tons/year, based on asbestos imports through July 2014. The chloralkali industry, which produces chlorine and sodium hydroxide necessary for some manufacturing processes, accounted for about 88 percent of U.S. consumption. The remainder was used in coatings and compounds, plastics, roofing products, and unknown commodities (according to <http://www.asbestos.com/asbestos/types.php>).

Chrysotile asbestos

Many studies have proven that exposure to chrysotile asbestos, commonly referred to as white asbestos, can cause various serious health conditions. While most commercial uses of asbestos in the United States have been of the chrysotile type, the use of this toxic mineral has declined significantly during the past few decades.

ITEM 11.1.

3403 Naturally occurring deposits of chrysotile are often accompanied by trace amounts of
 3404 tremolite (amphibole) asbestos, which is considered more toxic than chrysotile. However, several
 3405 reports have indicated that exposure to solely chrysotile asbestos fibers can occur, and such
 3406 exposure can be equally hazardous as exposure to amphibole asbestos types.

3407 Scientists from the National Institute for Occupational Safety and Health determined that
 3408 chrysotile asbestos should be treated with the same level of concern that the amphibole forms of
 3409 asbestos warrant.

3410 **Amphibole asbestos**

3411 The five other types of asbestos are classified in the amphibole category. Amosite (brown
 3412 asbestos) and crocidolite (blue asbestos) are the most commercially valuable types.
 3413 Anthophyllite, tremolite, and actinolite are non-commercial forms of amphibole asbestos. All
 3414 amphibole fibers are straight and longer than chrysotile fibers, and studies suggest that people
 3415 may develop mesothelioma with less exposure to amphibole asbestos in comparison to the
 3416 amount of chrysotile asbestos exposure required to trigger the disease.

3417 **Amosite asbestos**

3418 According to the American Cancer Society, exposure to amosite asbestos creates a higher
 3419 risk of cancer in comparison to other types of asbestos. Several asbestos studies suggest that
 3420 exposure to amosite can cause lung cancer, mesothelioma and asbestosis.

3421 In its natural state, amosite is known as the mineral grunerite. Commercially, grunerite is
 3422 referred to as amosite or brown asbestos. Approximately 80,000 tons of amosite were mined in
 3423 the Transvaal province of South Africa by 1970.

3424 **Crocidolite asbestos**

3425 Multiple asbestos studies suggest that crocidolite may be responsible for more deaths than
 3426 any other type of asbestos because its fibers are so thin – about the diameter of a strand of hair.
 3427 When airborne, these fibers can be inhaled easily and become lodged in the lining of the lungs,
 3428 more so than other forms of asbestos. Once inside the body, the fibers do not break down easily,
 3429 which can lead to potentially life-threatening lung and abdominal conditions, including lung
 3430 cancer, mesothelioma, and asbestosis.

ITEM 11.1.

3431 These health risks are especially serious among crocidolite miners. Research shows that an
3432 estimated 18 percent of crocidolite miners die from mesothelioma, and people living near
3433 crocidolite mines also may have increased risks for mesothelioma and other diseases. As a result,
3434 mining has virtually ceased in its major source region, South Africa.

3435

ITEM 11.1.

Chapter 18

“Mrs. Brown, You’ve Got a Lethal Daughter”

Radon, harmless mother, killer daughter!

Major impact: Lung cancer

Introduction

Radon is a colorless, odorless noble gas, a decay product of uranium and thorium in rocks. Noble gases compose a group of elements that for many years were considered to be inert; the group includes helium, neon, argon, krypton, and xenon, as well as radon. As a noble gas, radon forms no chemical reactions under ambient conditions and thus, when inhaled, almost all is promptly exhaled with little remaining in the lung.

Then things get sticky, however. Radon decays into isotopes of polonium (Po), which forms very fine or ultra-fine particles that can be deeply inhaled and efficiently captured by the lung. As it continues decaying, it emits two energetic alpha particles, the most damaging form of radiation. Cancer can result.

The most dangerous pathway starts with U^{238} (the most commonly found natural isotope of uranium), which decays down to Rn^{222} (Radon-222, a component of the radioactive decay chain of uranium-238). This form of radon, being a noble gas, can migrate through soil during its 3.8-day half life, with the possibility of arriving in areas of stagnant air such as a basement. At that point, Po^{218} again decays by various means down to stable Pb^{208} (a non-radioactive isotope of lead), with the most potential damage resulting from two energetic alpha particles, at 6.0 Mev and 7.7 Mev. Po^{218} and its decay products, called “daughters”, are all solids, form aerosols and allow efficient lung capture.

ITEM 11.1.

3459 **Nerd alert!** Recall that I was trained as a nuclear physicist. You can ignore this table, but all it
 3460 says is that the radon decay products (“daughters”) have powerful radiation that can cause
 3461 cancer.

Radon isotopes	Source	Half life	Decay mode	Decay energy MeV	Polonium isotopes	Further decays Mev	Stable end point
222Rn	U ²³⁸ decay	3.8 d	α	5.6	Po ²¹⁸	6.0, 7.7	Pb208
220Rn	Th ²³² decay	1 min	α	6.4	Po ²¹⁶		
219Rn	U ²³⁵ decay	1.8 ms	α	6.8	Po ²¹⁵		

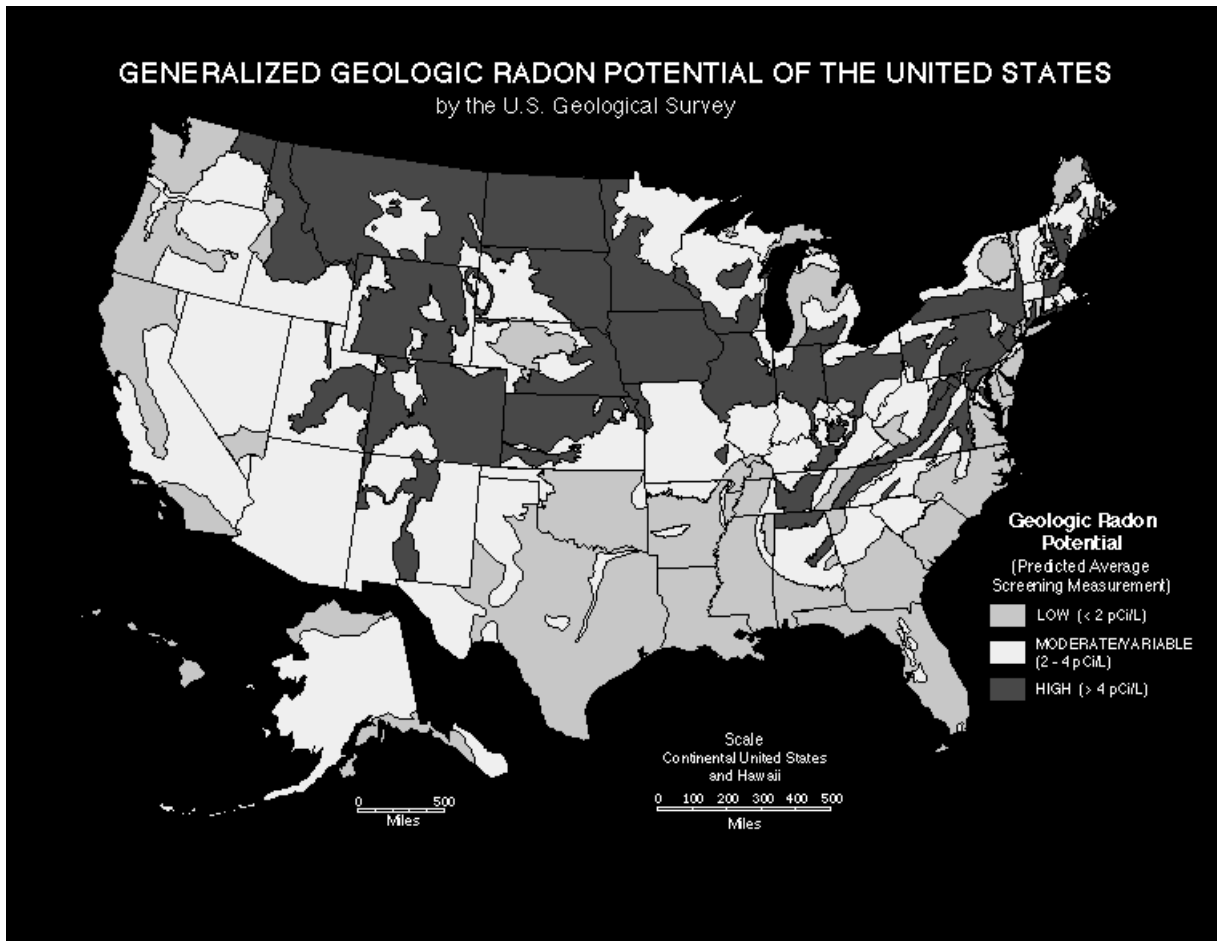
3462 Table 18-1. Forms of radon. MeV = million electron volts, a measure of the energy in the
 3463 decay product alpha (α) rays.

3464 The other forms of radon from Th²³² and U²³⁵ are less of a problem. The radon daughter of
 3465 thorium has a half life of only one minute, and that does not allow it enough time to escape from
 3466 its rock source matter. The same is even more true for U²³⁵, which also is only 0.7 percent of
 3467 normal uranium mass and has an even shorter half life. Other radon isotopes decay by other
 3468 means such as beta decay, which is far less damaging to cells.

3469 The problem of radon became prominent in the eastern United States, in which a belt of
 3470 rocks containing radioactive uranium and thorium runs from Pennsylvania to New England.
 3471 Many older houses in the area have roughly constructed basements with dirt or gravel floors and
 3472 fitted rock walls. I lived in one, clueless about the threat. With poor ventilation, the radon can
 3473 concentrate and, given time, can decay into a really nasty radioactive aerosols. When federal and
 3474 state agencies finally caught on to the problem, they realized that the radiation doses received
 3475 were way above proposed standards, even for nuclear plant workers.

3476 The answer obvious? Relax the standards, and exclude natural background.

ITEM 11.1.



3477

3478 Figure 18–1. Radon potential in the United States.

3479 How can I protect myself?

- 3480 • Avoid structures in which ground level radon can accumulate, and ventilate any that you may
3481 have (basements especially).
- 3482 • Perform radon tests if you have any suspicion of a problem, especially if you live in areas
3483 with uranium-rich rocks (see Figure 16-1).

3484 But you also can protect yourself by being aware of the actual, as opposed to perceived,
3485 threat of radiation. Radiation is one of the “dread risks” of Chapter 2, and overreaction can result
3486 in medical interventions that are far more harmful than the radiation itself. First, know the units.
3487 The SI unit is sievert (Sv), and 1 Sv = 100 rem. Natural U.S. background is about 310 rem from
3488 rocks and cosmic rays, or 3.1 mSv/year. Medical radiation about doubles that number.

ITEM 11.1.

3489 Let me give a very personal example. When I was about 2 years old, I had a swelling in my
 3490 throat, and enlarged thymus. This was thought to be a health threat (it wasn't), so I received
 3491 about 25,000 rads (250 Sv) of X-rays to shrink the thymus. Now we know that about one-third of
 3492 us will get thyroid cancer later in life. So when a lump showed up, my thyroid was removed
 3493 surgically. The lump was benign, but some of my vocal cords were damaged and now I have to
 3494 take thyroid pills for the rest of my life.

3495 More serious was the vast overreaction involving children near the Fukushima nuclear
 3496 reactors that were destroyed in the March 2011 tsunami that struck Japan. In the first year,
 3497 people had been exposed to between 12 and 25 mSv, about 5 to 10 times the 2.4 mSv/year of
 3498 Japanese natural background. Despite that, all the experts predicted a minimal increase in thyroid
 3499 cancers from the highest dose seen near Fukushima was only about 0.5 percent, screening was
 3500 started and lots of lumps appeared in children's thyroids. Before it was realized that such
 3501 harmless lumps are normal, lots of children had their thyroids removed, putting them at health
 3502 risks for the rest of their lives. A similar problem happened in Korea in 1999, where increased
 3503 ultrasound scans of children's thyroids resulted in massive surgical interventions with no sign of
 3504 increased cancers. Clearly, vis a vis Fukushima, Japan was not reading the Korean health
 3505 literature.

3506 If you want to really protect yourself, try to avoid whole-body CAT scans. The dose comes
 3507 close to the exposure some people received near Hiroshima.

3508 **Nitty-gritty details and background materials**

3509 **Natural background sources**

3510 Natural background radiation comes from the following three sources:

- 3511 1. Cosmic radiation
- 3512 2. Terrestrial radiation
- 3513 3. Internal radiation

3514 **Cosmic radiation**

ITEM 11.1.

3515 The sun and stars send a constant stream of cosmic radiation to Earth, much like a steady
 3516 drizzle of rain. Differences in elevation, atmospheric conditions, and the Earth's magnetic field
 3517 can change the amount (or dose) of cosmic radiation that we receive.

3518 **Terrestrial radiation**

3519 The Earth itself is a source of terrestrial radiation. Radioactive materials
 3520 (including uranium, thorium, and radium) exist naturally in soil and rock. Essentially all air
 3521 contains radon, which is responsible for most of the dose that Americans receive each year from
 3522 natural background sources. In addition, water contains small amounts of dissolved uranium and
 3523 thorium, and all organic matter (both plant and animal) contains radioactive carbon and
 3524 potassium. Some of these materials are ingested with food and water, while others (such as
 3525 radon) are inhaled. The dose from terrestrial sources varies in different parts of the world, but
 3526 locations with higher soil concentrations of uranium and thorium generally receive higher doses.

3527 **Internal radiation**

3528 All people have internal radiation, mainly from radioactive potassium-40 and carbon-14
 3529 inside their bodies from birth and, therefore, are sources of exposure to others. The variation in
 3530 dose from one person to another is not as great as that associated with cosmic and terrestrial
 3531 sources.

3532 ***Nerd alert!** I am including these definitions because the terms I was taught are so old that*
 3533 *I need to see them often. Also, if you have and medical irradiations, you will need to know these*
 3534 *terms.*

- 3535 • **Gray (Gy)** is the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1
 3536 joule per kilogram (100 rads). A joule is a unit of work or energy.
- 3537 • **Rad** is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs
 3538 per gram (an erg is one-ten-millionth of a joule) or 0.01 joule per kilogram (0.01 gray).
- 3539 • **Rem** is the special unit of any of the quantities expressed as dose equivalent. The dose
 3540 equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1
 3541 rem = 0.01 sievert).

ITEM 11.1.

- 3542 • **Sievert** is the SI unit of any of the quantities expressed as dose equivalent. The dose
 3543 equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality
 3544 factor (1 Sv=100 rems).

3545 Ref: <http://www.nrc.gov/about-nrc/radiation/around-us/sources/nat-bg-sources.html>

3546

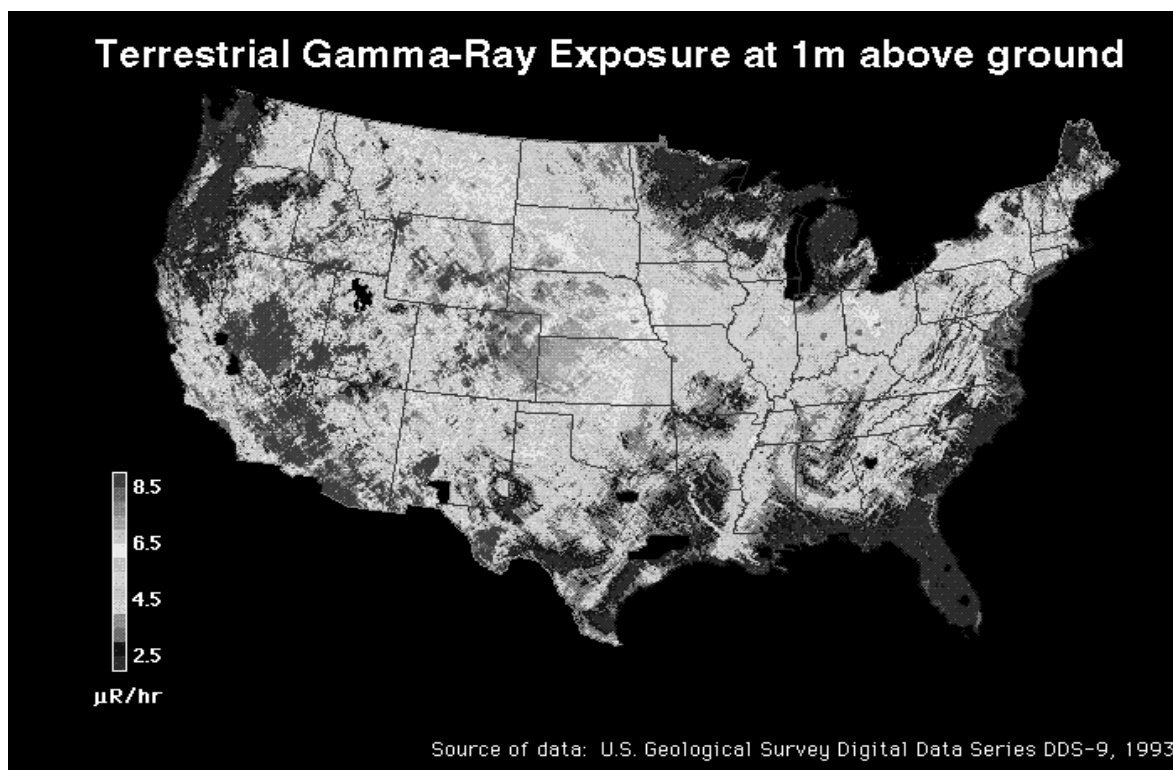
Radiation source	World	USA	Remark
Inhalation of air	1.26	2.28	mainly from radon, depends on indoor accumulation
Ingestion of food and water	0.29	0.28	(K-40, C-14, etc.)
Terrestrial radiation from ground	0.48	0.21	depends on soil and building material
Cosmic radiation from space	0.39	0.33	depends on altitude
subtotal (natural)	2.40	3.10	sizeable population groups receive 10-20 mSv
Medical	0.60	3.00	worldwide figure excludes radiotherapy
U.S. figure is mostly CT scans and nuclear medicine.			
Consumer items	-	0.13	cigarettes, air travel, building materials, etc.
Atmospheric nuclear testing	0.005	-	peak of 0.11 mSv in 1963 and declining since; higher near test sites
Occupational exposure	0.005	0.005	worldwide average to all workers is 0.7 mSv, mostly due to radon in mines;
In U.S., mostly due to medical and aviation workers			
Chernobyl accident	0.002	-	peak of 0.04 mSv in 1986 and declining since; higher near site
Nuclear fuel cycle	0.0002		up to 0.02 mSv near sites; excludes occupational exposure
Other	-	0.003	Industrial, security, medical, educational, and research
Subtotal (artificial)	0.61	3.14	
Total	3.01	6.24	millisievert per year

3547 Table 18-2. Radiation sources.

ITEM 11.1.

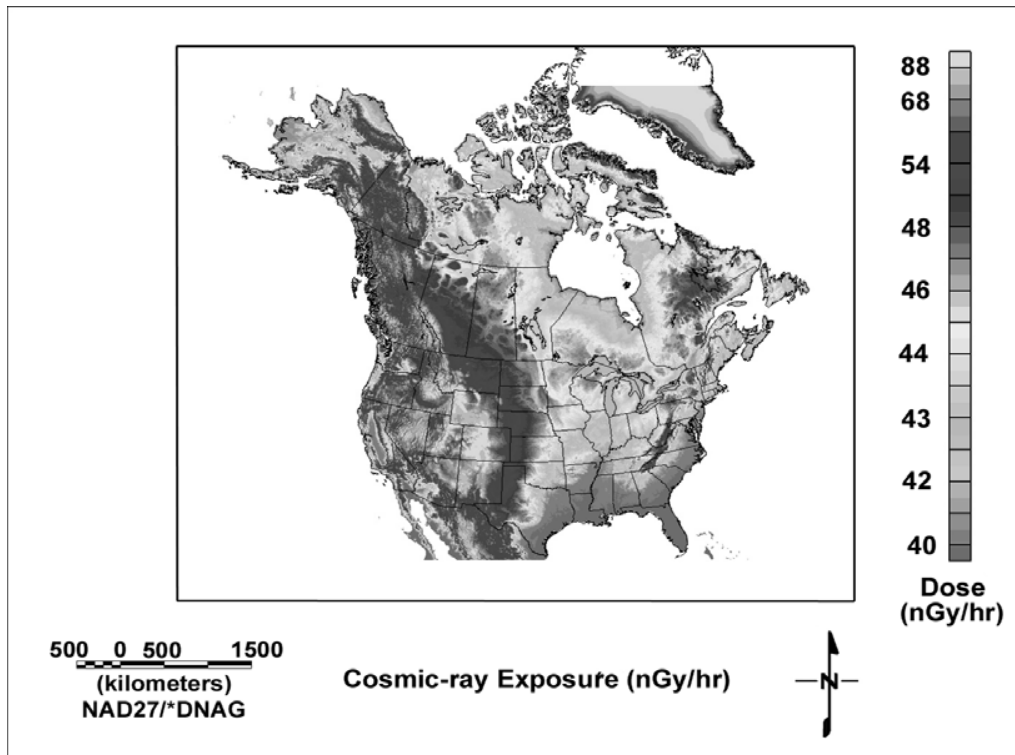
3548 **References**

- 3549 • Normile, D. March 4, 2016. "Epidemic of Fear." *Science* 351 (6277): 1022.
- 3550 • Wikipedia. "Background radiation" entry. Retrieved from:
- 3551 https://en.wikipedia.org/wiki/Background_radiation



3552 Figure 18–2. Terrestrial gamma ray exposure.

ITEM 11.1.



3553 Figure 18–3. Cosmic ray exposure.

3554

ITEM 11.1.

3555 **Section E**

3556 **And Finally, Some Good News**

3557

ITEM 11.1.

Chapter 19

*“I Can See Clearly Now, the Sulfur’s
Gone”*

*Haze and visibility reduction***Introduction**

I was fortunate to receive a three-year fellowship at UCLA toward my Ph.D. in physics in 1959. However, my first year as a graduate student, 1959–60, was brutal. The system was designed to take in a lot of students, teach them cheaply (no labs, no TAs, no discussion sections) for one year, insist they end up in the top half of three out of four classes and a written exam, or you were out on your ear. Only about one-third of the students made it to the second year. Having come from a small school with limited classes in physics, and lacking the experience of working hard, I was unprepared, and struggled mightily to avoid the cull. But I learned that classmates met in study groups and had copies of old exams, and with that assistance I survived. In my second year, I ended up as the top student in the 124-person class in nuclear physics, and joined a group building a new type of cyclotron for basic nuclear research.

As I finally gained confidence, a bunch of students and I started using weekends to rock climb on the Owens Valley (east) side of the Sierra Nevada. We would leave classes around 4 p.m., drive like hell to Independence or Big Pine, drive up into the mountains as far as we could, and then hike until the light gave out. Often we would “pitch our cookies” from the extreme change in altitude and exhaustion. We would climb in the Palisade Glacier or the Independence Pass region, leave the mountains Sunday evening, and drive often with little money for gas to return to L.A. at about 1 a.m., then attend classes beginning at 8 a.m. the next day.

It was fun, but while doing it, I noticed ugly smog rolling into the pristine deserts from L.A. and the San Joaquin Valley. However, at that time, I was unable to do anything about it.

When I returned to Davis after my stint in France in 1967, I was too concerned with inner stellar nuclear processes to think much about atmospheric visibility. But in 1970, a group of

ITEM 11.1.

young faculty members started trying to apply our nuclear and atomic expertise to California's air pollution problems, which were dire. I chose air pollution as one of my two thrusts (the other was radiation in space and the Pioneer and Voyager probes), and with the help of a paper from a Swedish scientist, found that my students and I could use the cyclotron to analyze particles in the air accurately and cheaply. Our embryonic work was noticed, and we got grants to study lead near Los Angeles freeways (see "Get the Lead Out," Chapter 11) and then throughout California.

We had developed technology that could measure particles by size, time, and composition (elements), all essential for being better able to understand light scattering. Impelled by my sad experiences with haze in Los Angeles and its transport into the remote desert areas of California, I submitted a proposal to the National Science Foundation in 1972 for measurements of aerosols and visibility in remote and wilderness areas of California. It was rejected because it wasn't very well written. As we gained experience, I submitted a new and much better proposal in 1974. Again, zilch! Now more than ever worrying about the western parks and monuments that relied so much on good visibility, I submitted yet another proposal in 1976. Before it could be turned down, a scientist in the U.S. EPA asked to have the proposal transferred to that agency. Then they turned it down. But EPA then issued a small request for proposals in the *Federal Register* for just three sites: Zion, Bryce, and Canyonlands national parks. We responded, and our proposal was funded.

What happened next was bizarre. The Arab Oil Embargo of 1978 prompted a massive national effort to develop western fossil fuel resources, but Congress demanded that any attempt must not sacrifice air quality. Looking around, they found only one *Federal Register* cleared grant – ours! They quickly took out their pens, and the three sites became 40, and the money was now substantial. The only problem was that the \$600. air sampler we had developed was not the EPA's developed \$6,000 sampler, the Dichot, but in these remote areas, and with the funds we had, ours was the only way. There was a further criticism – why routinely measure air quality in such clean areas? A copper smelter strike allowed us to identify sulfur impacts from a copper smelter at the Grand Canyon, and Mount St. Helens draped an ash plume over our network, and that criticism went away.

Three events were pivotal in this period. First, in 1981, we lost all EPA funds when President Ronald Reagan decimated the U.S. EPA budget. But with limited National Park

ITEM 11.1.

3614 Service money, occasional injections of cash directly from Congress, and a cadre of motivated
3615 and sharp students who were willing to work for modest pay, we kept going at nine key sites
3616 until 1986. But during that time we advanced our techniques enormously, which by 1986 were
3617 clearly the best in the world.

3618 The second point came about 1986. I was obsessed that the sum of all the elements from
3619 PIXE and XRF amounted to about only half of all the fine particles in the air that caused haze.
3620 While expensive combustion techniques were available, they required separate samplers and
3621 fired quartz filters. That didn't help me with the Teflon filters we had adapted. At that time, I
3622 was an outside expert for the Canadian National Research Council reviewing nuclear and atomic
3623 research programs at universities in Canada. We were in Quebec, where researchers were trying
3624 to emulate programs such as those we had in Davis to analyze aerosols by PIXE. They too were
3625 using these new super Teflon filters we favored. In their presentation, they showed a PIXE
3626 spectrum of Quebec aerosols, but in the middle was a large broad bump that appeared to be some
3627 sort of background. I asked what it was. The had scientists replied that it was displaying scattered
3628 protons from the PIXE beam, but after they put a filter into place that unwanted component
3629 disappeared. I approached him privately later and said, "You have a Teflon filter for aerosols, so
3630 you could use those protons to measure hydrogen in vacuum – which is mostly tied to organic
3631 matter." He said their problem was solved and ended the conversation.

3632 Based on what I had observed in Quebec, I knew my problem was solved. As soon as I
3633 got back to Davis, a student and I drilled a new hole in the cyclotron vacuum pipe of our PIXE
3634 setup and placed a detector designed to collect protons from hydrogen, and nothing else. It
3635 worked beautifully, and cost nothing. I called our senior NPS scientist and project manager, and
3636 told him our success. He said, "Don't bother, we have other ways."

3637 Well, I did what any good experimentalist would do. We started making hydrogen
3638 measurements at all sites in the limited NPS network throughout the next year, without
3639 additional cost, but never told Bill. On a Friday a year later, he called us on the phone, and he
3640 was in serious distress. Scientists with the Electric Power Research Institute (EPRI) were about
3641 to testify the following Monday at a Congressional hearing that they had done a massive
3642 multimillion dollar study in the West showing that most of the haze at the Grand Canyon
3643 consisted of organic matter, likely from trees. Bill asked what we had to refute that. "Well, I said,

ITEM 11.1.

we have one year's worth of organic data from that hydrogen work I mentioned last year [the same one he had rejected]. I'll look at EPRI's work and provide our data by Monday." Bob Eldred – my hard-working and intelligent No. 2 scientist – and I worked all weekend, and presented definitive data showing that EPRI had screwed up, mixing gases and particles together on a single filter. There were almost no organic particles from any source, especially not trees. Bill and the NPS were beyond grateful, and used the data in the hearing.

That 20-year effort culminating in the national IMPROVE (Interagency Monitoring for Protected Visual Environments) program was probably the best thing I ever did in my career. IMPROVE now protects well over 150 national parks and monuments using techniques I developed with my students at Davis. I finally retired from the program in 1997, but it continues in operation, and the samples are still analyzed at Davis.

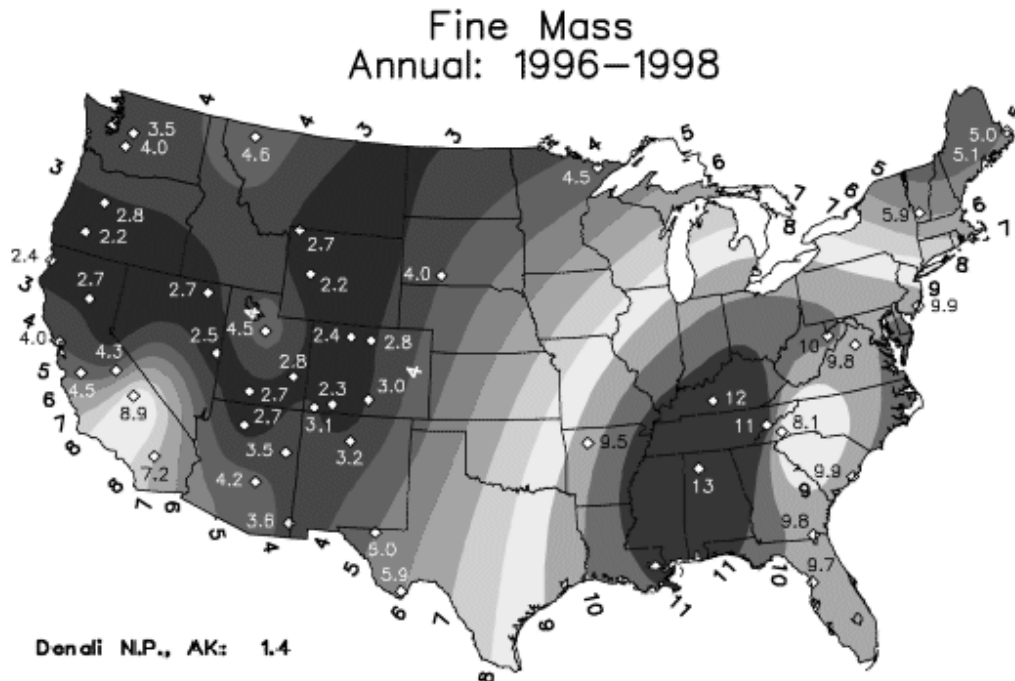
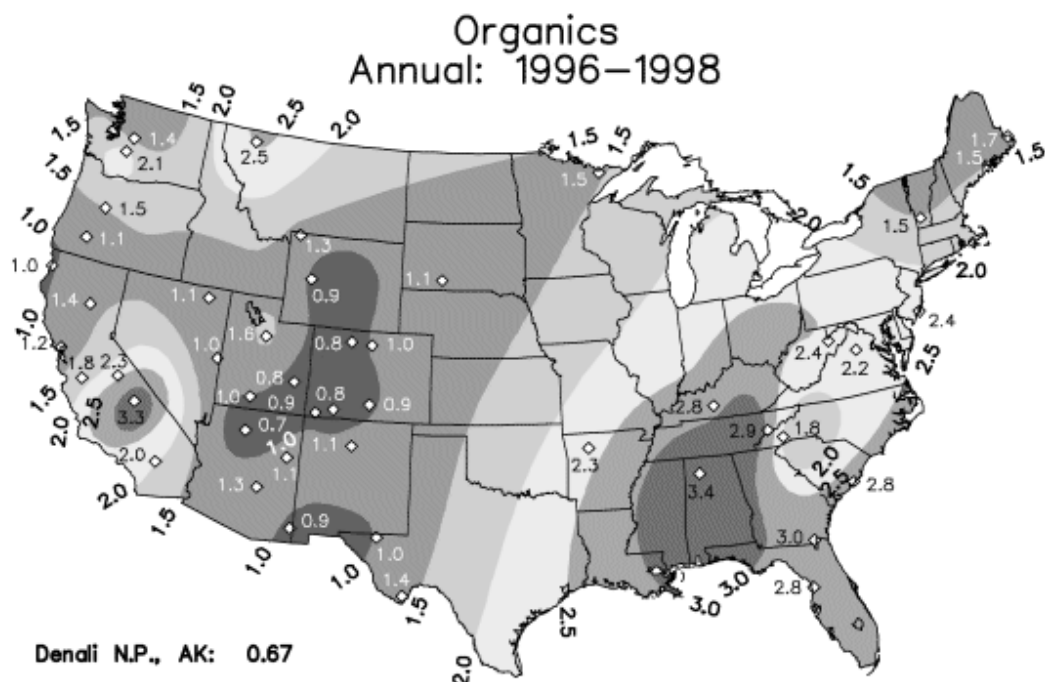


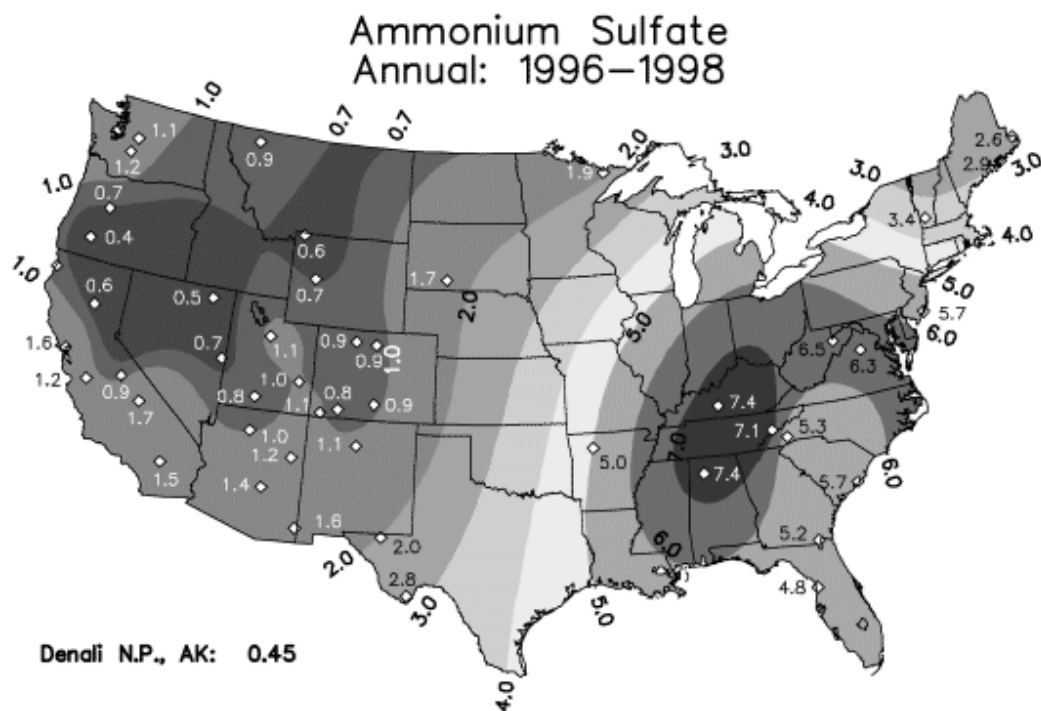
Figure 19-1a. This figure shows the mass of fine $PM_{2.5}$ μm across the United States, with the numbers representing our sampling sites. Note how much less mass in in the west.

ITEM 11.1.



3660

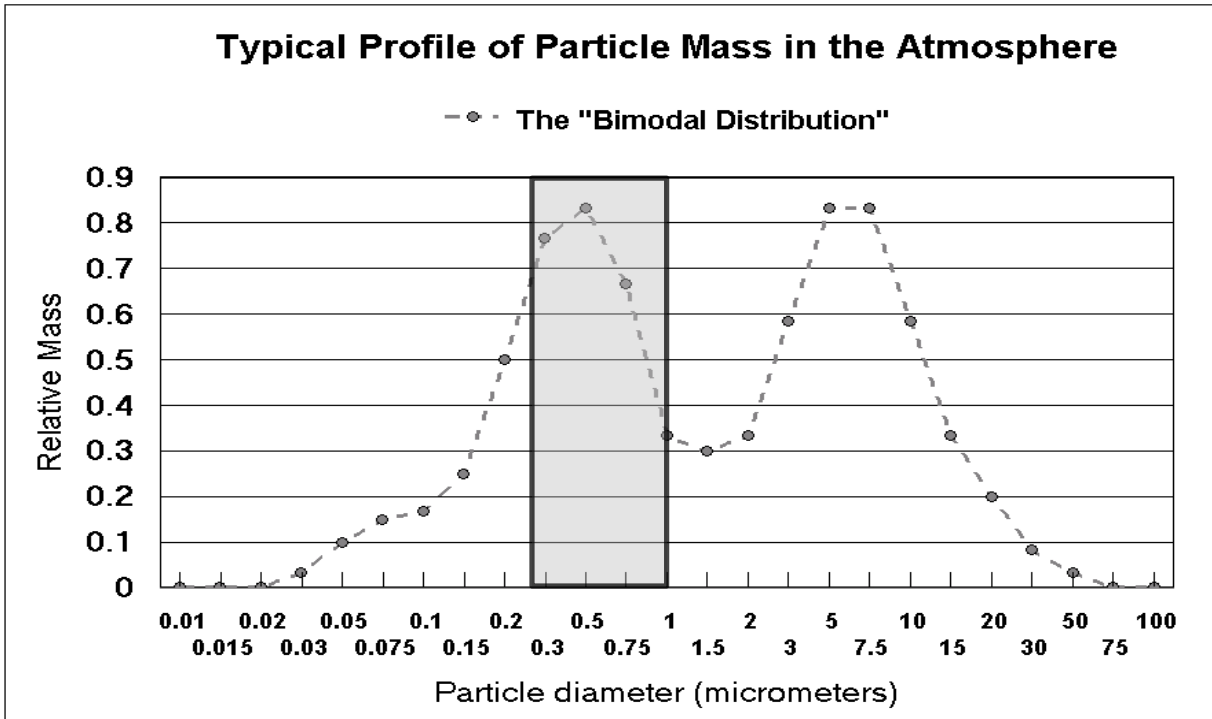
3661 Figure 19-1b. . This figure shows the mass of fine PM_{2.5} μ m organic particle mass across the
 3662 United States, with the numbers representing our sampling sites



3663

ITEM 11.1.

3664 Figure 19-1c. . This figure shows the mass of fine PM_{2.5} μm ammonium sulfate across the
 3665 United States, with the numbers representing our sampling sites. Ammonium sulfate is usually
 3666 the largest cause of bad visibility.



3667
 3668 Figure 19-2. Size range for aerosols that scatter light. Note that these are almost exactly
 3669 the size modes for wood smoke, which is why wood smoke is so easy to see.

3670 How can I protect myself?

3671 It is hard to hide haze, and your eyes are about the best detection method that exists. Hazes,
 3672 however, also cause glare and strain eyes.

3673 **1. In intense hazes, use sunglasses.** This was learned first in Los Angeles, where the intense
 3674 haze causes a very bright horizon as haze scatters light horizontally into your eyes. Thus
 3675 driving puts a major strain on your eyes, resulting in headaches and vision problems.

3676 **2. Haze is an excellent symptom of bad air quality.** Hazes are caused by PM_{2.5} aerosols, with
 3677 statistically well-established death rates. This is especially true if the haze appears brown,
 3678 often caused by soot and/or nitrates in the air, which often bring along with them unhealthy
 3679 aerosols such as diesel exhaust and ultra-fine metals.

ITEM 11.1.

Chapter 11, “Wood Smoke,” presents a partial exception because low-temperature wood fires produce a highly visible but largely harmless aerosol.

Yosemite Valley haze

How California is degrading its national parks



Figure 19-3 a. Yosemite Valley on a day with air quality among its 10 percent best.

Unlike most parks and wilderness areas in the country, the California national parks, especially Yosemite and Sequoia NP, and nearby wilderness areas, are not doing well.

The two main problems are:

1. Fine particles and haze, as in Figures 19-3 a and 19-3 b; and
2. Ozone that attacks Jeffrey pines (as described in Chapter 6).

ITEM 11.1.



Figure 19-3 b. Yosemite Valley on a day with air quality among its 10 percent worst.

Fine particles of potassium from soil and agricultural burning sweep into Yosemite and Sequoia NP every day, as figure 19-4 shows. The sun heats the western slopes of the Sierra Nevada, and the rising warm air creates a partial vacuum that sucks up any pollution on the floor of the San Joaquin Valley.

Then at night, cool air descends from the upper slopes, bringing down with it sulfates and nitrates from tall-stack oil refineries and power plants in the San Francisco Bay Area.

Add to the mix the occasional forest fire, and it is no surprise that the most glorious photos of Yosemite often are taken in spring, some showing snow on the upper peaks.

ITEM 11.1.

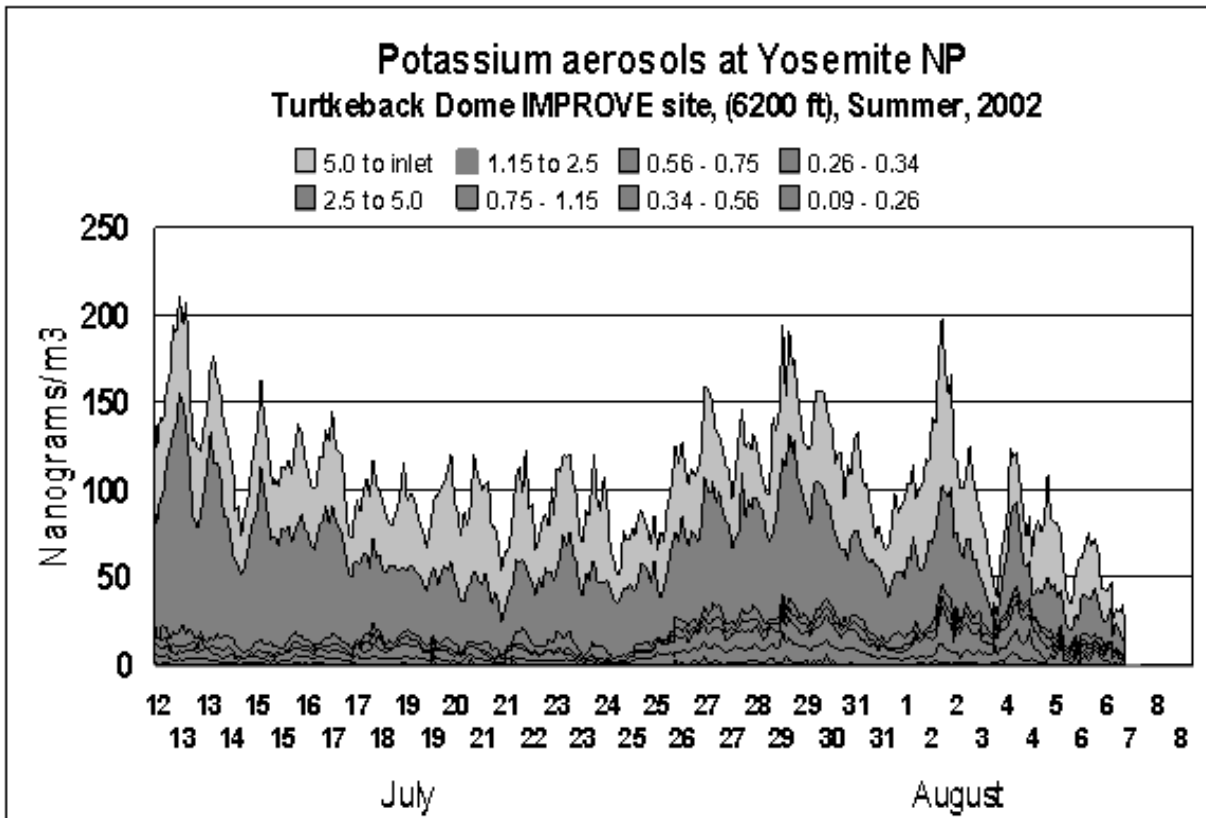


Figure 19-4. Fine potassium at Yosemite National Park.

The problem is that the state is focusing on attempts to reduce the winter PM_{2.5} mass in order to meet the EPA mass standards, but the visibility problem at the parks is a summer phenomenon. In addition, very small amounts of mass at just the right sizes ($0.3 < D_p$, $1.0 \mu\text{m}$) can produce a very visible haze. Thus, sulfates, nitrates, fine soil, and wood smoke are all problems, none of which is being adequately addressed. What is the first corrective measure that should be taken? SO₂ scrubbers should be installed on the Bay Area refineries and power plants.

ITEM 11.1.

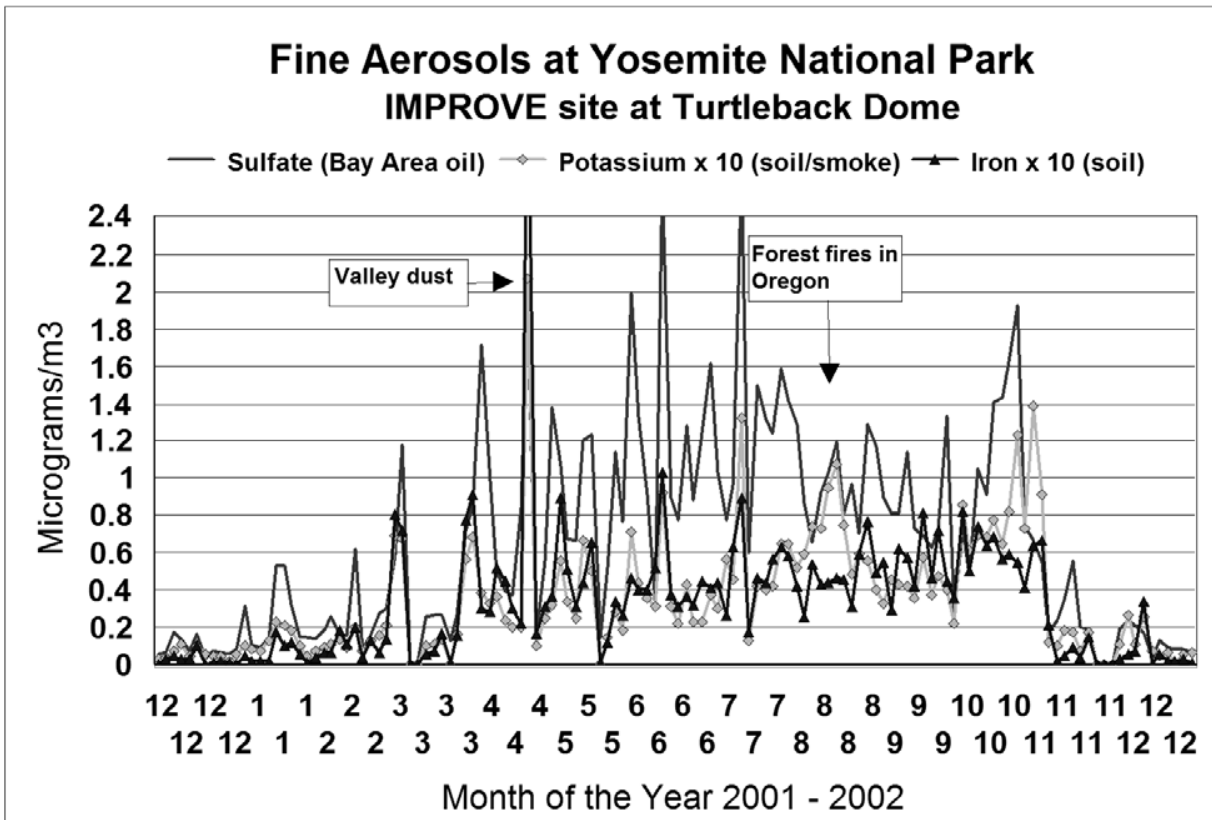


Figure 19-5. This plot reveals that the San Francisco Bay Area sulfates are usually the most dominant source of haze.

Shut down Tom – attempt No. 2

- **President Ronald Reagan, 1981 generic gutting of U.S. EPA and our efforts to control smelters and power plants**

As mentioned earlier, we finally had a major network of 40 aerosol samplers spread throughout the west, with successes controlling copper smelters and analyzing the Mt. St. Helen explosion. However, President Ronald Reagan as president in 1981 decimated the U.S. EPA budget, and we lost all EPA funds. But with limited National Park Service money, occasional injections of cash directly from Congress, and a cadre of motivated and sharp students who were willing to work for modest pay, we kept going at nine key sites until 1986. But during that time we advanced our techniques enormously, which by 1986 were clearly the best in the world. Thus when funds arrived in 1986, we became the designer and principal investigator for haze aerosols all across the U.S. in the massive

ITEM 11.1.

3724 IMPROVE program, which I ran until I retired from the program 1997. It is still the best
3725 in the world.

3726 **Visibility in China**

3727 ***The 2008 Olympics***

3728 In 2001, the Chinese Academia Sinica (the Chinese academy of sciences) asked me how to
3729 protect the 2008 Olympics from bad visibility

3730 When I first came to UCLA in 1959, the visibility in the area was awful all summer, only
3731 clearing up in winter just in time for the Rose Parade. But all our efforts have started to make it
3732 better, if not great, and we can see the mountains around the L.A. basin most of the time.

3733 It was not that way in China, where visibility went from bad to awful. I was about to leave
3734 Beijing for Kyoto in April 2001, as ACE-Asia was running smoothly, when I was invited to
3735 dinner by the Academia Sinica. I was picked up by an official black limousine with little red
3736 flags on the front fenders. My hotel hosts were suddenly impressed. At the dinner, one of the
3737 hosts mentioned that they had just received the news that they would get the 2008 summer
3738 Olympics. He then asked what I thought about a new gas pipeline to Beijing helping the
3739 Olympics. I responded gently that the natural gas line would be critical to air quality in winter,
3740 but the Olympics were in summer. His face fell. So I continued, "Do you remember the Los
3741 Angeles Olympics in 1984?" He replied, "Yes, I believe I do." I asked, "Do you remember
3742 seeing the mountains behind Los Angeles during the Olympics?" He replied, "Yes, I recall that."
3743 I asked him if he thought those mountains were usually visible in Los Angeles in July. He
3744 responded, "Tell me more."

3745 I explained that none of the local industries wanted to be blamed for the smog, so through
3746 an off-the-record and voluntary agreement, all L.A. refineries and power plants agreed to reduce
3747 operations preceding and during the Olympics by at least 30 percent, probably more, since
3748 records were deliberately not kept. I could see the lights go on in their heads. The important
3749 point is that (this is second-hand information) cities in China have boundaries set so they could
3750 raise enough food to feed the city in an emergency. So the Beijing city limits were way out, and
3751 within that zone city officials had total control.

ITEM 11.1.

3752 Based on my experience in China, I was fascinated by what the Chinese smog would do to
3753 the Olympics. Thus, every day, I gathered data from several sources and made a daily report on
3754 air pollution and visibility before and during the 2008 summer Olympics. I used data from

- 3755 1. The Chinese put out PM_{2.5} mass data on the web (written in Chinese) from their
3756 aerosol sampling sites each morning, then deleted the data on the next day.
- 3757 2. I also had a BBC reporter taking readings of aerosol mass at his hotel each noon,
- 3758 3. I downloaded the MODIS (Moderate Resolution Imaging Spectro-radiometer) satellite
3759 scans each day, and
- 3760 4. I did NOAA HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory)
3761 readings to show every day where the air came from. It is still posted on our DELTA
3762 Group website (<http://delta.ucdavis.edu>).

3763 I was interested enough to blog the Olympics using the data they put out on the web in
3764 Chinese from their aerosol sampling sites, but it was removed by the government on the next
3765 day. I also had a BBC guy taking readings of aerosol mass at his hotel each noon.

3766 But the efforts of the Chinese officials locally to improve air quality were almost totally
3767 useless. Most of their problems were regional, and all the upwind areas wanted their air
3768 conditioning, which required power plants to operate. The situation was different in Los Angeles,
3769 where all the sources are local. In the immortal words of Walt Kelly's Pogo, "We have met the
3770 enemy, and they is us."

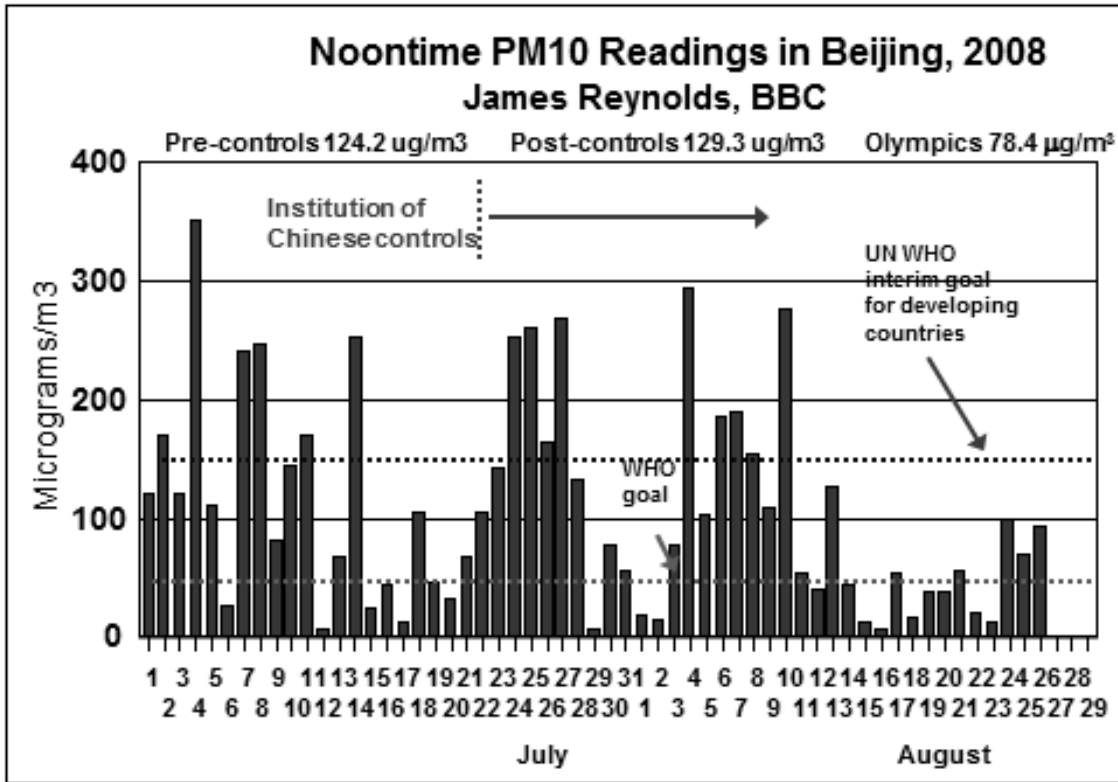
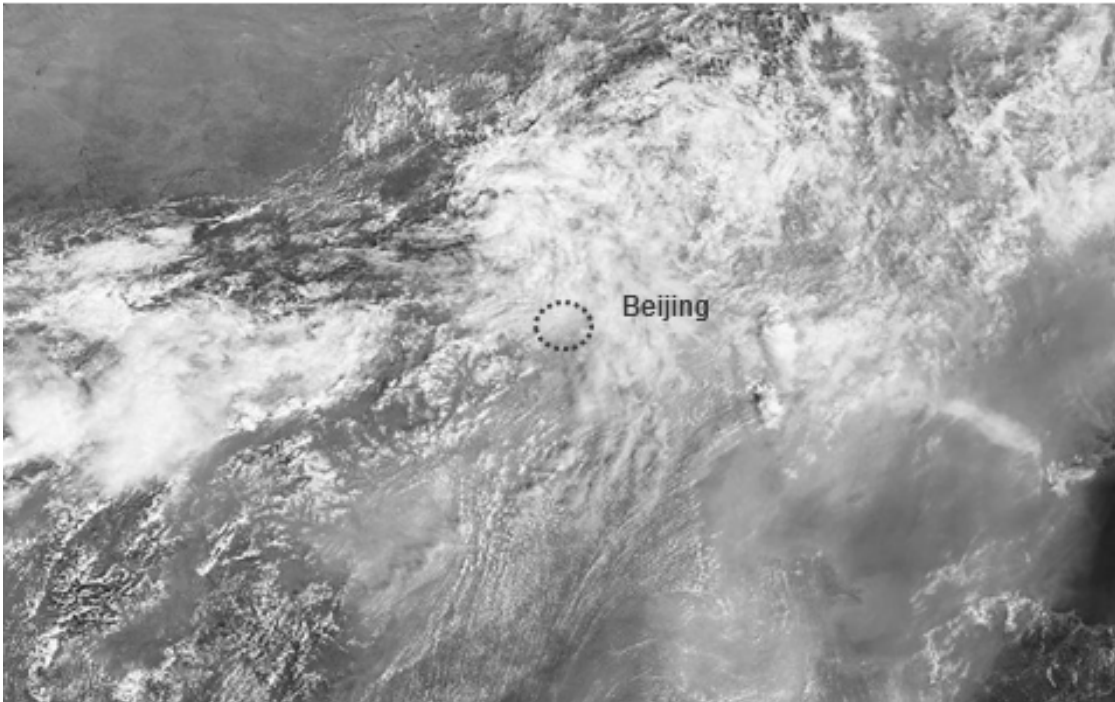


Figure 19-6. Noon PM₁₀ readings in Beijing.

The whole world was watching when the Olympics started on August 8, and the smog was so bad even local buildings looked hazy. The PM_{10} was $156 \mu\text{g}/\text{m}^3$, and the visibility about 2 miles. The wind was bringing sulfates in from the southwest, where all the coal was being burned. In the MODIS photograph, Beijing is under a pall.

ITEM 11.1.

August 8, 2008; T avg =29.7 C, RH avg = 72%, rain = 0.0
cm, $V_w = 8.3$ km/hr, Visibility = 3.6 km, $PM_{10} = 156 \mu\text{g}/\text{m}^3$



3777

3778 Figure 19-7. MODIS photograph of China on August 8, 2008, the first day of the
3779 Olympics.

3780 But in about three days, conditions improved a lot. The weather pattern changed, with
3781 days of reasonably clean marine air, and a considerable amount of rainfall. In summary, Chinese
3782 Olympics officials got lucky and except for a few days, the Games were not badly affected by
3783 the vast plumes from the coal-fired power plants to the west, southwest, and south of Beijing.

3784 Battle for the Grand Canyon

3785 In 1986, my colleagues and I convinced National Park Service officials that we could take
3786 on a big project to confront the Navajo Generating Station and its impact at the Grand Canyon.
3787 This also involved UC Davis being the contractor for the new IMPROVE network. We did the
3788 study, and nailed the 2,250-megawatt coal-fired Navajo power plant near Page, Arizona, as the
3789 source of the winter haze in the canyon. The power agency, Salt River Project (SRP), owner and
3790 operator of the Navajo Generating Station, demanded time to refute our study. Three years later,

ITEM 11.1.

3791 SRP's million-dollar study was done but no one had seen it. The *Federal Register* comments
3792 were to close on April 1, 1992. One public hearing was to be held in Phoenix on the SRP's
3793 results, refuting our study. But all the NPS and its contractors were under a gag order from the
3794 Bush administration prohibiting them from defending or even explain our study, and certainly
3795 forbidding them from testifying in Phoenix at the one hearing in March 1992.

3796 John Molenaar (of Air Resource Specialists, Colorado, the other prime contractor to the
3797 NPS) called me the week before the meeting and said he was going to go to the meeting as a
3798 volunteer for the Grand Canyon Trust to present his work, old and new. Was I interested? We
3799 knew the vengeance of the Bush administration could be brutal (think John H. Sununu, Bush's
3800 White House chief of staff from 1989 through '91). I had tenure, but my staff could lose their
3801 jobs if the NPS was forced to pull our contract. They all said, "Go!" I was so proud of them.

3802 So I prepared my testimony using only public data and my home computer, and showed up
3803 in Phoenix the night before the hearing, with 138 groups testifying, all but one against cleaning
3804 up the Navajo stacks. I called John and he said to be in a downtown office in Phoenix at 6 a.m. I
3805 showed up, and even to this day don't know who was at the meeting – about eight people. One
3806 was a representative of the Sierra Club, and others were from EPA. No preliminaries. "What
3807 have you got?" John laid out beautiful photos showing what the Grand Canyon would look like
3808 with no mitigation, 50 percent, 70 percent, and 90 percent control. I showed clear evidence that
3809 the haze in the canyon was from the power plant, and only the power plant.

3810 So it was decided that John and I would take the slot reserved for the Grand Canyon Trust,
3811 which would testify on the first day. Former Arizona Gov. Bruce Babbitt (later to serve as U.S.
3812 Secretary of the Interior) introduced us at a press conference as "volunteers" to the Grand
3813 Canyon Trust. The Salt River Project people were aghast. "What are you doing here?" their
3814 expressions appeared to ask.

3815 So we presented our work in one hour, and then had to sit through two days of groups
3816 advocating against control of the power plant. Both sides went home, and we officially filed our
3817 results in the *Federal Register* before the April 1 cut-off date. The Salt River Project filed its
3818 massive report on March 31, so no one could comment on their results. Then we waited.

3819 About a week later, the EPA called to summon us to a hearing on the matter at their North
3820 Carolina facility in Research Triangle Park. John and I were to be allocated four hours to make

ITEM 11.1.

3821 our case, the Salt River Project also would get four hours, followed by an hour for economic
3822 consideration. All the people who had officially submitted to the *Federal Register* – basically the
3823 Grand Canyon Trust and the Salt River Project – were seated at one small U-shaped table. We
3824 could ask and respond to questions. A much larger U shaped area was set aside for interested
3825 parties from the National Park Service and scores of consultants from the Salt River Project and
3826 other stakeholders. John and I presented our work, and finished within about three hours.

3827 My big moment was when I declared, “after all is said and done, we all agree on the
3828 science.”

3829 Dead silence.

3830 So I proceeded. The NPS said the power plant was creating a 70 percent reduction in
3831 visibility, while SRP said it was only 7 percent. So I backed out the blue sky and regional aerosol
3832 effects from the NPS work, and that recalculation reduced the NPS figure to about 35 percent
3833 visibility reduction attributable to power plant aerosols. Then I started on SRP, pointing out that
3834 organization had sampled on the canyon rim, whereas we took samples within the canyon (killer
3835 picture). As you can see, the difference is big – a factor of about 3, which put SRP at 21 percent
3836 visibility reduction if they had sampled in the canyon itself. Then meteorology. SRP had
3837 conducted their study during a really clean year, 30 percent better than the 10-year average. In an
3838 average year, the reduction in visibility would be at 27 percent. Then I added two smaller effects,
3839 bringing them to something like 33 percent, close to the NPS figure of 37 percent. The National
3840 Academy of Sciences says “substantial,” which could be at least 1/3 impact – so we all agree.

3841 Dead silence.

3842 Someone said, “Could you go through that again?” I replied, “With pleasure!” And I did. I
3843 still had 30 minutes left when I realized this was like an oral exam. The consultants had to
3844 answer! So I asked an SRP consultant, “Didn’t your report in 1977 show that the plume would
3845 hit the canyon on many winter days?” He protested that it was never published. I said, “I am
3846 keenly aware of that, but wasn’t that your conclusion?” He replied, “Well, yes.” And I grilled
3847 their tame meteorologist. I was on fire.

3848 At the end, one of the SRP consultants said, “You can’t prove it was the Navajo Power
3849 Plant that caused the haze!” I responded, “That is correct. But we can prove it was a large coal-

ITEM 11.1.

3850 fired power plant directly east of the canyon.” The audience laughed, for there was only one such
 3851 plant – and it was the Navajo Generating Station. That’s when I knew we had won.

3852 We broke for lunch, and in the afternoon, there was essentially no response to our work. A
 3853 very high-level EPA administrator phoned me the next morning. “That was some performance,
 3854 Tom,” he said. When I returned to Davis, I started to get phone calls – including from my good
 3855 friend from Yale, nuclear physicist Alan Bromley, presidential science adviser. My secretary
 3856 said breathlessly, “It’s the White House on the line!” So we negotiated, with the EPA willing to
 3857 accept a 70 percent reduction while we pushed for 90 percent.

3858 The issue was still unresolved when as part of discovery on another matter, a memo
 3859 surfaced from a high-level administrator at the Navajo facility, pointing out that the SRP’s use of
 3860 one pile of low-sulfur coal to meet the annual state of Arizona’s test on SO₂ [sulfur dioxide]
 3861 emissions put them all at serious risk!!!! Yes, that sentence in the memo was punctuated with
 3862 five exclamation points. After that disclosure, suddenly all was sweetness and light. Orders were
 3863 issued to install \$500,000,000 worth of SO₂ scrubbers, or \$20,000 per day per stack – and that
 3864 plant had three stacks. After a quick calculation, an agreement was made, and signed by
 3865 President George H.W. Bush on the rim of the Grand Canyon around October 1992. All the
 3866 people instrumental in the victory were nowhere near. It is amazing how much you can get done
 3867 if you are not too picky about who gets the credit.

3868 References

- 3869 • Flocchini, Robert G., Thomas A. Cahill, Lowell L. Ashbaugh, Robert A. Eldred, and Marc
 3870 Pitchford. 1981. “Seasonal Behavior of Particulate Matter at Three Rural Utah Sites.”
 3871 *Atmospheric Environment* 15: 315–320.
- 3872 • Flocchini, Robert G., Thomas A. Cahill, Danny J. Shadoan, Sandra J. Lange, Robert A.
 3873 Eldred, Patrick J. Feeney, Gordon W. Wolfe, Dean C. Simmeroth, and Jack K. Suder. 1976.
 3874 “Monitoring California’s Aerosols by Size and Elemental Composition.” *Environmental*
 3875 *Science and Technology* 10: 76–82.
- 3876 • Macias, E.S., J.O. Zwicker, J.R. Ouimette, S.V. Hering, S.K. Friedlander, T.A. Cahill, G.A.
 3877 Kuhlmeier, and L.W. Richards. 1981. “Regional Haze in the Southwestern US, II: Source

ITEM 11.1.

- 3878 Composition. Symposium on Plumes and Visibility, Grand Canyon, AZ, 1980.” *Atmospheric*
 3879 *Environment* 15: 1971–1986.
- 3880 • Malm, W.C., Sisler, J.F., Huffman, D., Eldred, R.A. and Cahill, T.A. January 20, 1994.
 3881 “Spatial and Seasonal Trends in Particle Concentration and Optical Extinction in the United
 3882 States.” *Journal of Geophysical Research* 99 (No. D1): 1347–1370.
- 3883 • Seinfeld, J.H., G.R. Carmichael, R. Arimoto, W.C. Conant, F. J. Brechtel, T. S. Bates, T. A.
 3884 Cahill, A.D. Clarke, B.J. Flatau, B.J. Huebert, J. Kim, K.M. Markowicz, S.J. Masonis, P.K.
 3885 Quinn, L.M. Russell, P.B. Russell, A. Shimizu, Y. Shinozuka, C.H. Song, Y. Tang, I. Uno,
 3886 A.M. Vogelmann, R.J. Weber, J-H. Woo, and Y. Zhang. 2004. “ACE-Asia: Regional Climatic
 3887 and Atmospheric Chemical Effects of Asian Dust and Pollution.” *Bulletin of the American*
 3888 *Meteorological Society* 85:367-380. doi:10.1175/BAMS-85-3-367.
- 3889
- 3890

ITEM 11.1.

3891 **Section F:**
3892 **And Then Some Bad News**
3893

ITEM 11.1.

Chapter 20

***“We Have Met the Enemy, and They Is
Us”***

Aerosols and global climate change

Introduction

The physics of climate change is actually simple. Impacts of the changes are tough to predict, however.

FACT 1: The Earth is in perfect balance with the sun.

a. Energy input from the hot sun during each day

is counterbalanced by

b. Energy output from the warm Earth day and night

If this were not so, and the sun ceased to shine, the cooling we see each night would continue, and in a few days, the Earth would be frozen solid. Likewise, if the Earth ceased to radiate away its heat, we would be cooked in a few days.

FACT 2: The sun’s energy input affects only the side facing the sun, but the Earth’s energy output extends all around the globe, day and night.

FACT 3: Wavelengths of the energy flow of the sun and the Earth differ from each other (as Figure 20-1 shows).

a. Because the sun is so hot, 6,000 degrees C, or about 10,800 degrees Fahrenheit, its heat output is in the form of light – short-wave radiation, visible sunlight.

b. Because the Earth is only warm, 300 C, or about 75 degrees Fahrenheit, its output is in the infra-red range – long-wave radiation, warmth felt but not seen.

FACT 4: The Earth deflects about one-third of the sun’s short-wave radiation (sunlight).

ITEM 11.1.

- a. 31 percent of the sun's energy radiated toward Earth is reflected back into space from clouds.
- b. 19 percent warms the atmosphere and also produces ozone in the stratosphere, which protects us from harmful ultraviolet rays.
- c. 47 percent reaches the surface of the Earth –two-thirds of that energy is absorbed in the oceans, and one-third blankets areas of land, powering weather and photosynthesis.
- d. Only 3 percent of the visible light that strikes land surfaces of the Earth is reflected back into space, but that's sufficient to produce the lovely images of Earth we see by satellite.

Now comes the fun. Forget for the moment the local heating and rainfall effects that are retained in the hydrological cycle, and let's go to the long-wavelength side of the Earth's balance.

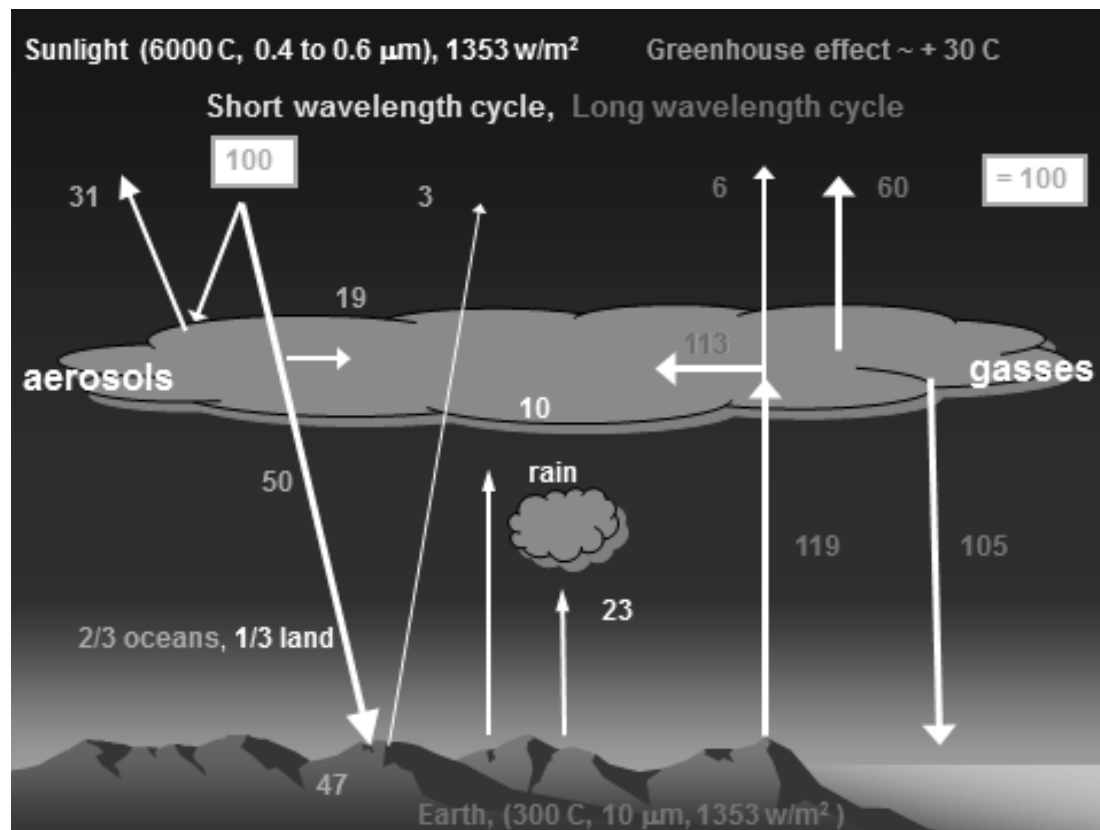


Figure 20-1. Energy balance of the Earth and the “greenhouse effect.”

ITEM 11.1.

3931 **FACT 5: The Earth tries to radiate away its heat energy gain from the sun, but ...**

- 3932 a. Most of the long-wavelength light is trapped by absorption in the atmosphere:
- 3933 • mostly by water vapor and
- 3934 • carbon dioxide, but also
- 3935 • methane and other smaller components
- 3936 b. This heats up the atmosphere, which in turn radiates heat energy in all directions, day and
- 3937 night:
- 3938 • outward into space, cooling the Earth, and
- 3939 • inward toward the ground, heating the Earth.

3940 **FACT 6: Because the top of the atmosphere is cooler than the surface of the Earth ...**

- 3941 a. An amount of energy equal to 60 percent of the input solar energy gets emitted from the
- 3942 warm atmosphere back into space as long-wavelength heat, along with the:
- 3943 • 6 percent of long-wavelength heat that leaks into space,
- 3944 • 31 percent of the short-wave sunlight reflected into space, and
- 3945 • 3 percent that is emitted from the ground as visible light and makes it into space
- 3946 b. That totals 100 percent of the sun's input energy – perfect energy balance!

3947 But what about us on the ground?

3948 **FACT 7: The warm atmosphere radiates heat back to the ground.** That's a phenomenon we

3949 know as the "greenhouse effect," causing that radiation to warm up by about 30 C, or about 86

3950 degrees Fahrenheit.

- 3951 a. If not for the atmospheric re-deflection of warmth, the average temperature of the Earth
- 3952 would be slightly below freezing.

3953 What about other planets? Do they benefit from the "greenhouse effect?"

3954 The Planet Mercury has no atmosphere, and always has the same face toward the sun. That

3955 continually lit side stays at 425 degrees C, about 800 degrees Fahrenheit. The dark side is -191

3956 C, or about -312 degrees Fahrenheit.

ITEM 11.1.

Venus has a very thick atmosphere and a runaway “greenhouse effect,” which keeps the perpetually cloud-covered planet at 425 C. or about 800 degrees Fahrenheit.

Mars has a thin atmosphere, only about 1 percent of Earth’s, and without a significant “greenhouse effect,” averages -60 C, or about -80 degrees Fahrenheit.

So what are the problems? The increasing CO₂ from human activities, rising at a rate not seen in thousands of years, is driving the “greenhouse effect” harder. As cartoonist Walt Kelley’s cartoon character “Pogo” proclaimed, “We have met the enemy, and they is us.”

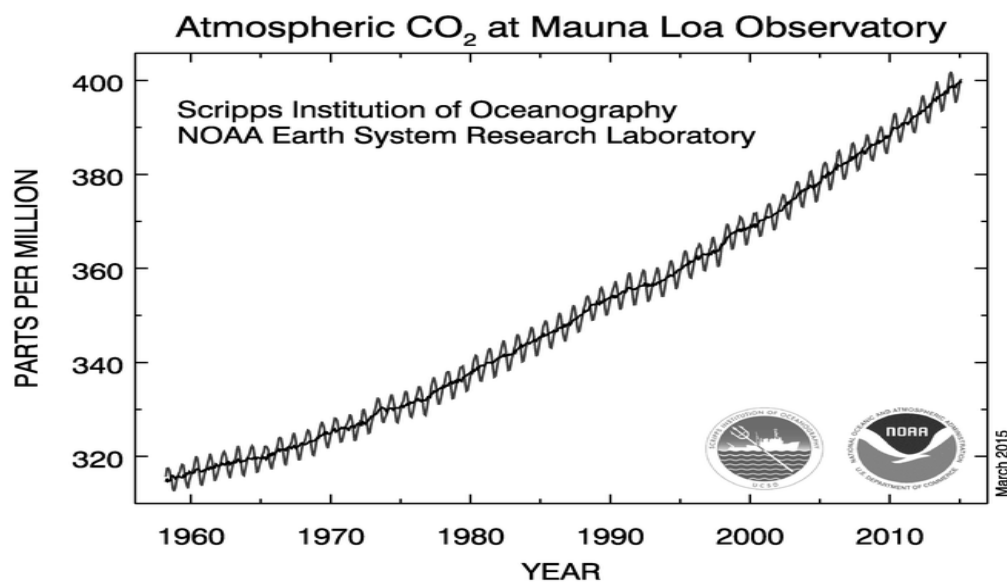


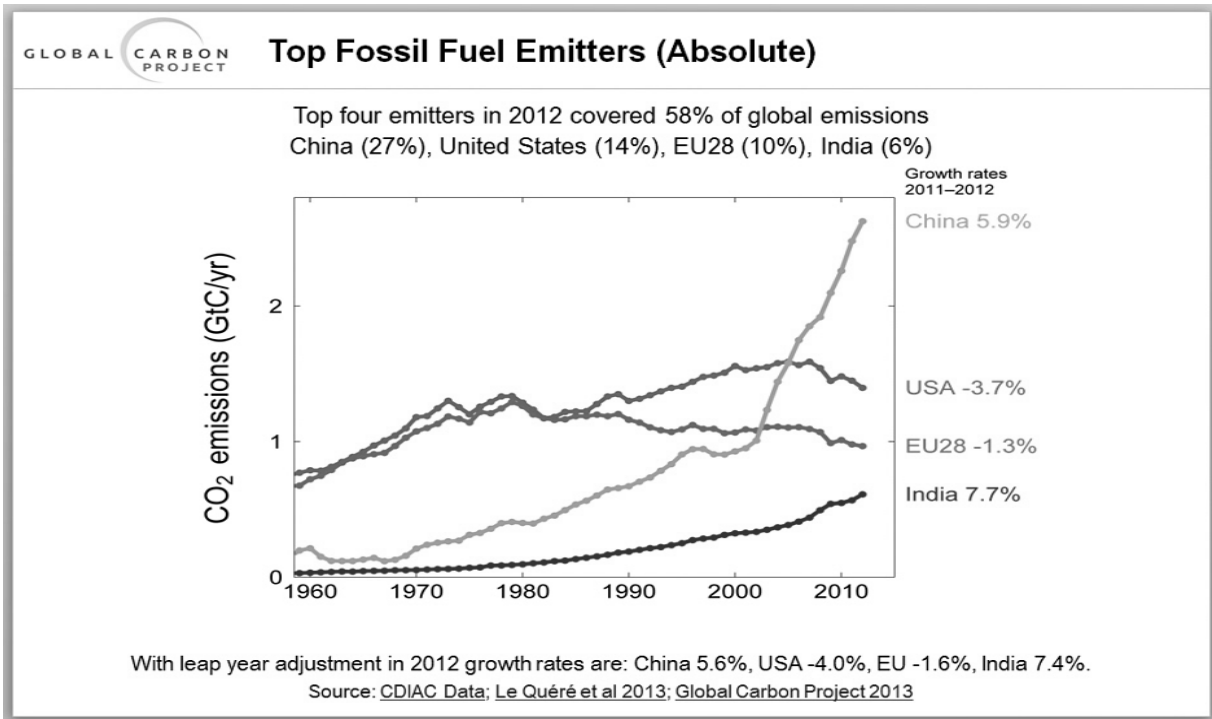
Figure 20-2. Record of CO₂ over time at Mauna Loa Observatory, Hawaii.

Numerous consequences are solid and already documented, including but not limited to:

1. Sea level rise, actually higher than the maximum prediction of the 2007 Intergovernmental Panel on Climate Change (IPCC) report
2. More intense storms instigated by the warmer oceans
3. Shifts of weather patterns – droughts and torrential rains, warming and cooling
4. Arctic warming and sea ice loss

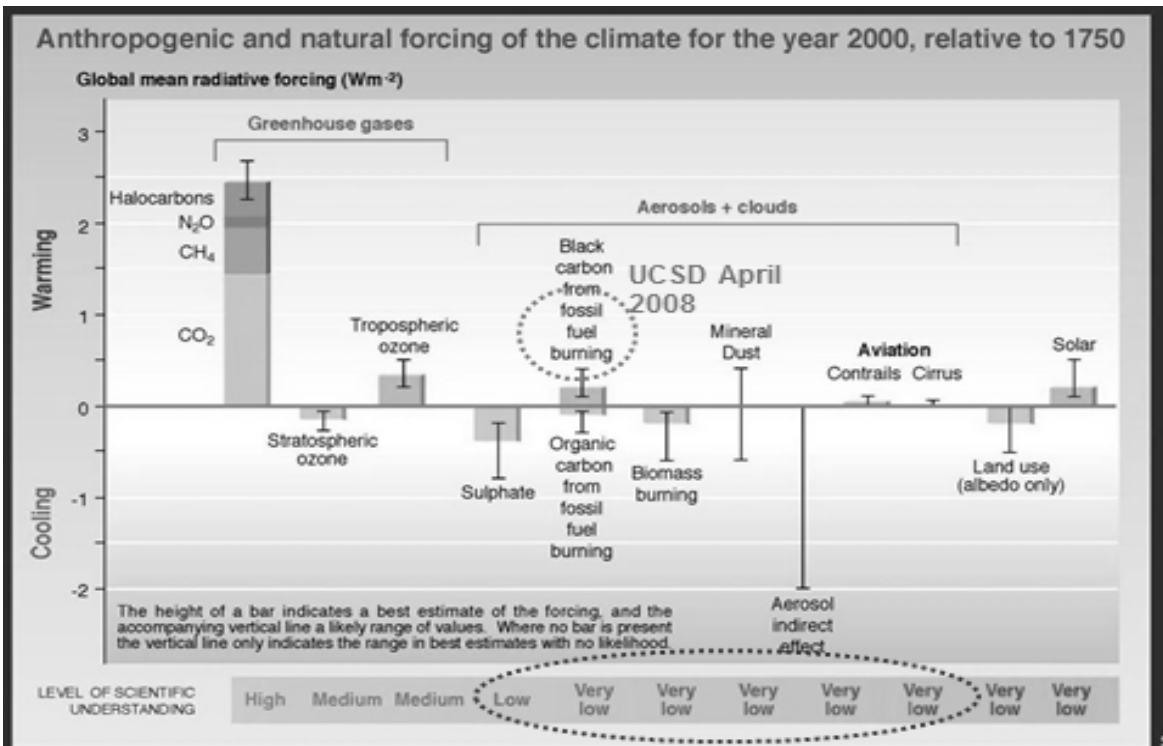
And which countries are driving the CO₂ record? Figure 20-3 reveals the repeat offenders.

ITEM 11.1.



3973

3974 Figure 20-3. Current principal emitters of CO₂. China has 630 coal-fired power plants
 3975 now, with about 350 more planned to begin operation by 2021. Cement manufacturing
 3976 in China also generates massive amounts of CO₂ emissions.

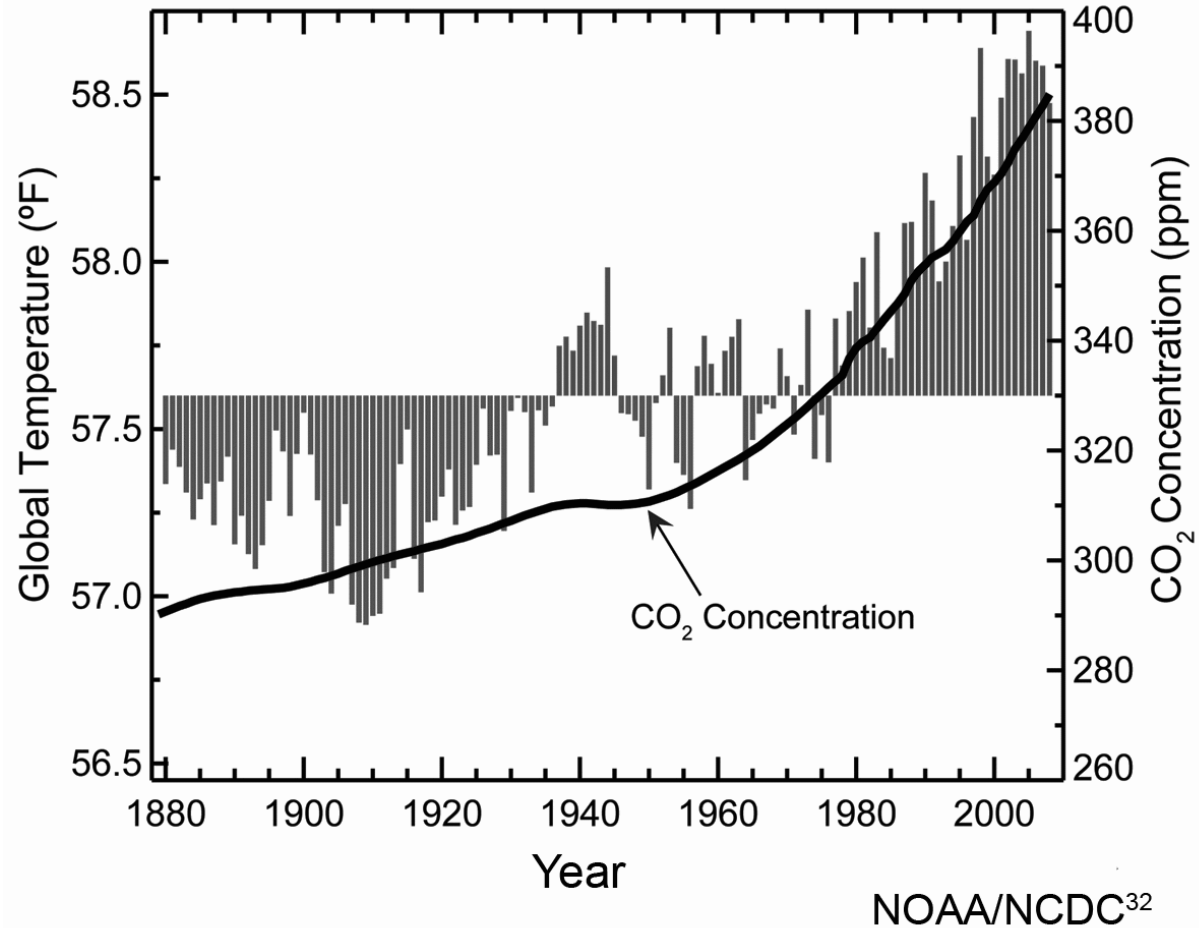


3977

3978 Figure 20-4. Change in greenhouse gases and aerosol levels causing increases in the
3979 temperature of the Earth.

3980 To help firm up the science of aerosols and climate, my colleagues and I have established
3981 sampling stations in Greenland and Hawaii (VanCuren et al., 2014).

ITEM 11.1.



3982

3983 Figure 20-5. Global temperature and CO₂ concentration since 1880.

3984 Two of the robust predictions of the models with best experimental confirmation are global
 3985 temperature rise and sea level rise – train wrecks in slow motion!

3986 Figure 20-6, a chart from NASA's Goddard Institute for Space Studies, shows temperature
 3987 rise for all land sites.

ITEM 11.1.

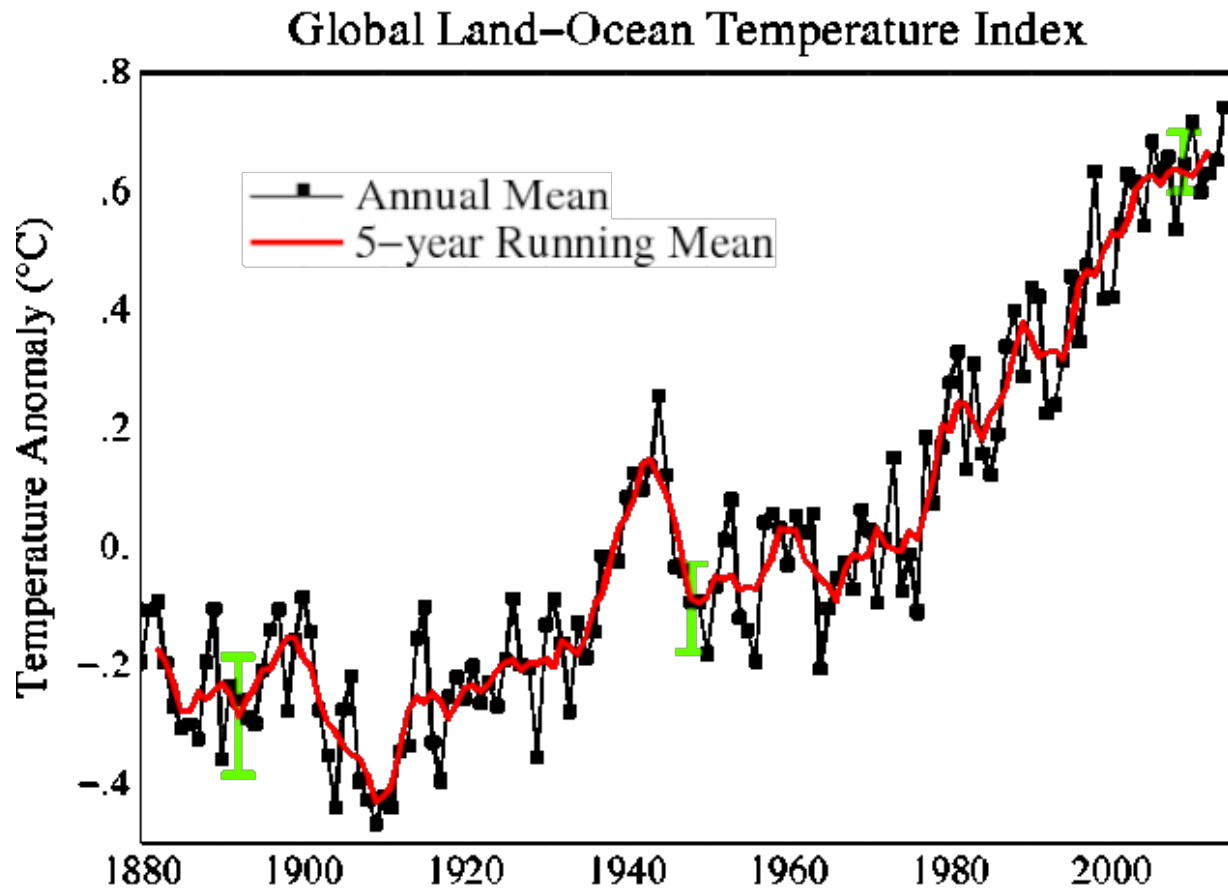
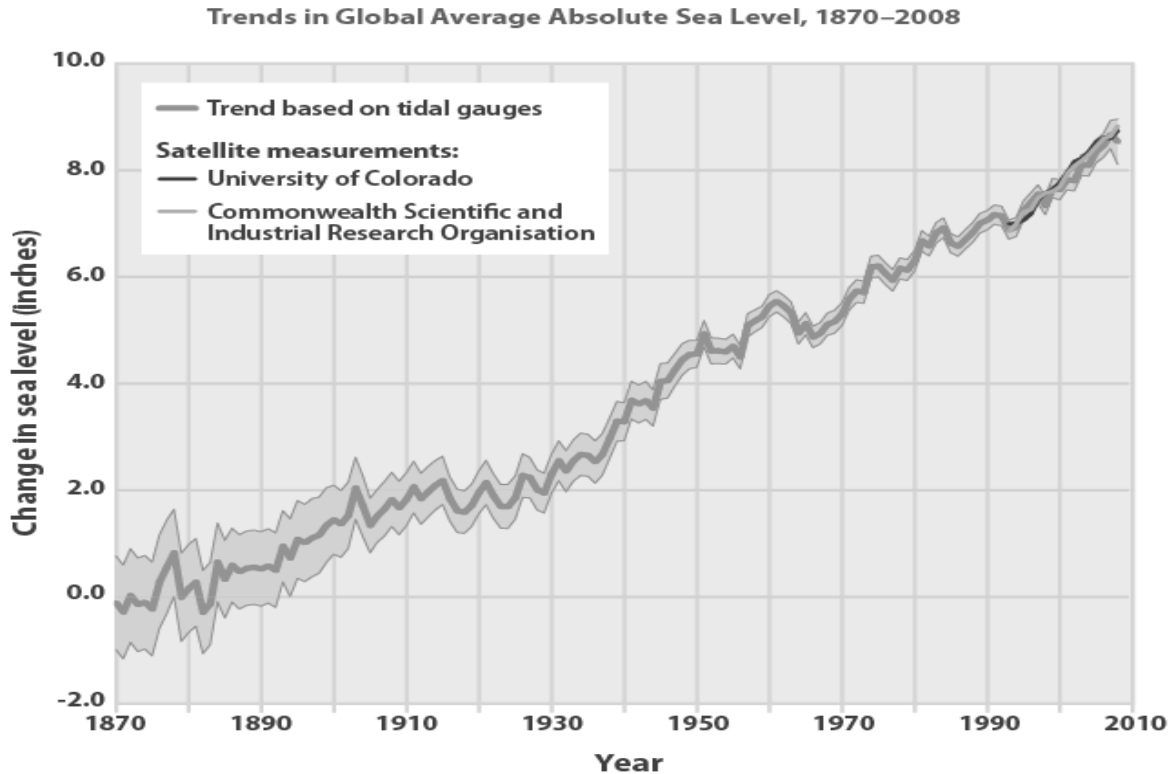


Figure 20-6. Changes in global temperatures over time.

Sea level rise data show that previous IPCC predictions were far too low. Strong evidence indicates that the global sea level is now rising at an increased rate, and will continue to rise during this century.

While studies show that sea levels changed little from AD 0 until 1900, sea levels began to climb in the 20th century. Roughly two-thirds of the effect is due to the thermal expansion caused by the warming of the oceans (since water expands as it warms) and one-third from the loss of land-based ice (such as glaciers and polar ice caps) due to increased melting. Records and research show that sea level has been steadily rising at a rate of 0.04 to 0.1 inches per year since 1900. This rate may be increasing. Since 1992, new methods of satellite altimetry (the measurement of elevation or altitude) indicate a rate of rise of 3 mm (0.12 inches) per year, or 4 inches by 2050.

ITEM 11.1.



Data sources:

- CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2009. Sea level rise. Accessed November 2009. <http://www.cmar.csiro.au/sealevel>.

- University of Colorado at Boulder. 2009. Sea level change: 2009 release #2. <http://sealevel.colorado.edu>.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/science/Indicators.

4001

4002 Figure 20-7. Rise in sea level over 138 years.

4003 **How I can protect myself?**

4004 The best way to protect yourself is to become knowledgeable about the impacts in your
4005 area, and plan accordingly.

4006 **1. Everywhere and everybody**

- 4007 • Learn your carbon footprint, and reduce it sharply.
- 4008 a. This involves research into considerations such as how much carbon is needed for:
- 4009 • A new car
- 4010 • An airplane trip to Asia
- 4011 • Increased use of water

ITEM 11.1.

- 4012 • Buying products that must be shipped in from overseas
- 4013 • Buying from countries with out-of-control carbon emissions (China especially
- 4014 because that country is so reliant on coal)
- 4015 • Purchasing imported versus local food
- 4016 • The carbon costs for beef versus lower carbon footprint meats (chicken and lamb)
- 4017 or grains and vegetables
- 4018 b. Try to avoid “feel good” environmentalism – stay on facts.
- 4019 • Examples
- 4020 1. Knee-jerk opposition to nuclear energy
- 4021 2. Plastic bag bans in the U.S. (China dumps 2.6 million tons of plastic each year
- 4022 into the Pacific Ocean (Indonesia and the Philippines are not far behind),
- 4023 while the U.S. dumps 0.08 million tons into the Pacific, Gulf, and Atlantic
- 4024 combined
- 4025 3. Some recycling uses more energy than it saves
- 4026 c. Research ways to reduce or replace high carbon costs
- 4027 • Smart houses
- 4028 • Smart cars such as plug-in hybrids
- 4029 • Teleconferencing and Skype versus travel
- 4030 d. Use of solar or wind power for your homes
- 4031 • Solar heated water – especially good

4032 These are among many other productive ways to reduce our carbon footprint.

4033 2. Coastal areas

- 4034 • The impacts are sea level rise and enhanced storms. Both make permanent residences and
- 4035 businesses subject to escalation in costs of damage.
- 4036 a. If possible, relocate in an area not so vulnerable

ITEM 11.1.

3. In the southwestern U.S.

- Expect ever dried and hotter conditions that may make maintaining dwellings and vegetation more difficult.
 - a. Homeowners should greatly enhance the insulation in their dwellings
 - b. Use solar energy to power air conditioning
 - c. Plant vegetation that is suitable to a desert environment

4. Almost everywhere

- Plan for more extreme storms

Nitty Gritty details

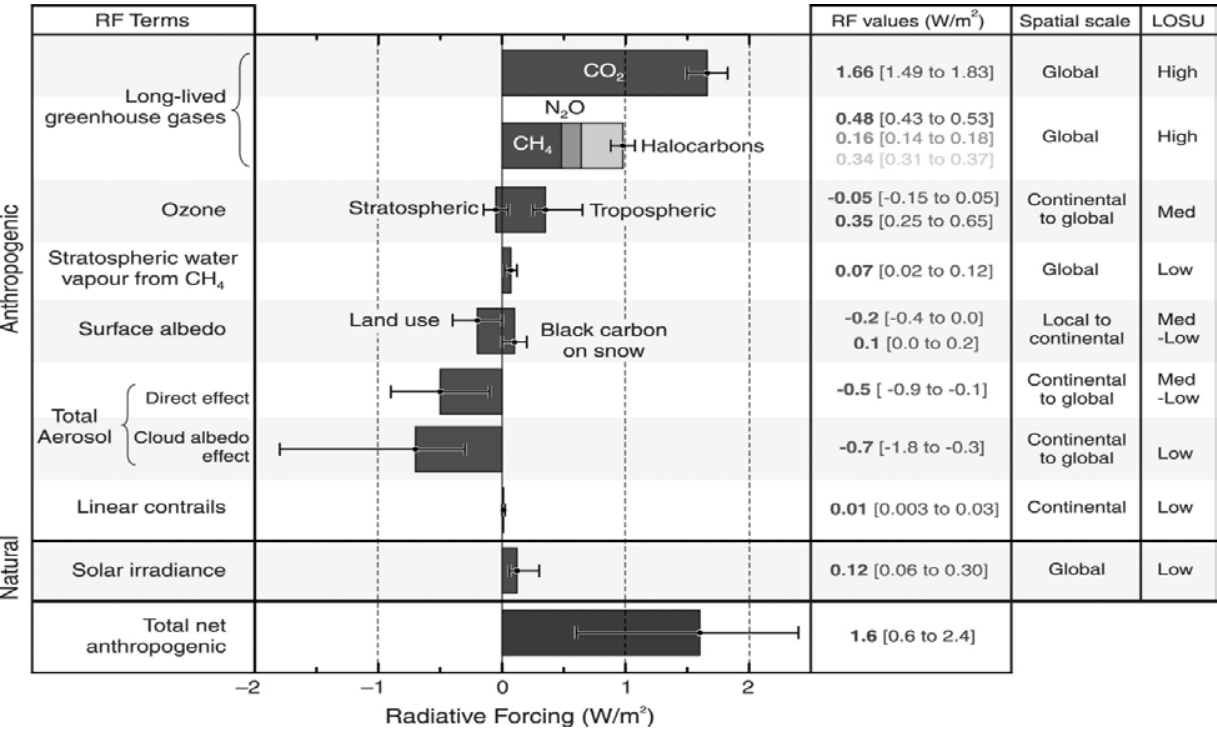


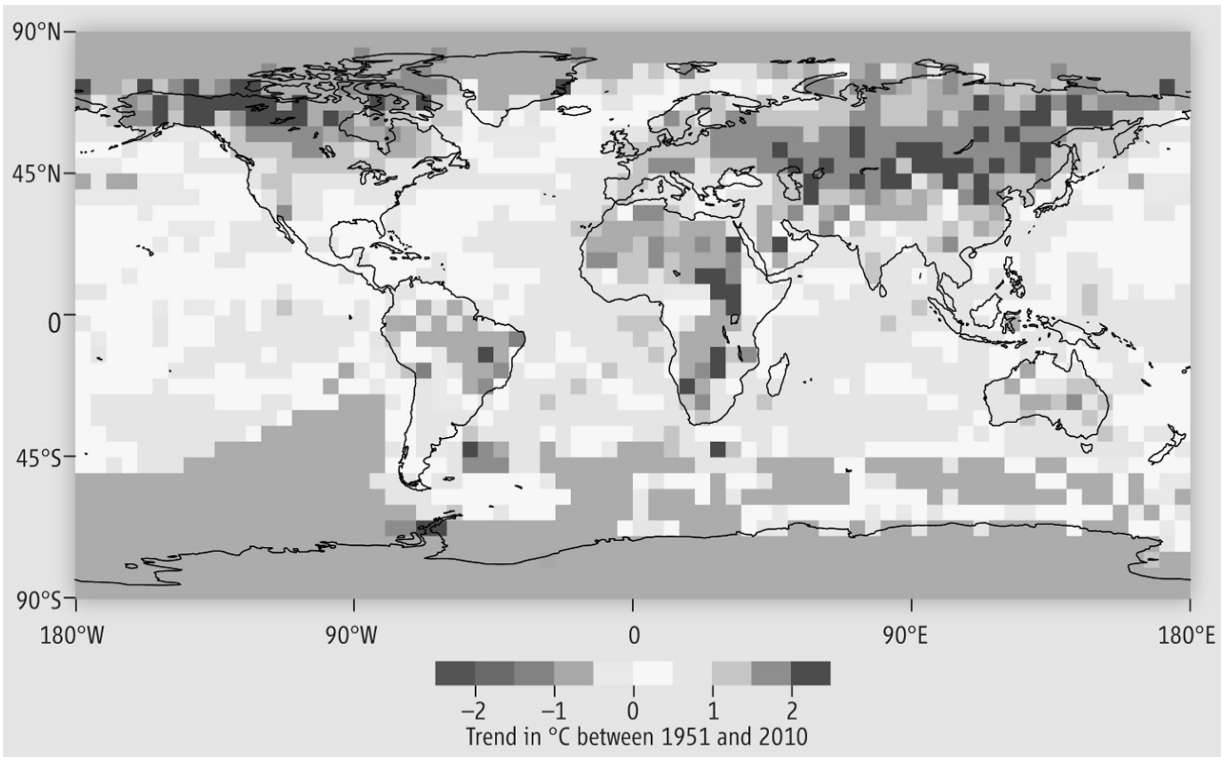
Figure 20-8. Drivers of climate change.

References

- Hegerl, G., and P. Stott. 2014. "Global Temperature Map." *Science* 343: 844–845.

ITEM 11.1.

- 4050 • Intergovernmental Panel on Climate Change (IPCC) assessment report:
4051 <http://www.ipcc.ch/report/ar5/>
- 4052 • National Aeronautics and Space Administration (NASA): <http://climate.nasa.gov/>
- 4053 • *National Geographic* Special Issue “Cool It.” November 2015.
- 4054 • National Oceanic and Atmospheric Administration (NOAA): <http://www.noaa.gov/climate>
- 4055 • U.S. Environmental Protection Agency (EPA): <https://www3.epa.gov/climatechange/>
- 4056 • Van Curen, Richard, Thomas Cahill, John Burkhart, David Barnes, Yongjing Zhao, Kevin
4057 Perry, Steven Cliff, and Joe McConnell. 2012. “Aerosols and Their Sources at Summit
4058 Greenland – First results of Continuous Size- and Time-resolved Sampling.” *Atmospheric
4059 Environment* 52: 82–97. doi:10.1016/j.atmosenv.2011.10.047.



4060
4061 Figure 20-9. Global temperature change over six decades.
4062
4063

ITEM 11.1.

Conclusions and Last Thoughts

First, congratulations on getting this far in my book. I have tried to summarize for the intelligent layperson what is contained in whole shelves of books in my office and enormous web data bases we all have access to. Even though I have tried to lighten up the tone, (yes, I played folk guitar in grad school), it is a hard book.

Second, I have tried in this book to provide the reader with the information needed to make valid evaluations of the risks from air pollution and methods to mitigate or even eliminate these threats. In doing so, I have shown that things people thought were a problems in past decades were really not important, while new and different threats have been identified that are not being effectively addressed by air pollution agencies. So it is up to you, the educated and involved citizen, to fill in the gaps by your own actions, and we have tried to give you the tools to take control.

What is needed in the (hopefully near) future? Ideally, open up the Clean Air Act to modifications that reflect current knowledge of the real threats to your health and our welfare. But in the current political arena, this is simply too dangerous because it could undermine much of the good the Clean Air Act has done. An alternative is to have California initiate such changes unilaterally, since it alone of all states has this power. The feds then usually find some way to follow, but often after long delays.

The most critical, and actually fairly easy and cheap, is to eliminate the metals from brake drums and pads. California is already doing that for copper, which is the most toxic of the ultra-fine metals. Note the cars that use electrical regeneration to brake, like my beloved Chevy Volt, have already solved this problem.

Another critical asset is to initiate on road testing to catch “gross emitter” and cheaters like Volkswagen, since a very few vehicles cause almost all of the highway air pollution.

But the most important step is a better educated citizen, able to see through the intellectual fog laid down by industry, well-meaning but illiterate air quality NGOs, and regulatory agencies trapped in the past. Good luck, and never give up trying.

Appendix A

Outdoor Air Mitigation

Threats from living near freeways and roadways

Despite the best efforts of California and the nation to reduce the detrimental effects of heavily traveled roadways on the health of nearby residential populations, automotive traffic continues to pose threats to health and welfare. Regulations have been enacted to diminish some of these health hazards, but recent research has disclosed serious threats for which no regulation or effective mitigation exists. They include:

a. Gross emitting cars

About one-tenth of all cars on California highways are responsible for about two-thirds of all automobile emissions.

b. Diesel exhaust

Effective reductions have occurred during the past 30 years, reducing diesel emissions by a factor of 10 or more. Nevertheless, diesel exhaust still constitutes about three-quarters of the impact of all Proposition 65 toxic air contaminants combined. These mitigations are encoded into the California default roadway impact model, EMFAC2007 (EMission FACtors), with periodic upgrades. The California ARB developed EMFAC as its model for estimating emissions from motor vehicles.

c. Very fine (< 0.25 µm) transition metals

Extensive data from ARB sponsored studies on the effect of Los Angeles freeways on the lung capacity of children in the 1990s is well documented in the peer-reviewed literature. The most likely candidate for the impact is inhalation of free radicals from reactions, including the Fenton reaction with the transition metals copper, iron, nickel, chromium, and manganese as the causal agents. The first three of these are emitted from braking actions of vehicles.

d. Very fine and ultra-fine (< 0.1 µm) insoluble aerosols

ITEM 11.1.

4118 These include but are not limited to transition metals. These particles migrate into the
 4119 bloodstream, with cardiovascular implications, including well-documented deaths by
 4120 ischemic heart disease and autism. Data on the incidence of autism near highways is
 4121 consistent with the ability of ultra-fine insolubles to pass the blood-brain barrier.

4122 **e. Fine (< 2.5 µm) and very fine aerosols**

4123 Extensive data show significant asthma increases for children living near freeways, but
 4124 because the causes are complex, they are excluded from this summary.

4125 *Nerd alert! We about to go off the high diving board into the deep end of the pool. Skim and*
 4126 *take what you need, but don't despair! Some of this was only published in April, 2016.*

4127 **Summary:**

4128 **1. Standard conditions as incorporated in Emfac2007**

4129 The default condition for Emfac2007 include many limitations:

4130 **a. wind within ± 30° to freeway normal**

4131 **b. an at-grade roadway with**

- 4132 • no lateral obstructions and
- 4133 • freely flowing traffic

4134 These conditions are well handled by Emfac2007 and supported by extensive field data.
 4135 They provide the default condition that can be applied to housing near roadways.

4136 **2. Impact modifiers to Emfac2007 for non-standard conditions.**

4137 A large body of peer-reviewed literature that modifies the impacts of roadways is based on
 4138 a factor not included in Emfac2007. The modifiers can **either raise or lower** the health impacts
 4139 **and extend or contract the distances** from the roadway for the effects. These include but are
 4140 not limited to:

4141 **a. Meteorology**

- 4142 • For winds that blow at an angle to the roadway, downwind health impact values must
 4143 be multiplied by a factor. For winds at 45 degrees from normal, the health factor is
 4144 enhanced by a 40 percent increase and the distances are contracted by 29 percent.

ITEM 11.1.

4145 The Emfac2007 supporting studies were largely taken under inversions conditions – the
 4146 marine inversion of Los Angeles and the Bay Area, and the radiation and subsidence
 4147 inversions of the Central Valley in the four months of fall and winter. Data in October
 4148 from I-96 in Detroit shows the same pattern. However, for hot summer non-inversion
 4149 conditions at Central Valley sites and Las Vegas study in spring, summer, and early
 4150 autumn, distance impacts should be contracted by a factor of 10. This will have the
 4151 annual net impact of Emfac2007 being reduced by a factor of x3 for hot summer and
 4152 Central Valley impacts. (see Figure 3.2)

4153 **b. Roadway configuration**

- 4154 • For an at-grade roadway with a 15-foot sound wall, the Emfac2007 **distances** should
 4155 be **multiplied by a factor of ~ 2 to 2.5** for the same health impact.
- 4156 • For a 30-foot depressed roadway, the Emfac2007 health impacts should be **divided**
 4157 **by a factor of ~ 5** for the same health impact.
- 4158 • For an elevated roadway on a berm taller than 20 feet, the Emfac2007 **distances** must
 4159 be multiplied by a **factor of ~ 20** for equivalent health impact.

4160 **c. Traffic behavior**

- 4161 • For any roadway downwind of routine (4 hr/day) and heavy braking, the **health impact**
 4162 **data** of Emfac2007 must be **multiplied by ~ 2 to 3** to account for the addition threat
 4163 of the very fine and ultra-fine metals.

4164

4165 These corrections are multiplicative – e.g., a raised roadway with heavy braking requires
 4166 **both downwind health data x ~ 2 to 3 and distances by ~ 20.**

4167 **Standard conditions**

4168 ***At-grade free flowing roadways, no obstructions***

4169 This is the default situation enshrined in Emfac2007 (ARB 2007, with updates until 2015).

Wind	Emfac 2007, meters	Depressed, free flowing	Depressed, braking	At grade, free flowing	At grade, braking	At grade, Braking, sound wall	Raised, free flowing	Raised, braking
------	--------------------------	----------------------------	-----------------------	---------------------------------	-------------------------	--	----------------------------	--------------------

ITEM 11.1.

		(diesel exhaust)	(ultra-fine metals)	(diesel exhaust)	(ultra- fine metals)	ultra-fine metals)	(diesel exhaust)	(ultra- fine metals)
Upwind	20	< 10	< 10	20	20	40	20	50
Calms	na	< 10	< 10	30	60	60	30	80
Down- wind	50	< 10	<10	50	120	300	1000	1500

4170 Table A1-1. Approximate distances in meters for reduced impact on health. The data
 4171 are keyed to 400/million incremental cancer risk at 16,000 peak hour. The shaded areas
 4172 in Emfac2007 and field data support this.

4173 The 82 separate freeway transects we made in Los Angeles in 1972 had the advantage of a
 4174 conserved ultra-fine unique roadway tracer, lead in the chlorobromide PbBrCl. The measured
 4175 downwind concentrations for an at-grade freeway matched beautifully a sliding box freeway
 4176 source model, with the source being the well-known lead emission rate. Downwind diffusion
 4177 was handled by a line source diffusion model.

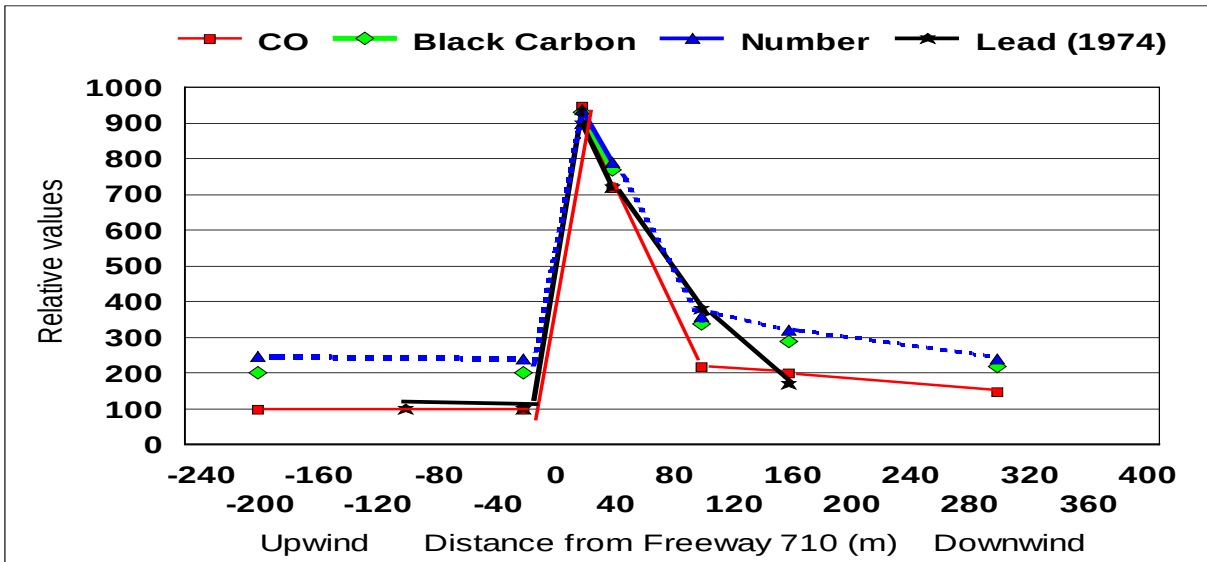
	Roadway sites	On roadway	Right-of- way fence	Downwind No. 1	Downwind No. 2
Roadway configuration	Distance to median	30 meters	40 meters	100 meters	160 meters
At-grade theory		4.0 ± 0.4 µg/m ³	3.1 µg/m ³	1.4 µg/m ³	0.41 µg/m ³
At-grade data	I – 405	4.0 ± 0.6 µg/m ³	3.4 ± 0.6 µg/m ³	1.4 ± 0.2 µg/m ³	0.35 ± 0.06 µg/m ³
Fill sections data	I – 405 at 137th St. (2)	4.8 ± 1.2 µg/m ³	2.3 ± 0.6 µg/m ³	3.1 ± 0.8 µg/m ³	3.5 ± 0.9 µg/m ³
Cut sections data	I-10 at 4th,(2) I-110 at 146th	4.7 ± 0.6* µg/m ³	1.3 ± 0.2 µg/m ³	0.3 ± 0.06 µg/m ³	

4178 Table A1-2. Lead levels in µg/m³ normalized to 5,000 v/h, for wind velocities > 5 km/hr.
 4179 Prior nomenclature was I-405 (San Diego), I-10 (Santa Monica), and I-110 (Harbor)

ITEM 11.1.

freeways. (Cahill et al., 1973, Feeney et al., 1975, Cahill et al 2012, Cahill et al., 2016 submitted).

The default condition for roadway influence is the ARB's Emfac2007, (ARB 2007) with periodic upgrades (latest in 2015). Emfac2007 is based on the health impact assessments of California Toxic Air Contaminants (TACs) under Proposition 65, with about 70 percent due to diesel exhaust alone. The conditions are for a lateral wind across an at-grade roadway without obstructions, and are supported in detail by both data and models, as shown in Figure A1-1.

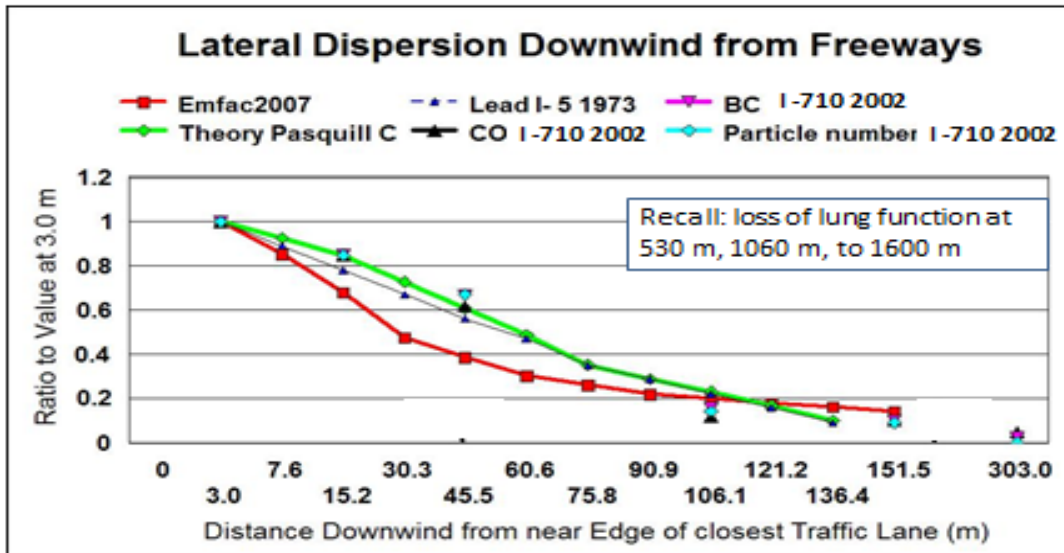


4187

Figure A1-1. Transects across an at-grade roadway (Zhu et al., 2002), with the data of Cahill et al., 1973 for lead (Cahill et al., 1973, Feeney et al., 1975, Zhu et al 2002 a,b).

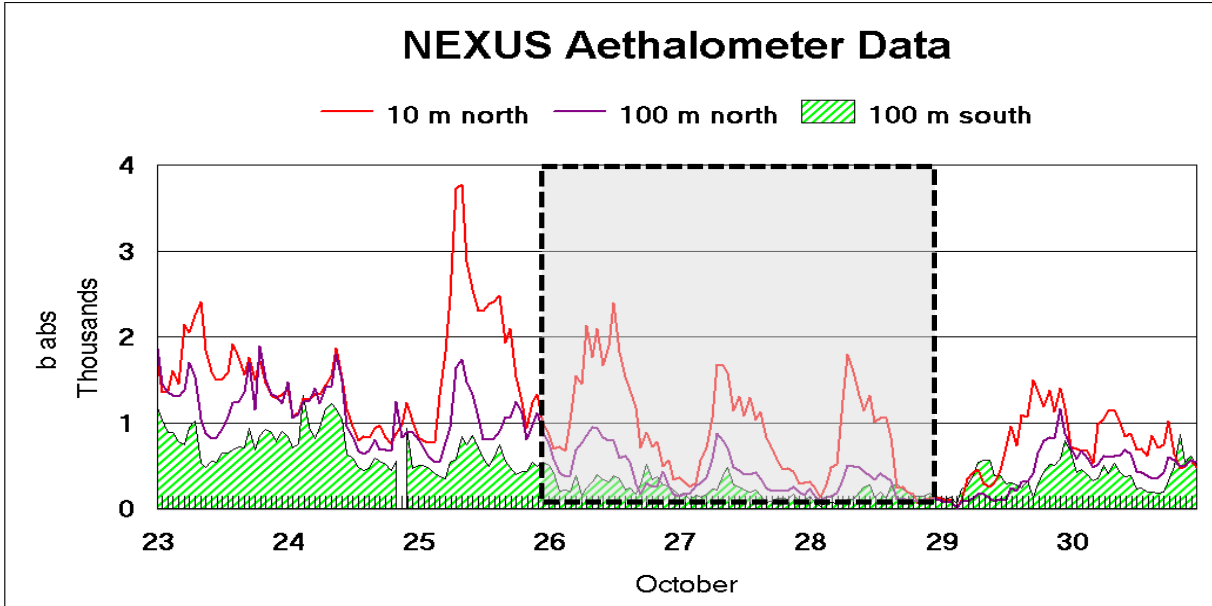
ITEM 11.1.

Comparison of line source diffusion models and pollutants downwind of an at-grade freeway



4190

4191 Figure A1-2. Emfac2007 versus Cahill et al., 1973 and Zhu et al., 2002 data.



4192

4193 Figure A1-3. Aethalometer data on optical absorption from I-96 west of Detroit (EPA
4194 2010).

ITEM 11.1.

4195 The aethalometer data reflect black carbon, dominated by diesel exhaust in almost all
 4196 instances of heavily traveled roadways with a high percentage of truck traffic, as was the case on
 4197 I-96 west of Detroit. These data also support the Emfac2007 downwind profiles for an at-grade
 4198 roadway.

4199 The data below are in excess of deaths per 70-year lifespan, and the worst listed is 1,488
 4200 deaths per million. To put this in perspective, since roughly 20 percent of all deaths are from
 4201 cancer (~ 200,000 per million), this is a 0.7 percent increase in the cancer death rate.

PROJECTS NORTH AND SOUTH OF AN EAST-WEST ROADWAY								
Distances in feet	Receptor distance from edge of nearest travel lane (feet)							
	10	25	50	100	200	300	400	500
Distances in meters	3	8	15	30	61	91	121	152
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: north (downwind)								
4,000	210	186	153	114	75	57	45	39
8,000	420	372	309	228	150	114	90	75
12,000	630	558	462	339	222	168	135	114
16,000	837	741	615	453	297	225	180	153
20,000	1047	927	768	567	372	279	228	192
24,000	1257	1113	924	681	447	336	273	228
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: south (upwind)								
4,000	117	96	75	54	36	27	21	18
8,000	234	192	153	108	69	51	42	36
12,000	351	291	228	165	105	78	63	54
16,000	468	387	306	219	138	105	84	69
20,000	582	486	381	273	177	132	105	87
24,000	699	582	459	327	210	159	126	105

PROJECTS EAST AND WEST OF A NORTH-SOUTH ROADWAY								
Distances in feet	Receptor distance from edge of nearest travel lane (feet)							
	10	25	50	100	200	300	400	500
Distances in meters	3	8	15	30	61	91	121	152
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: east (downwind)								
4,000	249	213	168	117	75	57	45	36
8,000	495	423	336	237	150	111	90	72
12,000	744	636	504	354	225	168	132	111

ITEM 11.1.

16,000	990	849	672	474	303	222	177	147
20,000	1239	1062	840	591	378	279	222	183
24,000	1488	1272	1008	711	453	336	267	219
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: west (upwind)								
4,000	159	123	93	63	39	27	21	18
8,000	315	249	183	126	78	57	45	36
12,000	474	375	276	189	117	87	69	54
16,000	633	501	369	252	156	114	90	75
20,000	792	627	459	315	198	144	114	93
24,000	948	750	552	378	237	174	135	111

4202 Table A1-3. Emfac2007. The shaded areas are roughly set at 400/millions, which is
4203 close to a 0.5 percent increase in the cancer death rate, or a 0.1 percent increase in the
4204 total death rate.

4205 For comparison, the worst death rate in California, roughly 2,700 per million, occurs
4206 downwind of the BNSF San Bernardino rail yard/intermodal facility. That constitutes a 1.35
4207 percent increase in the cancer death rate, but it affects only a few thousand people.

4208 Non-default EMFAC2007 conditions

4209 *Impact modifier: meteorology*

4210 A. Wind at an angle to the roadway

4211 When the wind is at an angle to the roadway other than a right angle (normal), the lateral
4212 displacement of the sliding box model (Cahill et al., 1973, Courtney et al., 1978) cell is slower;
4213 that allows pollutants to increase before the box slides off the downwind edge of the roadway,
4214 but pollutants stay closer to the roadway by a factor of 1.4. The extreme case is the wind almost
4215 parallel to the roadway, giving very high on-roadway and near-roadway (close in) impacts that
4216 are difficult to either model or measure – e.g., I-5 in the EDF Huron study, 2007 (EDF 2007).

	Normal to the roadway (degrees)	Deviation from normal (degrees)	Multiply health impacts by
Default = normal	90	0	1.00
	75	15	1.04
	60	30	1.15
	45	45	1.40

ITEM 11.1.

30	60	2.00
15	75	3.86

4217 Table A1-4. Effect of non-normal wind direction across roadway.

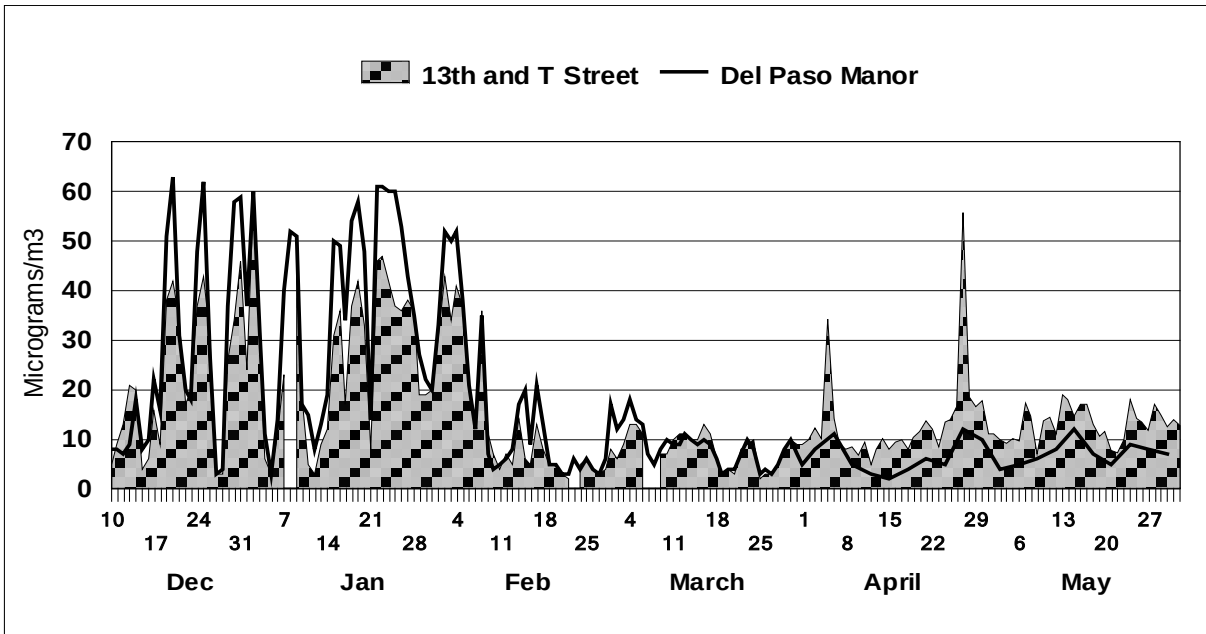
PROJECTS EAST AND WEST OF A NORTH-SOUTH ROADWAY								
Distances in feet	Receptor distance from edge of nearest travel lane (feet)							
	7	18	35	70	140	210	290	360
Distances in meters	2	5	11	20	40	65	90	110
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: east (downwind)								
4,000	180	150	121	86	54	39	32	25
8,000	330	300	240	170	110	80	65	50
12,000	530	460	360	250	160	120	90	80
16,000	710	610	480	340	210	140	130	110
20,000	890	760	600	420	270	200	160	130
24,000	1060	910	720	510	320	240	190	160
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: west (upwind)								
4,000	110	90	65	45	29	21	14	14
8,000	230	180	130	90	60	45	32	25
12,000	340	270	200	140	90	65	50	39
16,000	450	360	260	180	110	80	65	50
20,000	560	450	330	230	140	100	80	70
24,000	680	540	390	270	170	120	100	80

4218 Table A1-5. EMFAC2007 modified to reflect winds at 45 degrees to the freeway.

4219 **B. Hot summer sites**

4220 The EMFAC2007 supporting studies were largely taken under inversions conditions, the
 4221 cool marine inversion of Los Angeles and the Bay Area, and the radiation and subsidence
 4222 inversions of the Central Valley, during the four months of fall and winter. Data in October from
 4223 I-96 in Detroit shows the same pattern. However, for hot summer **non-inversion conditions**,
 4224 **enhanced ventilation sharply reduces downwind impacts by about a factor of 10** (Figure
 4225 A1-4 for PM_{2.5}, Figure A1-5 for ultra-fine metals).

ITEM 11.1.

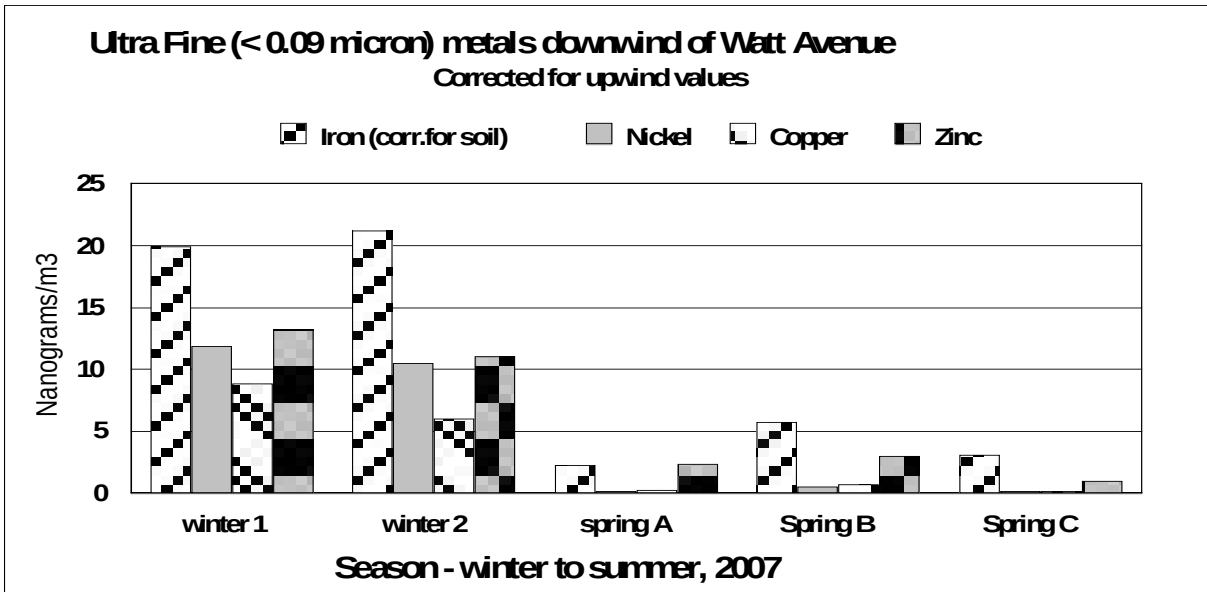


4226

4227 Figure A1-4. Example of PM_{2.5} aerosols at two sites about six miles apart in
 4228 Sacramento. Note the similarity between the sites, showing a regional aerosol, and the
 4229 effect the inversion break-up in spring.

4230 This temperature-enhanced lofting of pollutants was seen earlier in Los Angeles in below-
 4231 grade-level freeways, and is largely responsible for the reduced impact near below-grade
 4232 freeways. This also was seen in a study near Las Vegas freeways. Thus, the very low values in
 4233 spring, summer, and fall should be averaged with the winter months to give a reduction of a
 4234 factor of 3 on an annual average. Thus I propose that health impacts should be **reduced by a**
 4235 **factor of x 3 for hot summer and Central Valley impacts. (Figure 3.2)**

ITEM 11.1.



4236

4237 Figure A1-5. Ultra-fine metals downwind of Watt Avenue in Sacramento.

PROJECTS EAST AND WEST OF A NORTH-SOUTH ROADWAY								
Distances in feet	Receptor distance from edge of nearest travel lane (feet)							
	10	25	50	100	200	300	400	500
Distances in meters	3	8	15	30	61	91	121	152
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: east (downwind)								
4,000	85	70	60	40	25	18	15	12
8,000	150	140	110	80	50	37	30	23
12,000	250	215	170	120	80	60	43	37
16,000	330	280	220	160	100	70	60	50
20,000	410	350	280	200	130	95	75	60
24,000	500	420	340	240	150	110	90	75
Peak-hour traffic (vehicle/hr) incremental cancer risk per million: west (upwind)								
4,000	50	40	30	22	13	10	7	7
8,000	110	85	60	45	27	20	15	12
12,000	160	127	93	63	40	30	23	18
16,000	210	170	120	85	55	40	30	25
20,000	260	210	150	110	65	45	37	32
24,000	320	250	180	130	80	55	45	37

228

Cahill -- 00000233

ITEM 11.1.

4238 Table A1-6. EMFAC2007 modified for hot summer sites in the Central Valley.

4239 ***Impact modifier: physical conditions***

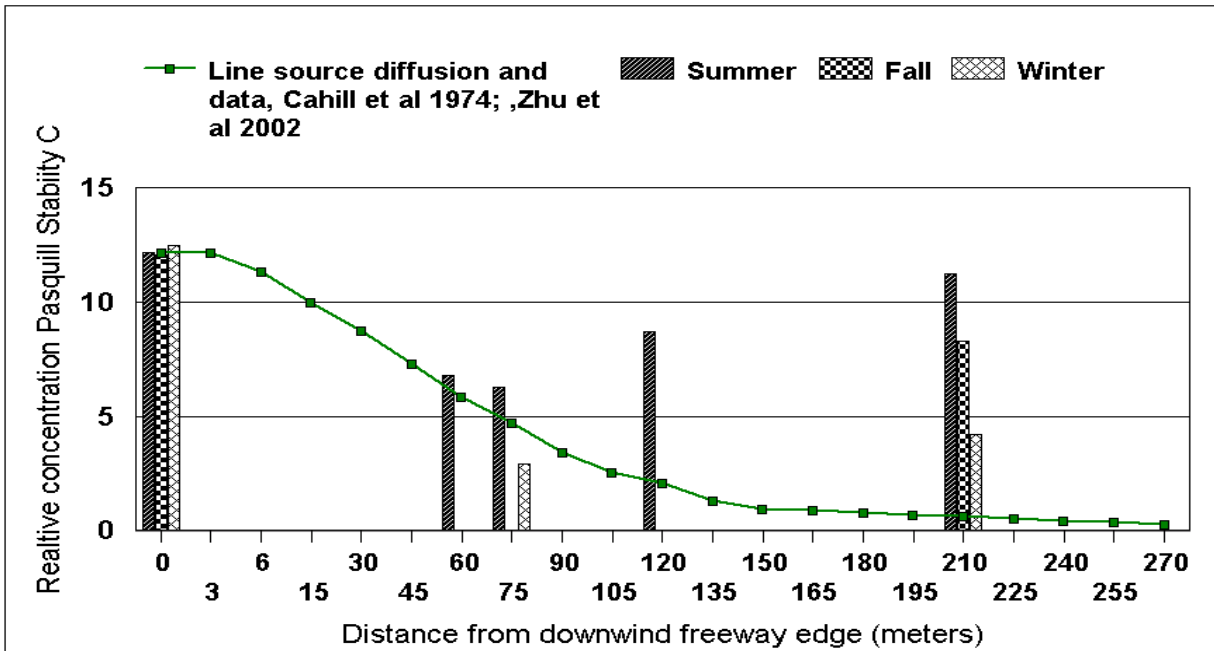
4240 **A. Near roadway obstructions**

Wind	EMFAC 2007, meters	Below grade, free- flowing (diesel exhaust)	Below grade, braking (ultra- fine metals)	At grade, free- flowing (diesel exhaust)	At grade, braking (ultra- fine metals)	At grade, braking, sound wall ultra-fine metals)	Raised, free flowing (diesel exhaust)	Raised, braking (ultra- fine metals)
Upwind	20	< 10	< 10	20	20	40	20	50
Calm	na	< 10	< 10	30	60	60	30	80
Down- wind	50	< 10	<10	50	120	300	1000	1500

4241 Table A1-7. Approximate distances in meters for reduced impact on health. The data
 4242 are keyed to 400/million incremental cancer risk at 16,000 peak hr. The shaded areas in
 4243 EMFAC2007 and field data support this.

4244 Recent data on sound walls show that they tend to pitch the pollutants farther downwind
 4245 (Cahill et al., 2016). Tables A1-2 and A1-7 also includes the effect of upwind braking and ultra-
 4246 fine metals.

ITEM 11.1.



4247

4248 Figure A1-6. Transport of very fine and ultra-fine flare tracer aerosols downwind of I-5
 4249 on 10th Avenue in Sacramento as a function of season.

4250 The plot also includes the line source diffusion modeling results that matched the lead
 4251 (Cahill et al., 1973) and fine aerosol and CO results (Zhu et al., 2002b) at at-grade roadways.

4252 Based on these results, the distances in EMFAC2007 must be **multiplied by a factor of 2 to 2.5**
 4253 for the same health impact.

Downwind								
Distances, ft	25	63	125	250	500	750	1,000	1,250
Distances, m	8	20	38	75	153	228	303	380
Peak traffic hour (v/hr)								
4,000	250	210	170	120	75	55	45	35
8,000	460	420	340	240	150	110	90	70
12,000	740	640	500	350	230	170	130	110
16,000	990	850	670	470	300	200	180	150
20,000	1240	1060	840	590	380	280	220	180
24,000	1490	1270	1010	710	450	340	270	220

Upwind

230

ITEM 11.1.

Distances, ft	10	25	50	100	200	300	400	500
Distances, m	3	8	15	30	61	91	121	152
Peak traffic hour (v/hr)								
4,000	160	120	90	65	40	30	20	20
8,000	320	250	180	130	80	60	45	35
12,000	480	380	280	190	120	90	70	55
16,000	630	500	370	250	160	110	90	75
20,000	790	630	460	320	200	140	110	95
24,000	950	750	550	380	240	170	140	110

4254 Table A1-8. Incidental cancer risk per million downwind of a sound wall.

4255 Vegetation is under study and probably will provide some protection (Baldauf et al., 2013).

4256 However, the most robust result to date is that a downwind tree canopy provides about a factor of

4257 2 (50%) reduction in fine roadways aerosols.

4258 **B. Roadway configuration other than at-grade:**

4259 **1. Depressed sections $\geq$ 30 feet.**

Wind	EMFAC 2007, meters	Below grade, free flowing (diesel exhaust)	Below grade, braking (ultra- fine metals)	At grade, free flowing (diesel exhaust)	At grade, braking (ultra- fine metals)	At grade, braking, sound wall ultra-fine metals)	Raised, free flowing (diesel exhaust)	Raised, braking (ultra- fine metals)
Upwind	20	< 10	< 10	20	20	40	20	50
Calm	na	< 10	< 10	30	60	60	30	80
Downwind	50	< 10	<10	50	120	300	1000	1500

4260 Table A1-9. Approximate distances in meters for reduced impact on health. The data

4261 are keyed to 400/million incremental cancer risk at 16,000 peak hour. The shaded areas

4262 in EMFAC2007 and field data support this.

ITEM 11.1.

4263 During the effort to remove lead from gasoline and incorporate the catalytic converter in
 4264 California, 80 transects were made from Los Angeles roadways, aided by the presence of a
 4265 quantified unique tracer of gasoline combustion: lead in the form PbBrCl (lead chlorobromide).
 4266 One set was made at an at-grade roadway, two from depressed roadways, and two others from
 4267 raised roadways.

	Roadway sites	On roadway	Right-of-way fence	Downwind No. 1	Downwind No. 2
Roadway configuration	Distance to median	30 meters	40 meters	100 meters	160 meters
At-grade theory		4.0 ± 0.4 µg/m ³	3.1 µg/m ³	1.4 µg/m ³	0.41 µg/m ³
At-grade data	I – 405	4.0 ± 0.6 µg/m ³	3.4 ± 0.6 µg/m ³	1.4 ± 0.2 µg/m ³	0.35 ± 0.06 µg/m ³
Fill sections data	I-405 at 137th St. (2)	4.8 ± 1.2 µg/m ³	2.3 ± 0.6 µg/m ³	3.1 ± 0.8 µg/m ³	3.5 ± 0.9 µg/m ³
Cut sections data	I-10 at 4th,(2) I-110 at 146th	4.7 ± 0.6* µg/m ³	1.3 ± 0.2 µg/m ³	0.3 ± 0.06 µg/m ³	

4268 Table A1-10. Lead levels in µg/m³ normalized to 5,000 v/h, for wind velocities > 5 km/hr.
 4269 Prior nomenclature was I-405 (San Diego), I-10 (Santa Monica), and I-110 (Harbor)
 4270 freeways (Cahill et al., 1973; Feeney et al., 1975; Cahill et al., 2012; Cahill et al., 2016
 4271 submitted). Data taken on pedestrian bridge over the middle of the freeway.

4272 While the at-grade results were in excellent agreement with a line source diffusion model,
 4273 and later echoed by the work of Zhu et al., 2002 a, b, and EMFAC2007, the below-grade **section**
 4274 **had only 20 percent of the amount of lead** that the at-grade results indicated.

Downwind

Distances, ft	10	25	50	100	200	300	400	500
Distances, m	3	8	15	30	61	91	121	152
Pk traffic hour (v/hr)								
4000	50	42	34	24	15	11	9	7
8,000	92	84	68	48	30	22	18	14
12,000	148	128	100	70	46	34	26	22
16,000	198	170	134	94	60	40	36	30

ITEM 11.1.

20,000	248	212	168	118	76	56	44	36
24,000	298	254	202	142	90	68	54	44

Upwind

Distances, ft	10	25	50	100	200	300	400	500
Distances, m	3	8	15	30	61	91	121	152

Pk traffic hour
(v/hr)

4,000	32	24	18	13	8	6	4	4
8,000	64	50	36	26	16	12	9	7
12,000	96	76	56	38	24	18	14	11
16,000	126	100	74	50	32	22	18	15
20,000	158	126	92	64	40	28	22	19
24,000	190	150	110	76	48	34	28	22

4275 Table A1-11. Incidental cancer risk per million for a below-grade roadway.

4276 Based upon the results in Table A1-10, the EMFAC2007 results should **be divided by a**
 4277 **factor of 5**. These roadways have far less impact downwind.

4278 **2. Elevated sections on a berm $\geq$ 30 feet.**

Wind	EMFAC 2007, meters	Depressed, free flowing (diesel exhaust)	Depressed, braking (ultra-fine metals)	At grade, free flowing (diesel exhaust)	At grade, braking (ultra- fine metals)	At grade, braking, sound wall ultra-fine metals)	Raised, free flowing (diesel exhaust)	Raised, braking (ultra- fine metals)
Upwind	20	< 10	< 10	20	20	40	20	50
Calm	na	< 10	< 10	30	60	60	30	80
Down- wind	50	< 10	<10	50	120	300	1000	1500

4279 Table A1-12. Highway impact distances for reduced impact on health. The data are
 4280 keyed to an 82 percent reduction in highway impact. The data are based on our 2014
 4281 BC/SET HETF studies on I-5.

ITEM 11.1.

	Roadway sites	On roadway	Right-of-way fence	Downwind No. 1	Downwind No. 2
Roadway configuration	Distance to median	30 meters	40 meters	100 meters	160 meters
At-grade theory		$4.0 \pm 0.4 \mu\text{g}/\text{m}^3$	$3.1 \mu\text{g}/\text{m}^3$	$1.4 \mu\text{g}/\text{m}^3$	$0.41 \mu\text{g}/\text{m}^3$
At-grade data	I-405	$4.0 \pm 0.6 \mu\text{g}/\text{m}^3$	$3.4 \pm 0.6 \mu\text{g}/\text{m}^3$	$1.4 \pm 0.2 \mu\text{g}/\text{m}^3$	$0.35 \pm 0.06 \mu\text{g}/\text{m}^3$
Fill sections data	I-405 at 137th St. (2)	$4.8 \pm 1.2 \mu\text{g}/\text{m}^3$	$2.3 \pm 0.6 \mu\text{g}/\text{m}^3$	$3.1 \pm 0.8 \mu\text{g}/\text{m}^3$	$3.5 \pm 0.9 \mu\text{g}/\text{m}^3$
Cut sections data	I-10 at 4th,(2) I-110 at 146th	$4.7 \pm 0.6^* \mu\text{g}/\text{m}^3$	$1.3 \pm 0.2 \mu\text{g}/\text{m}^3$	$0.3 \pm 0.06 \mu\text{g}/\text{m}^3$	

4282 Table A1-13. Lead levels in $\mu\text{g}/\text{m}^3$ normalized to 5,000 v/h, for wind velocities > 5 km/hr.
 4283 Prior nomenclature was I-405 (San Diego), I-10 (Santa Monica), and I-110 (Harbor)
 4284 freeways.

4285 Recall that the Peters et al. 1999 health data on loss of lung function in children extended
 4286 out to ~ 1,600 m downwind, and Volk et al. 2010 autism study had impacts out to ~ 1,500 m
 4287 downwind.

ITEM 11.1.

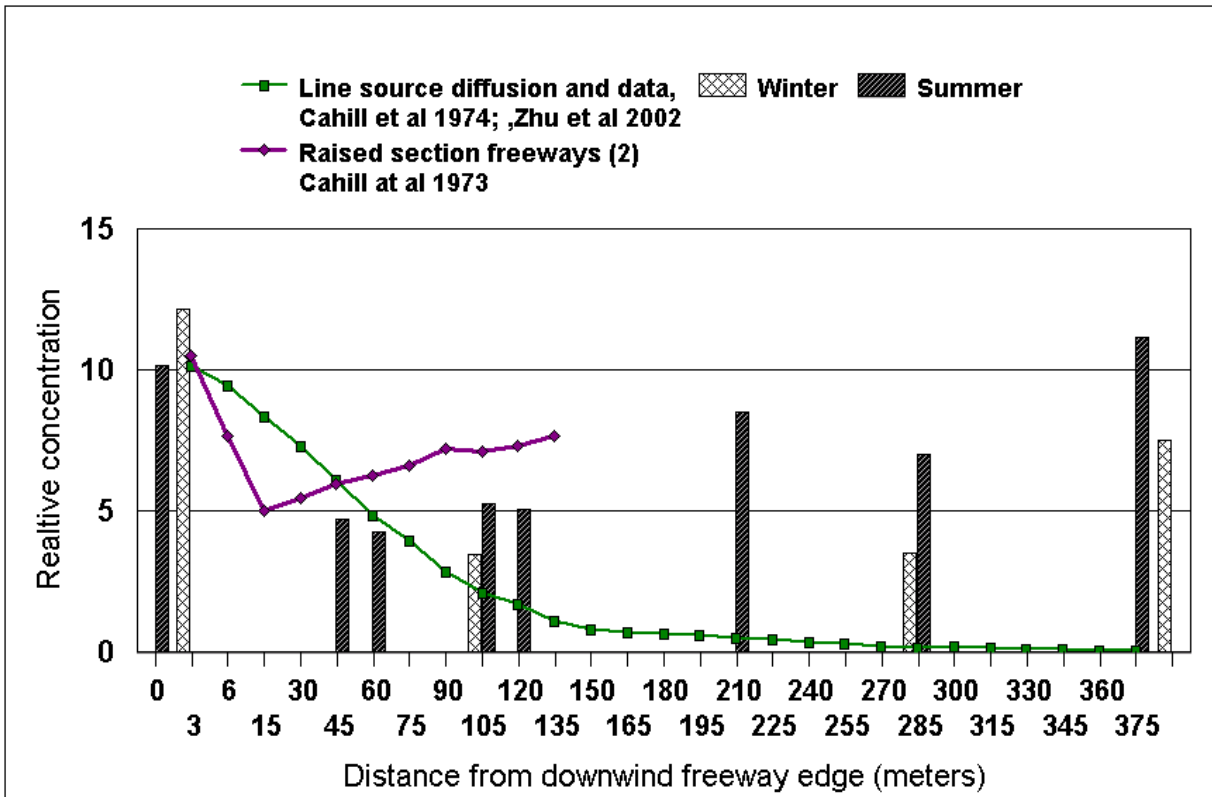


Figure A1-7. Results of the 35th Avenue fill section roadway, summer and winter.

Based upon these results, the EMFAC2007 table **distances must be multiplied by a factor of ~ 20** for the same health impact (Cahill et al., 2016).

Note that these distances are a good match to the near-freeway health data. The Peters et al. 1999 lung function distances were set at < 500 m (1,650 feet), 500 m to 1,500 m (4,950 ft) and < 1,500 m, while the Volk et al. autism data were based on < 309 m (1,020 feet), to 607 m (2,135 feet), to 1,419 m (4,682 feet), with controls (50 percent of the population) beyond 1,419 m (4,682 feet).

Downwind								
Distances, ft	200	500	1,000	2,000	4,000	6,000	8,000	10,000
Distances, m	60	160	300	600	1,220	1,820	2,420	3,040
Peak traffic hour (v/hr)								
4,000	250	210	170	120	75	55	45	35

ITEM 11.1.

8,000	460	420	340	240	150	110	90	70
12,000	740	640	500	350	230	170	130	110
16,000	990	850	670	470	300	200	180	150
20,000	1240	1060	840	590	380	280	220	180
24,000	1490	1270	1010	710	450	340	270	220

Upwind

Distances, ft	10	25	50	100	200	300	400	500
Distances, m	3	8	15	30	61	91	121	152

Peak traffic
hour (v/hr)

4,000	160	120	90	65	40	30	20	20
8,000	320	250	180	130	80	60	45	35
12,000	480	380	280	190	120	90	70	55
16,000	630	500	370	250	160	110	90	75
20,000	790	630	460	320	200	140	110	95
24,000	950	750	550	380	240	170	140	110

4298 Table A1-14. Incidental cancer risk per million downwind of a raised-section roadway.

4299 **Impact modifier: traffic conditions**

4300 **A. Very fine and ultra-fine “wear” aerosols from braking**

Wind	EMFAC 2007, meters	Depressed, free flowing (diesel exhaust)	Depressed, braking (ultra-fine metals)	At grade, free flowing (diesel exhaust)	At grade, braking (ultra- fine metals)	At grade, braking, sound wall ultra-fine metals)	Raised, free flowing (diesel exhaust)	Raised, braking (ultra- fine metals)
Upwind	20	< 10	< 10	20	20	40	20	50
Calm	na	< 10	< 10	30	60	60	30	80
Downwind	50	< 10	< 10	50	120	300	1,000	1,500

ITEM 11.1.

4301 Table A1-15. Highway impact data. The data are keyed to an 82 percent reduction in
 4302 highway impact. The data are based on our recent BC/SET HETF I-5 transects (in
 4303 press), our Central Valley peer-reviewed studies, and OEHHA peer-reviewed literature.

4304 Some predictions indicate that aerosols associated from vehicular wear are on track to
 4305 exceed tailpipe emissions in the near future (Denier et al., 2013). Only limited data are available
 4306 on wear aerosols by size and composition, but a major source is known to be ultra-fine metals
 4307 from abrasion of brake pads and drums (Cahill et al., 2014). For the calculations below, I
 4308 matched the fraction of braking just upwind of Arden Middle School, about 4 daytime hours out
 4309 of 12, using the Watt Avenue traffic peak of about 4,000 vehicles/hr.

4310 Based upon the IHD death rate in Bakersfield, and the ultra-fine braking aerosols at Arden
 4311 Middle School, the health impact data of EMFAC2007 must be **multiplied by 2 to 3 to account**
 4312 **for the addition threat of the ultra-fine metals.**

4313 For roadways with sound walls and non at-grade configurations, the factor 2.5 should be
 4314 used to convert the EMFAC2007 estimates when persistent (about 4 hr/day) braking is present
 4315 upwind of the site. This should be applied to both the upwind and downwind transects from the
 4316 roadway.

4317

Downwind

Distances, ft	10	25	50	100	200	300	400	500
Distances, m	3	8	15	30	61	91	121	152

Peak traffic
hour (v/hr)

4,000	625	525	425	300	187.5	137.5	112.5	87.5
8,000	1150	1050	850	600	375	275	225	175
12,000	1850	1600	1250	875	575	425	325	275
16,000	2475	2125	1675	1175	750	500	450	375
20,000	3100	2650	2100	1475	950	700	550	450
24,000	3725	3175	2525	1775	1125	850	675	550

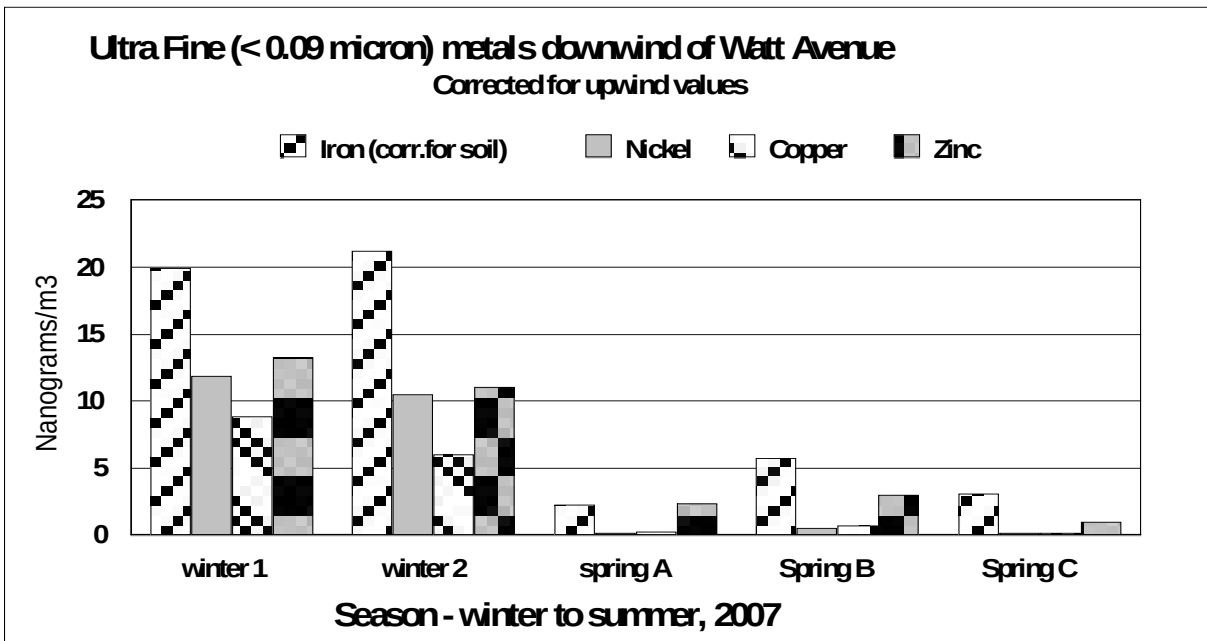
Upwind

Distances, ft	10	25	50	100	200	300	400	500
---------------	----	----	----	-----	-----	-----	-----	-----

ITEM 11.1.

Distances, m	3	8	15	30	61	91	121	152
Peak traffic hour (v/hr)								
4,000	400	300	225	160	100	75	50	50
8,000	800	625	450	325	200	150	110	85
12,000	1200	950	700	475	300	225	175	140
16,000	1575	1250	925	625	400	275	225	185
20,000	1975	1575	1150	800	500	350	275	235
24,000	2375	1875	1375	950	600	425	350	275
Downwind								

4318 Table A1-16. Incidental cancer risk per million downwind of an at-grade freeway with no
4319 sound wall.



4320

4321 Figure A1-8. Plot of the four major ultra-fine elements downwind of Watt Avenue in
4322 Sacramento (Cahill et al., 2014).

4323 Extensive laboratory results support the epidemiological data. In vitro laboratory studies of
4324 nanoparticles raise concerns about the health impacts of highway emissions, especially very fine
4325 and ultra-fine metals due to their propensity for penetrating to the deepest portions of the lung
4326 and diffusing into the circulatory system (Lewis et al., 2005; Chen et al., 2009; Lippmann, 2009;

ITEM 11.1.

4327 Oberdorster et al., 2007; Denier van de Gon et al., 2013). Additionally, epidemiological health
 4328 studies continue to show that highway emissions are damaging to both pulmonary and
 4329 cardiovascular systems of people living near highways, (Cahill et al., 2011), with exacerbated
 4330 lung function in children (Peters et al., 1999 a, b); Gauderman et al., 2000; HEI, 2009; Lin et al.,
 4331 2010), and also have a relationship to incidence of autism (Volk et al., 2011). These data have
 4332 been combined with data on the health impacts of roadway pollutants, including potential cancer
 4333 impacts largely from diesel exhaust, and used to generate estimated health impacts in models
 4334 such as EMFAC2007 (ARB 2007).

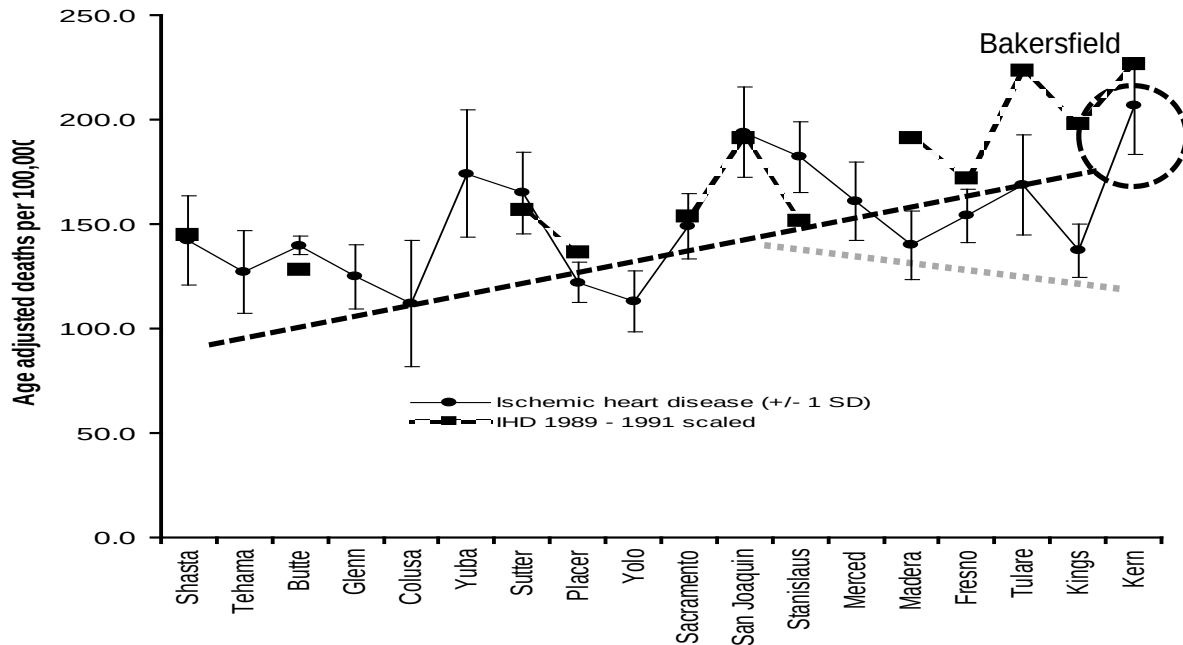
4335 A recent European survey noted that wear aerosols were approaching and would soon
 4336 exceed exhaust aerosols near roadways, with uncertain health impacts. Their consensus
 4337 statement concludes, “In light of the continuous increase of the relative contribution of non-
 4338 exhaust emission to ambient PM, where it is becoming the dominant emission process for urban
 4339 transport, it is more than timely to devote greater efforts to properly quantifying non-exhaust
 4340 emissions and assessing health relevance” (Denier van der Gon et al., 2013).

4341 These transition metals are implicated in both loss of lung function in children (Peters et
 4342 al., 1999), death by ischemic heart disease (Cahill et al., 2011), autism (Volk et al., 2011), and
 4343 asthma. Based upon these data, the health impact data of EMFAC2007 must be **multiplied by ~**
 4344 **2 to 3 to account for the additional threat of the ultra-fine metals.**

4345 **The impact of “wear” aerosols from brakes**

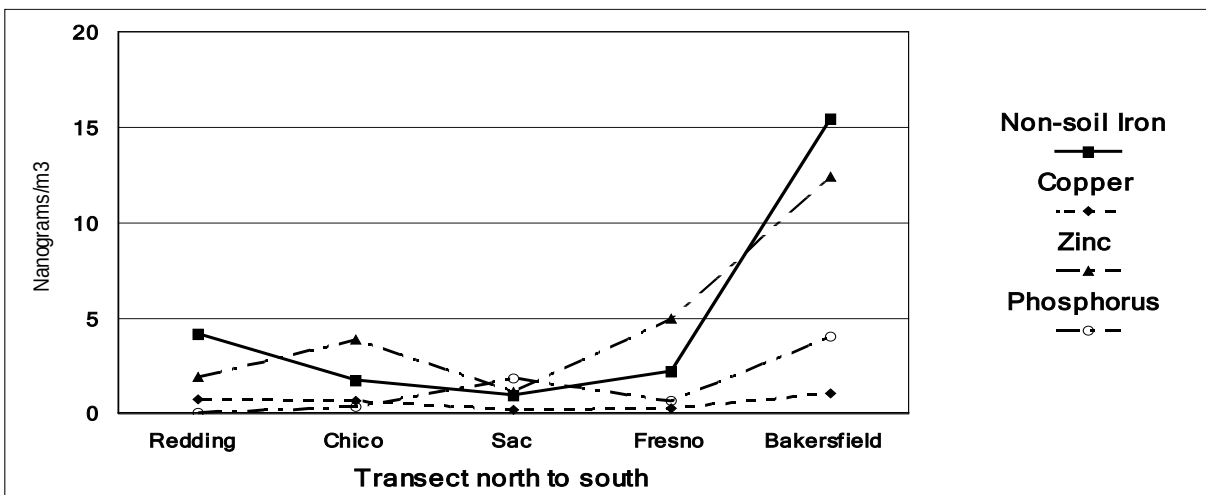
4346 ***Supporting data and peer-reviewed publications***

ITEM 11.1.



4347 Figure A1-9. The comparison of ischemic heart disease death rates from Redding (at
 4348 the northern end of California's Central Valley) to Bakersfield (in the southern Central
 4349 Valley), both for 1989–1991 and 2005.

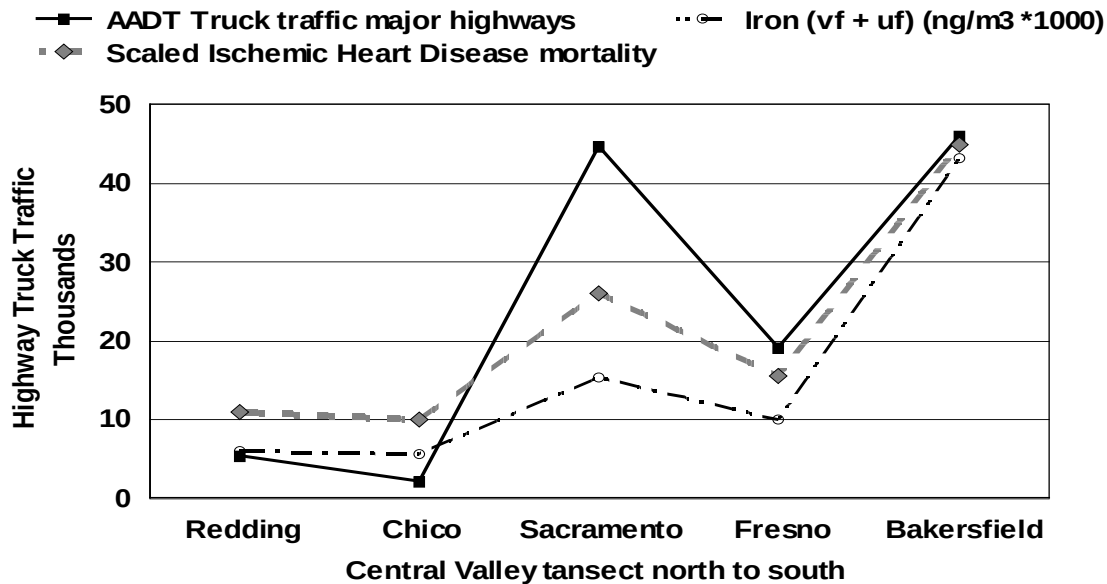
4350 The sharp reduction just north of Bakersfield in 2005 is tied to better methods for oil
 4351 removal, decreasing ultra-fine nickel and vanadium by about 99 percent after 1991 (Cahill et al.,
 4352 2011b). Bakersfield, however, is only slightly improved. Winter winds blow north from
 4353 Bakersfield toward Fresno.



ITEM 11.1.

4355 Figure A1-10. Very fine and ultra-fine metals from braking in the Central Valley (Cahill et
4356 al., 2011).

4357 As Figure A1-5 shows, the same aerosols implicated in cardiovascular impacts in the
4358 laboratory and seen downwind of Watt Avenue in Sacramento are seen again at Bakersfield.



4359

4360 Figure A1-11. Association between local average annual daily truck (AADT) traffic on
4361 major roadways, scaled ischemic heart disease, and very fine plus ultra-fine iron.

4362 In Figure A1-11, Cahill et al., 2011, also show that the impacts seen so strongly at
4363 Bakersfield are also present at other sites in the Central Valley with high local traffic.
4364 Sacramento, in particular, is heavily affected as two major north-south freeways, I-5 and
4365 California Highway 99, are squeezed together to avoid the DELTA and access Sacramento,
4366 while two major east-west freeways, I-80 to the north, and U.S. 50 to the south, complete the box
4367 around downtown Sacramento.

4368 References and bibliography

- 4369 • Baldauf, Richard, Greg McPherson, Linda Wheaton, Max Zhabg, Tom Cahill, Chad Bailey,
4370 Christina Hemphill-Fuller, Earl Withycombe, and Kori Titus. 2013. "Integrating Vegetation
4371 and Green Infrastructure into Sustainable Transportation Planning." *Transportation Research*
4372 *Bulletin*, National Academy of Sciences.

ITEM 11.1.

- 4373 • Cahill, Thomas A., David E. Barnes, Nicholas J. Spada, Jonathan A. Lawton, and Thomas M.
 4374 Cahill. 2011a. "Very Fine and Ultra-Fine Metals and Ischemic Heart Disease in the California
 4375 Central Valley 1: 2003–2007." *Aerosol Science and Technology* 45: 1125–1134.
- 4376 • Cahill, Thomas A., David E. Barnes, Leann Wuest, Sean Barberie, David Gribble, David
 4377 Buscho, Jason Snyder, Roger E. Miller, and intern Camille De la Croix. 2016. "Artificial
 4378 Ultra-Fine Aerosol Tracers for Highway Transect Studies." *Atmospheric Environment*
 4379 (submitted).
- 4380 • Cahill, T.A., and Feeney, P. J. 1973. "Contribution of Roadway Traffic to Airborne
 4381 Particulate Matter." *Final report of the California Air Resources Board, Contract ARB-502*.
- 4382 • Cahill, Thomas M., and Thomas A. Cahill. 2013. "Seasonal Variability of Particle-Associated
 4383 Organic Compounds Near a Heavily Traveled Secondary Road." *Aerosol Science and*
 4384 *Technology*. doi: 10.1080/02786826.2013.857757
- 4385 • California Air Resources Board. 2007. ARB, EMFAC2007. Retrieved from
 4386 www.arb.ca.gov/msei/onroad/.../docs/user_guide_emfac2007.pdf
- 4387 • Charriera, Jessica G., and Cort Anastasio. 2011. "Impacts of Antioxidants on Hydroxyl
 4388 Radical Production From Individual and Mixed Transition Metals in a Surrogate Lung Fluid."
 4389 *Atmospheric Environment* 45 (40): 7555–7562.
- 4390 • Chen, L. C., and M. Lippmann. 2009. "Effects of Metals Within Ambient Air Particulate
 4391 Matter (PM) on Human Health." *Inhalation Toxicology: International Forum for Respiratory*
 4392 *Research* 21: 1–31.
- 4393 • Courtney, W.J., S. Rheingrover, J. Pilotte, H.C. Kaufmann, T.A. Cahill, and J.W. Nelson.
 4394 1978. "Continuous Observation of Particulates During the General Motors Sulfate Dispersion
 4395 Experiment." *Journal of the Air Pollution Control Association* 28: 225–228.
- 4396 • Denier Van der Gon, H., M. GerlofsNijland, R. Gehrig, M. Gustafsson, N. Janssen, R.
 4397 Harrison, J. Hulskotte, C. Johansson, M. Jozwicka, M. Keuken, K. Krijgheld, L.
 4398 Ntziachristos, M. Riediker, and F. Cassee. 2013. "The Policy Relevance of Wear Emissions
 4399 From Road Transport, Now and in the Future—An International Workshop Report and
 4400 Consensus Statement." *Journal of the Air & Waste Management Association* 63: 136–149.

ITEM 11.1.

- 4401 Cahill et al, EDF 2007. Study of aerosols in Huron, CA.
- 4402 • Feeney, P.J., T.A. Cahill, R.G. Flocchini, R.A. Eldred, D.J. Shadoan, and T. Dunn. 1975.
- 4403 “Effect of Roadbed Configuration on Traffic Derived Aerosols.” *Journal of the Air Pollution*
- 4404 *Control Association* 25: 1145–1147.
- 4405 • Gauderman, W. J., R. McConnell, F. Gilliland, S. London, D. Thomas, E. Avol, H. Vora, K.
- 4406 Berhane, E. B. Rappaport, F. Lurmann, H. G. Margolis, and J. Peters. 2000. “Association
- 4407 Between Air Pollution and Lung Function Growth in Southern California Children.”
- 4408 *American Journal of Respiratory and Critical Care Medicine* 162: 1383–1390.
- 4409 • Gertler, Alan; Mahmoud Abu-Allaban, William Coulombe, John A. Gillies, William R.
- 4410 Pierson, C. Fred Rogers, John C. Sagebiel, Leland Tarnay, and Thomas A. Cahill. 2003.
- 4411 “Measurements of Mobile Source Particulate Emissions in a Highway Tunnel.” *International*
- 4412 *Journal of Vehicle Design* 27: 86-93.
- 4413 • Health Effects Institute. 2009. “Traffic Related Air Pollution: A Critical Review of the
- 4414 Literature on Emissions, Exposure, and Health Effects.” *Special Report 17*. Health Effects
- 4415 Institute, Boston.
- 4416 • Karner, A. A., D.S. Eisinger, and D. A. Neimeier. 2010. “Near Roadway Air Quality:
- 4417 Synthesizing the Findings from Real World Data.” *Environmental Science and Technology*
- 4418 44, 5334-5344.
- 4419 • Lewis, T. C., T. G. Robins, J. T. Dvonch, G. J. Keeler, F. Y. Yip, G. B. Mentz, X. H. Lin, E.
- 4420 A. Parker, B. A. Israel, L. Gonzalez, and Y. Hill. 2005. “Air Pollution – Associated Changes
- 4421 in Lung Function Among Asthmatic Children in Detroit.” *Environmental Health Perspectives*
- 4422 113: 1068–1075.
- 4423 • Lin, C. C. and C. K. Peng. 2010. “Characterization of Indoor PM10, PM2.5, and Ultra-fine
- 4424 Particles in Elementary School Classrooms: A Review.” *Environmental Engineering Science*
- 4425 27: 915–922.
- 4426 • Lippmann, Morton. 2009. “Semi-continuous Speciation Analyses For Ambient Air Particulate
- 4427 Matter: An Urgent Need for Health Effects Studies.” *Journal of Exposure Science and*
- 4428 *Epidemiological Studies* 19: 235–247.

ITEM 11.1.

- 4429 • McGee, M. A., A. S. Kamal, J. K. McGee, C. E. Wood, J. A. Dye, Q. T. Krantz, M. S. Landis,
 4430 M. I. Gilmour and S. H. Gavett. 2015. "Differential Effects of Particulate Matter Upwind and
 4431 Downwind of an Urban Roadway in an Allergic Mouse Model." *Environmental Science &*
 4432 *Technology* 49 (6): 3930-3939.
- 4433 • Oberdorster, Gunter, Vicki Stone, and Ken Donaldson. March 2007. "Toxicology of
 4434 nanoparticles: A Historical Perspective." *Nanotoxicology* 1 (1): 2–25.
- 4435 • Peters, John M., Edward Avol, William Navidi, Stephanie J. London, W. James Gauderman,
 4436 Fred Lurman, William S. Linn, Helene Margolis, Edward Rappaport, Henry Gong, Jr., and
 4437 Duncan C. Thomas. 1999. "A Study of Twelve Southern California Communities with
 4438 Differing Levels and Types of Air Pollution, I: Prevalence of Respiratory Morbidity."
 4439 *American Journal of Respiratory and Critical Care Medicine* 159 (3): 760–767(a).
- 4440 • Peters, John M., Edward Avol, William Navidi, Stephanie J. London, W. James Gauderman,
 4441 Fred Lurman, William S. Linn, Helene Margolis, Edward Rappaport, Henry Gong, Jr., and
 4442 Duncan C. Thomas. 1999. "A Study of Twelve Southern California Communities with
 4443 Differing Levels and Types of Air Pollution, II: Effects on Pulmonary Function." *American*
 4444 *Journal of Respiratory and Critical Care Medicine* 159 (3): 768–775. (b)
- 4445 • Vette, A., J. Burke, G. Norris, M. Landis, S. Batterman, M. Breen, V. Isakov, T. Lewis, M. I.
 4446 Gilmour, A. Kamal, D. Hammond, R. Vedantham, S. Bereznicki, N. Tian and C. Croghan.
 4447 2013. "The Near-Road Exposures and Effects of Urban Air Pollutants Study (NEXUS): Study
 4448 Design and Methods." *Science of the Total Environment* 448: 38–47.
- 4449 • Volk, H. E., I. Hertz-Picciotto, L. Delwiche, F. Lurmann, and R. McConnell. 2011.
 4450 "Residential Proximity to Freeways and Autism in the CHARGE Study." *Environmental*
 4451 *Health Perspectives* 119 (6): 289.
- 4452 • Zielinska, B., W. Goliff, M. McDaniel, T. Cahill, D. Kittelson, and W. Watts. 2003.
 4453 "Chemical Analyses of Collected Diesel Particulate Matter Samples in the E-43 Project."
 4454 National Renewable Energy Laboratory.
- 4455 • Zielinska, B, J. Sagebiel, J.D. McDonald, K. Whitney, and D. R. Lawson. 2004. "Emission
 4456 Rates and Comparative Chemical Composition From Selected in-use Diesel and Gasoline
 4457 Fueled Vehicles." *Journal of the Air & Waste Management Association* 54: 1138–1150.

ITEM 11.1.

- 4458 • Zhu, Y., W.C. Hinds, S. Kim, S. Shen, and C. Sioutas. 2002. "Study of Ultra-fine Particles
4459 Near a Major Highway With Heavy Duty Diesel Traffic." *Atmospheric Environment* 36:
4460 4323–4335 (a,b).
4461

ITEM 11.1.

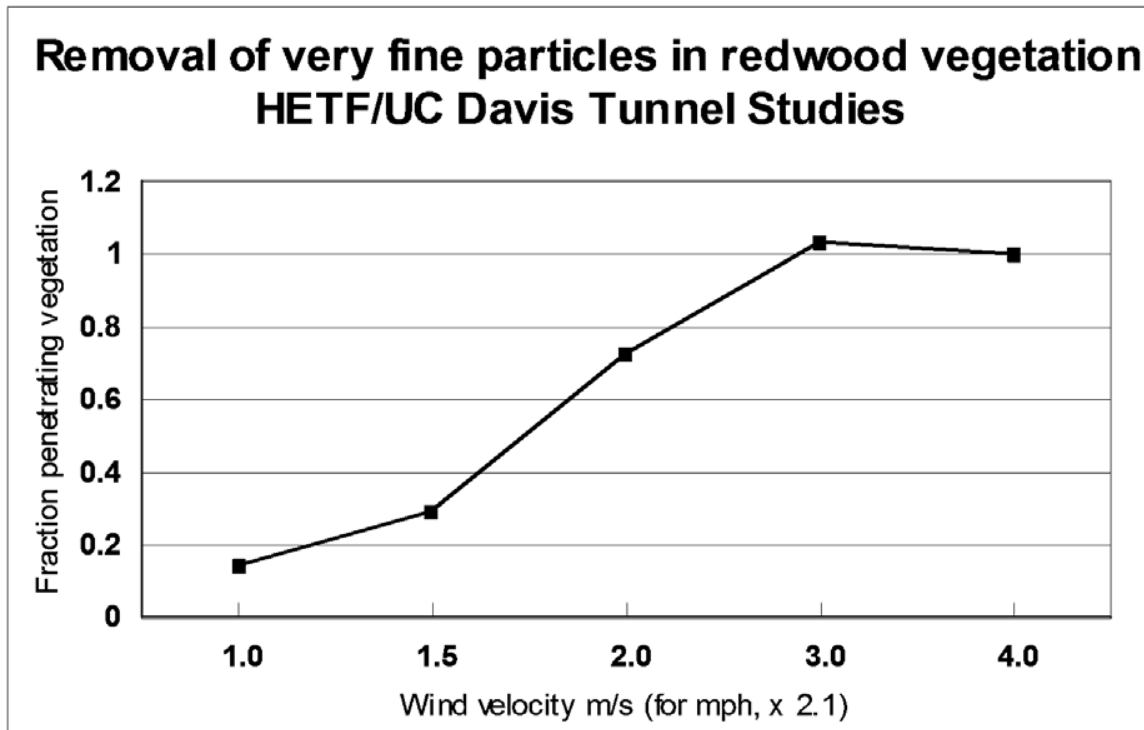
4462 **Appendix B**4463 **How to make your own air filtration system:**

4464 Now you'll learn how we built a high-volume, ultra-fine particle whole house air cleaner –
4465 and how you can build your own.

4466 First, let's be clear on what we are trying to do. The previous sections abundantly
4467 demonstrated that the greatest threat to health comes from very fine ($0.25 > D_p > 0.1 \mu\text{m}$) and
4468 especially ultra-fine ($D_p < 0.1 \mu\text{m}$) insoluble toxic particles that reach the lung and penetrate into
4469 the bloodstream. The most dangerous are diesel exhaust (associated with heavy PAHs and
4470 cancer); very fine reduced transition metals, especially iron and copper (capable of causing free
4471 radicals in lung fluid and loss of lung capacity, especially in children); and very fine to ultra-fine
4472 insoluble particles that pass into the bloodstream (associated with arteriosclerosis and ischemic
4473 heart disease). Recent work has shown that these particles are largely hydrophobic and don't
4474 easily pick up water, so they stay small in the atmosphere.

4475 Figure 18-1 verifies that diffusion to a surface is essentially the only way to remove such
4476 particles. Our tests in wind tunnels (Figure 18-3) allowed us to quantify this effect, including
4477 tests on standard high-quality (3M Filtrete) furnace filters.

ITEM 11.1.



4478

4479 Figure B-1 Removal of very fine aerosols through redwood branches in the UC Davis
4480 wind tunnel. For ultra-fine particles, the removal approaches 99 percent.

4481 The velocity of the air at the face of the filter (face velocity) must be slowed through filters
4482 to 20 to 25 percent of normal in order to give the particles time to stick. Any of several designs
4483 can accomplish that task.

4484 Before we begin this section, I would recommend **at the very least** that you replace your
4485 furnace filters by the highest quality 3M Filtrete filters (no, I don't hold their stock!)

4486

4487 **Design 0: Add better filters to an existing system**

4488 **Replace existing furnace filter with a single 3M Filtrete Health grade filter.**

4489 This is basically what we did at Arden Middle School with good results.

4490 **Note;** Check with your heating and cooling professional since these filters have a higher
4491 pressure drop than normal furnace filters and put a strain on some fan motors. The stacks that
4492 we have developed don't have this problem

247

ITEM 11.1.

Design 1: A “drop-in” addition to a standard furnace filter

If sufficient space is available above the existing furnace filter, we can design a pack that slows the air by a factor of 4 (an 80 percent reduction in speed). We use a stack of four standard 3M Filtrete electrostatic filters (combined cost about \$120) run in parallel in a flat pack that sits on top of the usual furnace filter.

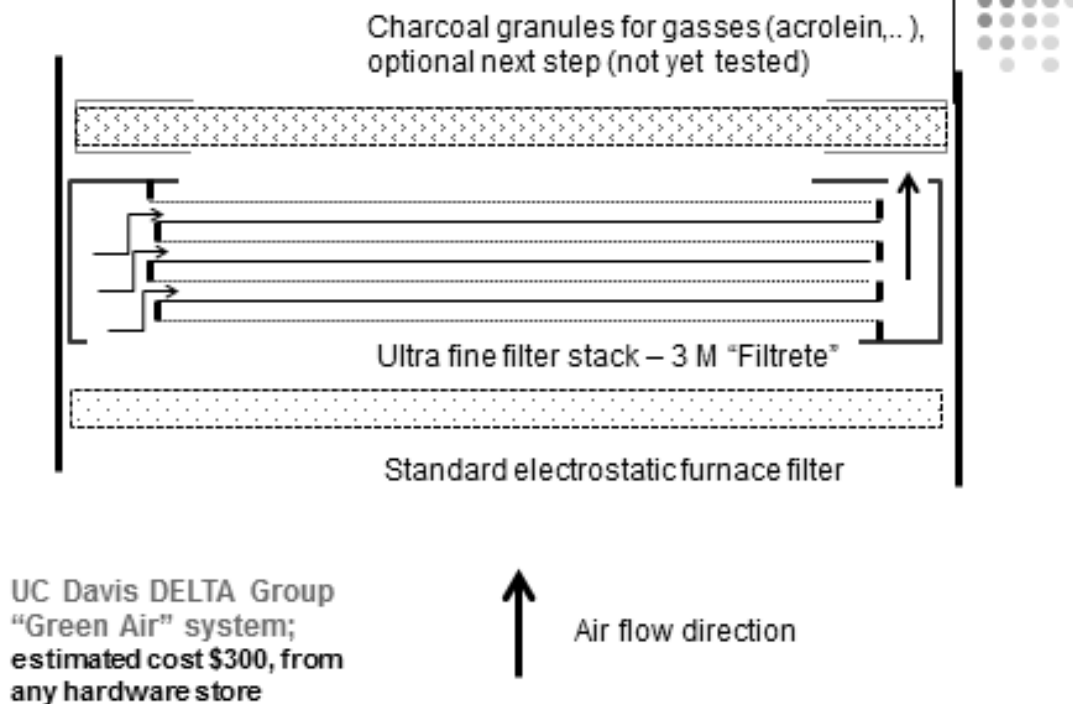
And for the retrofits....4 filters in parallel

Figure B-2. One design of the high-volume, high-efficiency air filtration system that the UC Davis DELTA Group developed. This unit is designed to drop on top of a standard furnace filter.

The key to the effectiveness of the drop-in unit is a series of carefully designed baffles that force the air to go through the filters **in parallel**, thus slowing the air speed by a factor of roughly 5 (20% of normal), whatever you need. Some additional pressure drop (about 30 percent) occurs, so the whole-house air turnover is slightly slowed. The ultra-fine removal stack should last for years because so little mass exists in this size mode.

ITEM 11.1.

4507 A configuration like this has been tested, and achieved greater than 90 percent removal for
4508 very fine particles (0.26 to 0.09 μm) and a predicted greater than 95 percent efficiency for all
4509 ultra-fines. This was the design used in the “green air box” tests at the San Bernardino rail yard.

4510

4511 **Parts list:**

- 4512 • 1 standard high-quality furnace filter – ideally 3M Filtrete (Health) which was what ewe
4513 used. (Description appended) size determined by the dimension of your furnace filter
4514 holder
- 4515 • 4 high-efficiency standard furnace filters (we used 3M Filtrete) 2 inches narrower than
4516 the existing standard filter
- 4517 • 2 baffles, cut from plastic sheets, with offset slots so the air is forced to go through each
4518 filter in parallel, with support screen holders

4519 **Baffle No. 1:**

4520

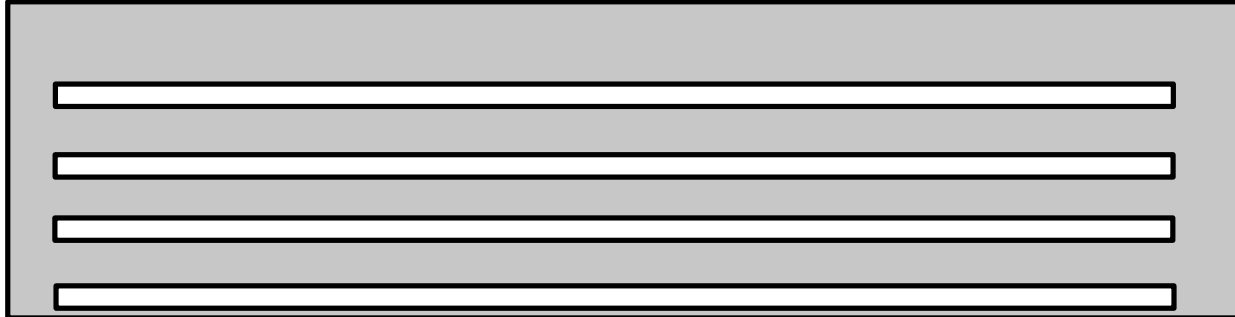
4521

4522

4523

4524

4525

4526 **Baffle No. 2:**

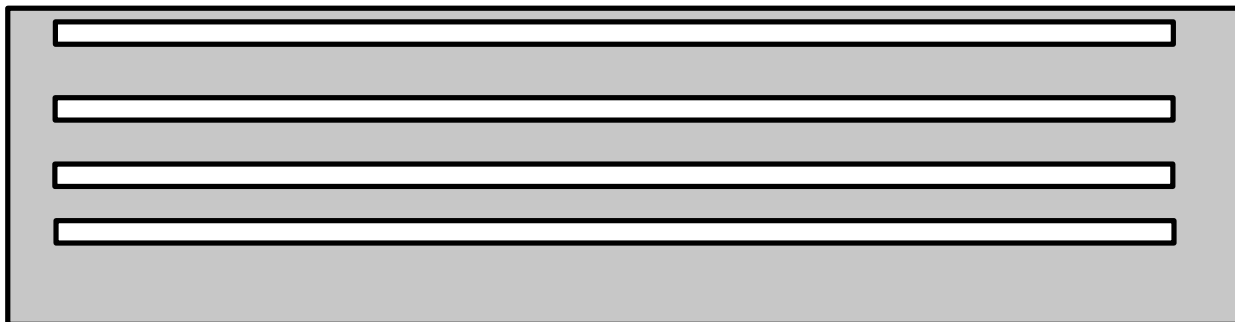
4527

4528

4529

4530

4531



249

ITEM 11.1.

4532

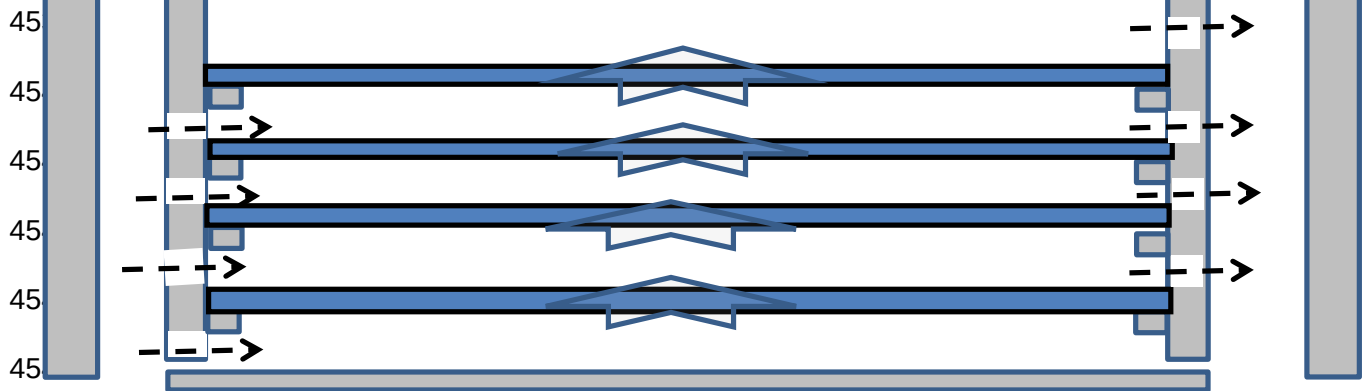
4533

4534

4535

4536 Two sheets, top and bottom, each designed to direct the air into either the left side (bottom, air
4537 inlet) and out the right side (top, air exit)

4538



4545

4546

4547 **1 Bottom sheet**

4548

4549



Cahill -- 00000255

ITEM 11.1.

4550

4551

4552

4553

4554

4555

4556

4557

4558

4559

4560 **1 Top sheet**

4561 Figure 10-6 a,b,c,d,e. 4 outside sheets; back, both sides, and front, all designed to
4562 exactly match the size of the standard furnace filter in the hot air system, with spacers
4563 and internal supports as needed. The front and back should have weather stripping
4564 designed to fit against the filter for a sealant. The front plate should be removable to
4565 access the filters.

4566 **Design 2: Filtration on the return air**

4567 For homes in which the furnace filter pack is inaccessible, we designed a unit that installs
4568 directly on top of the return air vents. The same reduction in filter face velocity can be achieved
4569 by simply having a thin box with four or more filters, as figure 18-7 shows.

4570

4571

4572

4573

4574

ITEM 11.1.

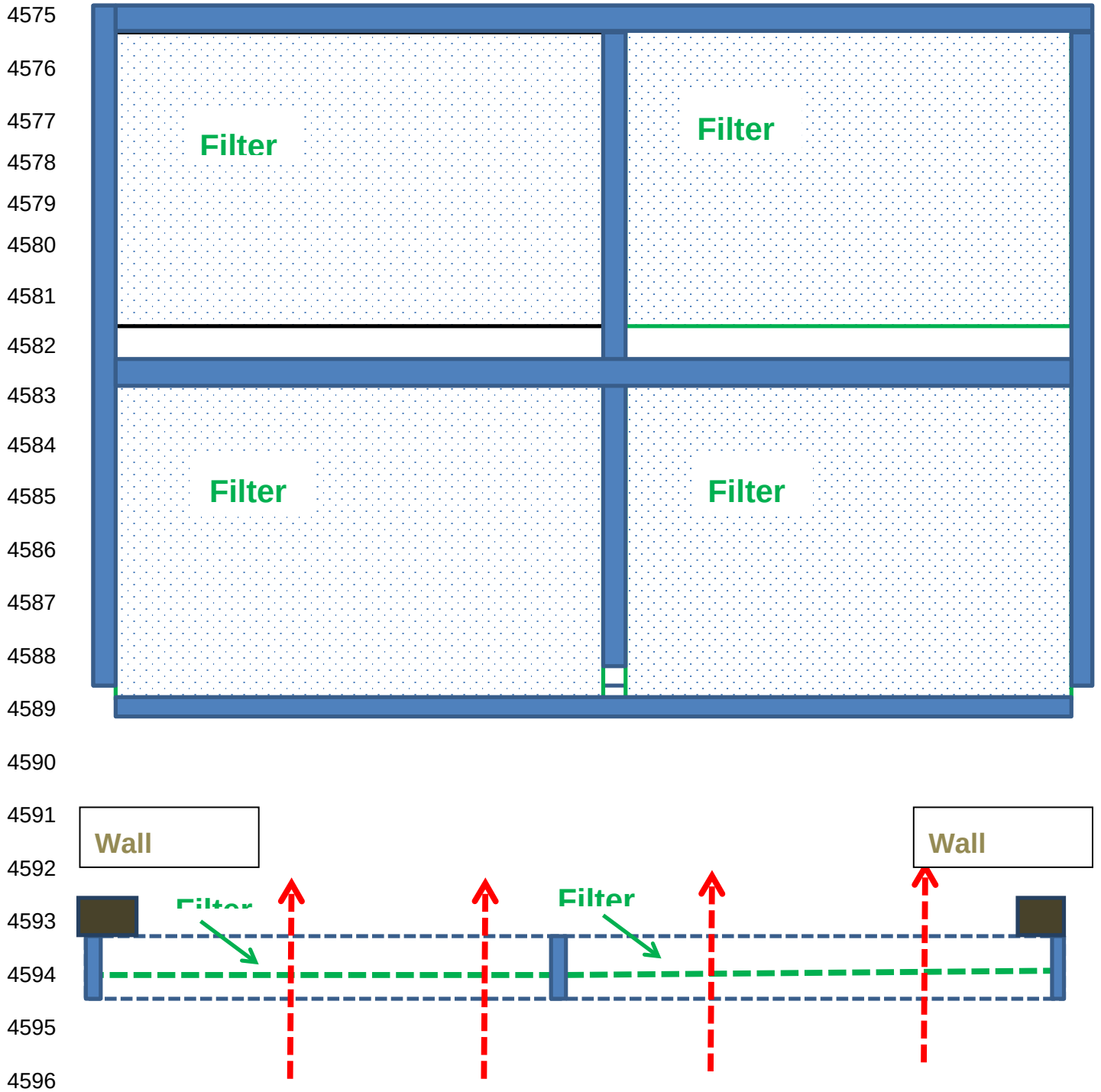


Figure 10-7. A flat configuration that achieves efficient filtration in a stack no more than 2 inches (5 cm) thick. This is suitable for placing over either air intakes or air returns in a forced air system.

ITEM 11.1.

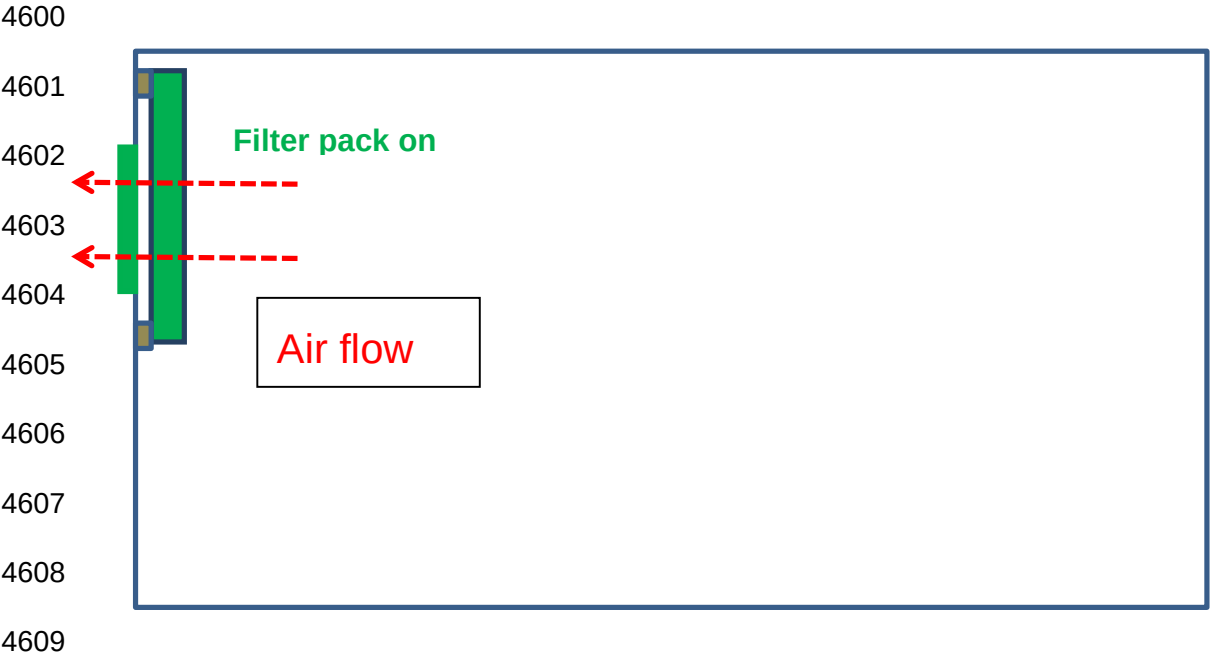


Figure 10-8. Possible filter arrangement in an apartment.

This design may be less efficient than the furnace filter because multiple return paths back to the furnace may exist. Even with a filter installed on only one of three such vents, the rapid air motion in hot air systems will still yield excellent removal rates. We have not, however, tested this design in a house. This unit could be hidden behind a large painting or other wall hanging.

Estimation of removal rates

Volume of the house		English units	Metric units
Area		1,600 square feet	147 square meters
Ceiling height		8 feet	2.4 meters
Volume		12,800 cubic feet	356 cubic meters

ITEM 11.1.

Ventilation	Air Changes/hour	Volume/hour		Flow rate			
	3	1,069	m3/hr	18	m3/min	17,809	L/min
	2	712	m3/hr	12	m3/min	11,873	L/min
	1.5	534	m3/hr	9	m3/min	8,904	L/min
	1	356	m3/hr	6	m3/min	5,936	L/min
	0.75	267	m3/hr	4	m3/min	4,452	L/min
	0.5	178	m3/hr	3	m3/min	2,968	L/min

Area of filters 2 ft2 0.61 m2

Face velocity of filters		Flow/filter					# of filters for 3 Air changes per hour
3	mph	49.1	m3/min	2945.5	m3/hr		0.36
2	mph	32.7	m3/min	1963.6	m3/hr		0.54
1	mph	16.4	m3/min	981.8	m3/hr		1.09
0.5	mph	8.2	m3/min	490.9	m3/hr		2.18
0.25	mph	4.1	m3/min	245.5	m3/hr		4.35

4618 Table 18-1. The relative efficiency of filters under varying conditions.

4619

ITEM 11.1.

4620 **Instructions for building your own ultra-filtration system**4621 **From the 3M web site –**

4622 Keeping your home clean and healthy is your mission and Filtrete™ Healthy Living filters can
4623 be your perfect partner. Featuring high performing electrostatic technology, Filtrete Healthy
4624 Living filters proactively capture dust, bacteria, germs, viruses and allergens in your air. For
4625 optimum performance, change your filter every 90 days or sooner.

- 4626 • Featuring high performing electrostatic technology, Filtrete™ Healthy Living filters proactively attract
4627 and capture microscopic particles, including: PM 2.5 air pollution, candle soot and smoke, cough and
4628 sneeze debris, bacteria and viruses along with large particles like lint, dust and pollen from air passing
4629 through the filter
- 4630 • Designed with Filtrete™ Brand 3-in-1 technology from 3M to pull in and trap unwanted air particles
4631 while letting clean air flow through
- 4632 • **Microparticle Performance Rating 1913**
- 4633 • 4 times better small particle capture compared to non-electrostatic pleated filters for the capture of 0.3
4634 to 1.0 micron particles.
- 4635 • Outperforms fiberglass, washable and non-electrostatic pleated 1" filters
- 4636 • Lasts up to 3 months
- 4637 • For residential use only
- 4638 • Manufactured by 3M

4639

4640



Download PDF



Export

Search ScienceDirect



Advanced search

Article outline is loading...

*Atmospheric Environment*

Volume 136, July 2016, Pages 31–42

*Artificial ultra-fine aerosol tracers for highway transect studies*Thomas A. Cahill^{a, b, *}, David E. Barnes^a, Leann Wuest^a, David Gribble^a, David Buscho^a, Roger S. Miller^a, Camille De la Croix^c[Show more](#)Under a Creative Commons [license](#)[Open Access](#)**Abstract**

The persistent evidence of health impacts of roadway aerosols requires extensive information for urban planning to avoid putting populations at risk, especially in-fill projects. The required information must cover both highway aerosol sources as well as transport into residential areas under a variety of roadway configurations, traffic conditions, downwind vegetation, and meteorology. Such studies are difficult and expensive to do, but were easier in the past when there was a robust fine aerosol tracer uniquely tied to traffic – lead. In this report we propose and test a modern alternative, highway safety flare aerosols. Roadway safety flares on vehicles in traffic can provide very fine and ultra-fine aerosols of unique composition that can be detected quantitatively far downwind of roadways due to a lack of upwind interferences. The collection method uses inexpensive portable aerosol collection hardware and x-ray analysis protocols. The time required for each transect is typically 1 h. Side by side tests showed precision at $\pm 4\%$. We have evaluated this technique both by aerosol removal in vegetation in a wind tunnel and by tracking aerosols downwind of freeways as a function of season, highway configuration and vegetation coverage. The results show that sound walls for at-grade freeways cause freeway pollution to extend much farther downwind than standard models predict. The elevated or fill section freeway on a berm projected essentially undiluted roadway aerosols at distances well beyond 325 m, deep into residential neighborhoods. Canopy vegetation with roughly 70% cover reduced very fine and ultra-fine aerosols by up to a factor of 2 at distances up to 200 m downwind.

Keywords

Aerosols; Roadway configurations; Downwind distribution vs configuration; Vegetation

1. Introduction

Pollutants emitted from vehicles have a disproportionate impact on sensitive receptor populations, such as residences, schools, senior housing, and medical facilities, since roadways are so ubiquitous. This situation is exacerbated when efforts to reduce energy use favors infill development close to roadways. This makes the ability to accurately predict pollutant concentrations downwind of roadways critical in terms of both roadway design and urban and sub-urban planning.

Clearly, the primary effort must be to reduce toxic emission rates from vehicles on roadways. Enormous advances have been made in the past 40 years in reducing particulate pollutants from highway vehicles, including the elimination of lead from

Cahill -- 00000261

ITEM 11.1.

gasoline. California's pioneering effort in this regard was driven, however, primarily by the need to remove reactive hydrocarbons and oxides of nitrogen from exhaust to control ozone. The lead removal was a necessary requirement for the catalytic converter to operate. California also controlled sulfur in gasoline to avoid sulfuric acid emissions from the converter (Courtney et al., 1978). Emissions of diesel exhaust from trucks also dropped steadily in these decades. (Gertler et al., 2003 and Propper et al., 2015). The stunning success of these actions resulted in less emphasis on highway impact studies in the next decade.

In the 1990s, epidemiological studies showed important health impacts near freeways, even after the elimination of lead. Specifically, there was a significant loss of lung function in children living within 1.6 km of Los Angeles freeways (Peters et al., 1999a, Peters et al., 1999b and Gauderman et al., 2000). The problem was made more complex by an increased understanding of vehicular emissions, and especially the role of very fine ($0.25 > D_p > 0.1 \mu\text{m}$) and ultra-fine ($< 0.1 \mu\text{m}$) insoluble aerosols on cardio-vascular disease. Very fine and ultra-fine metals are known to penetrate into the deep lung and transport into the circulatory system (Lewis et al., 2005; Chen and Lippmann, 2009, Oberdorster et al., 2007, Lippmann, 2009, Ostro et al., 2010 and EPA, 2015). Traffic is increasingly implicated (Brugge et al., 2007, Hagler et al., 2009, Health Effects Institute, 2009, Lin and Peng, 2010, Karner et al., 2010 and WHO, 2013), with copper and iron implicated in hydroxyl radical formation in lung fluid (Charrier et al., 2014 and Charrier and Anastasio, 2015). Recent publications have identified very fine and ultra-fine transition metals, including iron and copper, as a major component of "wear" aerosols from brake debris (Cahill et al., 2014 and Grigoratos and Martini, 2015). These very fine and ultra-fine "wear" aerosols are tied to a very sharp (~25%) increase in ischemic heart disease death rates in Bakersfield, CA (Cahill et al., 2011).

A recent European survey noted that mass derived from "wear" aerosols from brakes, roadway resuspensions, etc. was approaching and would soon pass exhaust aerosols near roadways, with uncertain health impacts (Denier Van der Gon et al., 2013). Their consensus statement concludes, "In light of the continuous increase of the relative contribution of non-exhaust emission to ambient PM, where it is becoming the dominant emission process for urban transport, it is more than timely to devote greater efforts to properly quantifying non-exhaust emissions and assessing health relevance."

A key factor in assessing health relevance of highway pollution is establishment of transport phenomena from roadways into receptor populations, largely by downwind transect studies. The primary method used to establish transects of downwind impacts of roadways is use of highway pollutants themselves. This was especially easy when one had very fine lead uniquely associated with automobiles, and especially the unique form PbBrCl, with few interfering species. The largest study of this kind was part of the California effort in 1972 to assess the impact of lead in Los Angeles (Cahill and Feeney, 1973). While at-grade freeways without obstructions were in excellent agreement with predictions from lead emission rates and line source downwind dispersion, dramatic order of magnitude differences were seen as a function of freeway configuration (Feeney et al., 1975). Specifically, elevated or fill section freeways on a berm had 10 times the lead at 160 m downwind than the at-grade freeways. At 100 m downwind, the 24 h lead level in a residential area was $10 \mu\text{g}/\text{m}^3$, 4 times the admittedly inadequate California standard of the time and 67 times the current US EPA standard of $0.15 \mu\text{g}/\text{m}^3$. This problem was resolved in California by removal of lead from gasoline, required so as to not poison the catalytic converter.

Now with a new appreciation of health impacts from roadways, both from diesel exhaust and very fine and ultra-fine metals, the need for transects again becomes urgent, both to aid urban planners who might inadvertently put downwind populations at risk and also to better understand the existing health impact data. However, the very success of prior efforts at tailpipe emissions has made measurement of such transects more difficult. The competition between the highway pollutant and the regional or upwind background limits natural tracers to freeway species that dominate the local environment. An additional criterion is that the pollutant must be a robust measure of the traffic flow to allow

Cahill -- 00000262

extension of the results to other sites. Finally, priority should be given to those pollutants that have the highest chance of deleterious impact, especially to health.

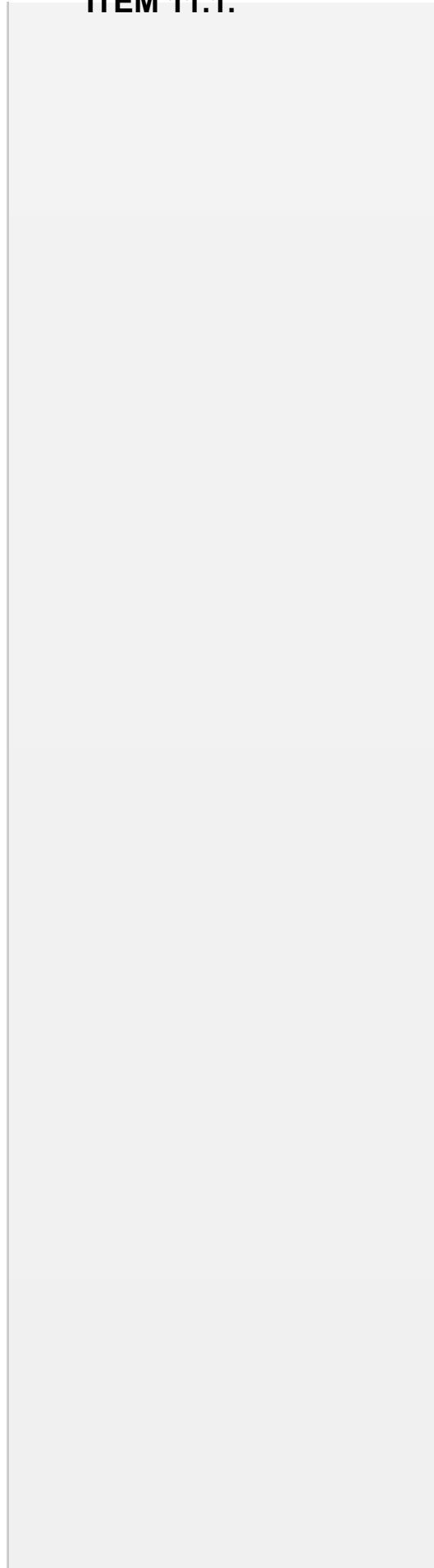
In response to the health concerns and lack of data, new studies of freeway impacts have been initiated in the past 15 years. Two studies especially relevant to the health data were done in Los Angeles, first for the automobile-dominated I-405 (Zhu et al., 2002a) and the second on the heavily truck traveled I-710 freeway (Zhu et al., 2002b). I-710 connects the ports of Los Angeles and Long Beach to the intermodal truck-rail facilities near San Bernardino, and thus has very heavy truck traffic. In 2002, that averaged an average traffic flow of around 216,000 v/day with roughly 25% trucks, more than ½ with 5 axels or more (CalTrans, 2015). Further, the Zhu et al. studies occurred in the typical marine inversion of the Los Angeles basin, similar to that in the 1972 lead studies and the Peters et al., 1999b children's health data. This team used natural tracers from highway emissions, black carbon (diesel dominated), particle numbers, and carbon monoxide, upwind and downwind of the freeways (Fig. 1). There is a good to excellent correlation between black carbon, particle number, and carbon monoxide, all of which have important upwind concentrations. The pattern from the I-710 freeway was also very similar to that seen in Zhu et al., 2002a for the I-405 freeway.

► Recommended articles

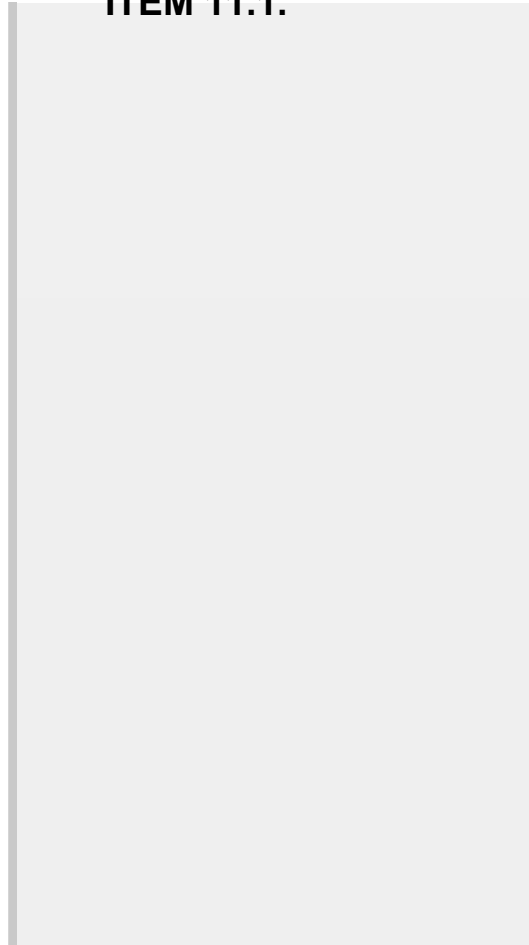
► Citing articles (0)

► Related book content

ITEM 11.1.



ITEM 11.1.



ITEM 11.1.

Editor -

May I refer your readers to an excellent article will appear in the LA Times? “Freeway pollution travels farther than we thought. Here's how to protect yourself”, TONY BARBOZA, DEC 30, 2017. It was the latest in a series by Tony Barboza, for which I hope he gets a Pulitzer. It is relevant to the ongoing discussions of Nishi ver 2:
<http://www.latimes.com/local/california/la-me-freeway-pollution-what-you-can-do-20171230-htmlstory.html#nws=mcnewsletter>, The whole story is worth a close reading as it is based on the long awaited Final Report by Prof. Suzanne Paulson, UCLA, on her ARB-supported study of freeway transport. I have freely been sending her the results of our US EPA and local foundation funded work in Sacramento, other parts of California, Detroit and Cleveland, and most of what I have read so far is clearly in accord.

Two parts stood out in the LA Times article, so I quote.

“Avoid truck routes and the ‘diesel death zone’

It’s especially unhealthful to live near freeways and roads frequented by diesel trucks, which spew many times more harmful gases and particles than cars. Diesel particulate matter, carcinogen-laden soot that deposits deep in the lungs, is responsible for the bulk of the cancer risk from air pollution and more than 1,000 early deaths a year in California. Experts are most concerned about people living near ports, warehouse distribution centers and other freight corridors. Asthma rates and cancer risk there can be so elevated that physicians have labeled it the “diesel death zone.”

An air-monitoring station next to a truck-congested stretch of the 60 Freeway in Ontario had the highest levels of fine-particle pollution, or soot, of all near-roadway sites in the nation, according to 2015 [U.S. Environmental Protection Agency data](#). About 217,000 vehicles a day passed by in 2015, more than 29,000 of them trucks.” (actual number, 29,121 CalTrans)

So let’s compare “the worst in the nation...” to Nishi, I-80 from looking west from the Solano/Yolo line:

	Nishi	Hwy 60
Total AADT traffic	136,700	217,000
Truck AADT number	11,989	29,121
Truck AADT percent	8.8 %	13.4%

ITEM 11.1.

So Nishi is only 41% (trucks only) or 63% (trucks plus cars) as bad as the worst near freeway site in the entire USA. That's like looking to buy a house near a water body that the developed boasts is only 41% or 63% as bad as the Love Canal – infamous Superfund site near Buffalo that sickened hundreds.

But what about the famous neck-down of I-80 upwind of Nishi and the legendary braking to stop and go traffic that happened so often? The Hwy 60 section has no such problem. And then there is the train diesel, shown to be 6 times more toxic than truck diesel per unit mass? Both effects push up Nishi closer to the “worst in the USA” leader.

And the article goes on....

“More important, soot can be an indication of traffic pollution you can't see but may be breathing in. Scientists are especially concerned about ultrafine particles, exhaust pollutants less than one-thousandth the width of a human hair. They're so tiny they can lodge deep in the lungs and move into bloodstream, where they may harm the heart, brain and other organs.

Ultrafine particles are suspected of causing some of the illnesses among people living near traffic, but more research is needed to say for certain.”

Actually, much of the research has already occurred and is published, most recently in the UCD/US EPA jointly authored and agency approved article on our Detroit freeway work that concludes:

“This result supports earlier publications showing the ability of very fine and ultra-fine particles to transport to sites well removed from the freeway sources. The concentrations of very fine and ultra-fine metals from brake wear and zinc in motor oil observed in Detroit have the potential of being a significant component in statistically established PM_{2.5} mortality rates.”

Thomas A. Cahill, David E. Barnes, Jonathan A Lawton, Roger Miller, Nicholas Spada, Robert D. Willis (EPA) and Sue Kimbrough (EPA), **Transition metals in coarse, fine, very fine and ultra-fine particles from an interstate highway transect near Detroit**, Atmospheric Environment 145, 158 – 175 (2016)

If you e mail me at [tacahill2718@41% \(trucks only\) gmail.com](mailto:tacahill2718@41% (trucks only) gmail.com), I can send you the entire LA Times article plus other new materials relevant to the upcoming Nishi debate.

A personal note. When I retired from UC Davis Physics and Atmospheric Sciences in 1994, it left me free as an Emeritus to focus on 3 new initiatives. One was the effect of particles on global climate and the other on the new and unexplained health effects of people, especially teen agers, living near freeways. The first effort still keeps me busy as, at the request of the National Science Foundation, I and my team run the aerosol site on the Greenland Ice cap until 2021. For the second effort, I joined the Health Effects Task Force of the local American Lung

ITEM 11.1.

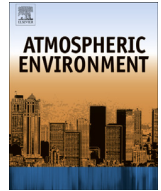
Association (ALA), work that has gained us the approval and support of the US EPA (among many others) plus publications as late as December, 2016. It also gained me personally the ALA award Scientific Volunteer of the Year in 2002. It is from this second effort the Nishi health concern analysis are based. We of the Health Effects Task Force are pleased see our work becoming incorporated into the national debate. This work is also a focus in my new book, "I Can Breathe Clearly Now! Protecting yourself from air pollution" EditPros Davis Dec 2016.

And the third initiative I chose for my retirement? Write Science Fiction books for fun. Check me out at the Avid Reader or on Amazon or Banned and Noble



Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Seasonal variability of ultra-fine metals downwind of a heavily traveled secondary road

Thomas A. Cahill^{a,b,*}, David E. Barnes^a, Nicholas J. Spada^a^a The DELTA Group, University of California, Davis, CA, USA^b The Health Effects Task Force, Breathe California of Sacramento Emigrant Trails, Sacramento, CA, USA

HIGHLIGHTS

- Ultra-fine transition metals were measured downwind of a road.
- Concentrations were <10% at a suburban site 500 m upwind.
- The sources of the metals were brake wear and zinc in lubricating oil.
- Similar ultra-fine metals associate with ischemic heart disease in California.
- Concentrations decreased sharply ($\sim \times 0.1$) as one went from winter into spring.

ARTICLE INFO

Article history:

Received 19 December 2013

Received in revised form

8 May 2014

Accepted 12 May 2014

Available online 14 May 2014

Keywords:

Ultra-fine metallic aerosols

Roadway emissions

Seasonal variability

Vehicle brakes

ABSTRACT

Since 2002, we have been studying the impact of a heavily traveled secondary road on an adjacent downwind school located at a stop light controlled intersection. The prior studies were all performed in winter conditions with typically strong inversions, but established significant $PM_{2.5}$ impacts on the school roughly in accord with theoretical models and the relevant literature. In this project, we have enhanced this effort by extending the study from winter to summer, and adding compositionally-resolved ultra-fine aerosol measurements. Ultra-fine aerosols, including metals derived from both brake wear and zinc in lubricating oil, were present at high concentrations in winter downwind of the roadway but absent at a residential site 500 m upwind. Their concentrations faded to minor levels in spring and early summer, while coarse roadway resuspended dust increased in that period. A comparison of ultra-fine measurements in downtown Sacramento and other California Central Valley sites indicates that these traffic derived aerosols are widely present in urban areas impacted by heavy traffic, freeways and secondary streets, especially where heavy braking is occurring. The potential for health impacts of ultra-fine metals associated with cars braking and accelerating in inversion conditions is a serious health concern based on recent epidemiological studies.

© 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

1. Introduction

There is a large body of data on the downwind impacts of aerosols from roadways, from the studies on lead in the 1970s (Cahill and Feeney, 1973; Feeney et al., 1975) to the present (including Zhu et al., 2002; Karner et al., 2010 and many others). There is also a rich history of studies investigating the health impacts of aerosols (Davidson et al., 2005) and especially toxicity of

ultra-fine particles (Oberdorster et al., 2007), showing increasing concern about the impacts of ultra-fine aerosols on health. Since the Southern California studies of Peters et al. (1999a,b), abundant new data have been developed showing the increased potential for deposition into the deepest portions of the lungs (aeoli) and transmission into the circulatory system of ultra-fine particles, especially near freeways (Wilhelm and Ritz, 2003; Gauderman et al., 2004; Zhang et al., 2004; Fruin et al., 2007; Lippmann, 2009). Other studies, such as by Wallenborn et al. (2009), have chronicled the transport of isotopic ultra-fine particles through the bodies of rats demonstrating both lag times and accumulation characteristics for specific organs (i.e. heart, liver, spleen, and kidney). These data, and especially data on diesel toxicity, have been combined and used to generate predicted health impacts in models

* Corresponding author. The DELTA Group, University of California, Davis, CA, USA.

E-mail addresses: tomandginny12@gmail.com, tacahill@ucdavis.edu (T.A. Cahill).

ITEM 11.1.

174

T.A. Cahill et al. / Atmospheric Environment 94 (2014) 173–179



Fig. 1. Sampling sites within the Sacramento Metropolitan Area for the winter, 2007 Watt study. The distance between Sebastian Way (SEWA) and Watt Avenue, at Arden Middle School (ARMI) was 500 m. The ARB 13th and T Street aerosol monitoring site is 10 km southwest, and the Del Paso Manor site 1.2 km to the northeast.

such as [Emfac2007](#) (ARB 2007), despite the uncertainty about exactly which roadway pollutants are responsible for specific health impacts ([HEI, 2009](#)). While an examination of the full extent of this work is beyond the scope of this paper, these studies support our efforts to document the presence of ultra-fine metals near heavily traveled roadways.

There are several problems encountered in trying to mesh the data on ambient roadway pollution to the health impacts: 1) The aerosol data rarely if ever contain information on particle size and composition, especially for very fine ($<0.25\ \mu\text{m}$) and ultra-fine ($<0.1\ \mu\text{m}$) metals, known to be important by medical research ([HEI, 2009](#)), 2) The aerosol data have often been taken under limited meteorological conditions, including many studies under the persistent marine inversions in the Los Angeles basin ([Zhu et al., 2002; Zhang et al., 2004](#)) and the radiation inversions in the California Central Valley in winter ([Cahill et al., 2011](#)), 3) The aerosol studies have rarely addressed the known strong effects of roadway configuration (at grade, depressed, and raised, [Feeney et al., 1975](#)), or other effects such as vegetation ([Baldauf et al., 2013](#)), 4) There are only limited data on the effects of traffic mix, traffic conditions such as speed, and traffic behavior, such as heavy braking. 5) The models routinely used do not represent the reality in several important ways. Studies show that the measured health impacts of roadways extend downwind far beyond the model predictions, up to 1600 m ([Peters et al., 1999a,b](#)), when line source dispersion models like [Emfac2007](#) ([Emfac2007](#)) indicate little impact beyond 150 m. In addition, several studies document typical roadway pollutants, including ultra-fine aerosols, extending well upwind of the roadways ([Zhu et al., 2002](#)).

In this paper, we have attempted to address several of these concerns using a heavily traveled secondary street, Watt Avenue, in suburban Sacramento, California. Specifically, we have performed a roadway transect study under winter conditions, when inversions are strong, and into spring and summer, when inversions are weak. We have located at a site where heavy braking and acceleration are the norm, and we have focused on ultra-fine transition metals that are indicated as plausible causal factors in some of the observed health impacts in the health literature. A companion paper examined size segregated speciated organics ([Cahill and Cahill, 2013](#)) at the same sites and times.

2. Experimental methods

The University of California, Davis DELTA Group and the Health Effects Task Force of Breathe California of Sacramento-Emigrant Trails have studied a heavily traveled secondary road in suburban Sacramento, Watt Avenue (north–south, 9 traffic lanes, 65,000 v/day, 1.5% heavy trucks >5 axels) ([Cahill et al., 2005, 2007; CalTrans, 2007](#)). Watt Avenue is directly (20 m) upwind of Arden Middle School, and the studies were initiated due to potential health impacts at the school. At the north edge of the school property, Watt Avenue crosses Arden Way (east–west, 35,000 v/day, $<0.3\%$ heavy trucks), resulting in heavy braking and acceleration upwind of the school during daylight hours. An identical site was set up in a residential neighborhood at Sebastian Way, 330 m west of Watt Ave and 500 m upwind of the school site on the prevailing southwest daytime wind direction. Regional background data were also available from the Del Paso Manor site of Sacramento Metropolitan AQMD, 1.2 km northwest of Arden Middle School, which was also a national Speciation Trends Network site ([Fig. 1](#)) ([ADAM 2010](#)).

Two earlier studies of Watt Avenue, each about 5 weeks in duration, in December 2001 to January, 2002 ([Cahill et al., 2003](#)), and January to February, 2004 ([Cahill et al., 2005](#)), looked at $\text{PM}_{2.5}$ impacts downwind of Watt Avenue. The measured $\text{PM}_{2.5}$ mass at Arden Middle School due to Watt Avenue traffic in winter, 2004, was $4.7 \pm 1.0\ \mu\text{g}/\text{m}^3$, using the Sebastian Way site for background. These results were in approximate accord with roadway emission data, including the Tuscarora tunnel study ([Gertler et al., 2001](#)) which used some of the same aerosol collection and analysis protocols used later at Watt Avenue.

2.1. Collection and analysis of ultra-fine aerosols

Ultra-fine aerosols were collected using 25 mm stretched Teflon filters behind the final $0.09\ \mu\text{m}$ stage of an 8 stage DRUM sampler ([Cahill et al., 1985](#)). The $0.09\ \mu\text{m}$ size cut was predicted from Marple theory ([Raabe et al., 1988](#)) and validated to $0.09 \pm 0.01\ \mu\text{m}$ by TDMA size studies ([Lawton and Cahill, 2010](#)). Protection from coarser aerosols was provided by 6 Apiezon-coated ([Wesolowski et al., 1978; Cahill, 1979](#)) greased stages below $2.5\ \mu\text{m}$, which have been shown to essentially eliminate particle bounce from coarser stages ([Cahill et al., 1985](#)).

ITEM 11.1.

T.A. Cahill et al. / Atmospheric Environment 94 (2014) 173–179

175

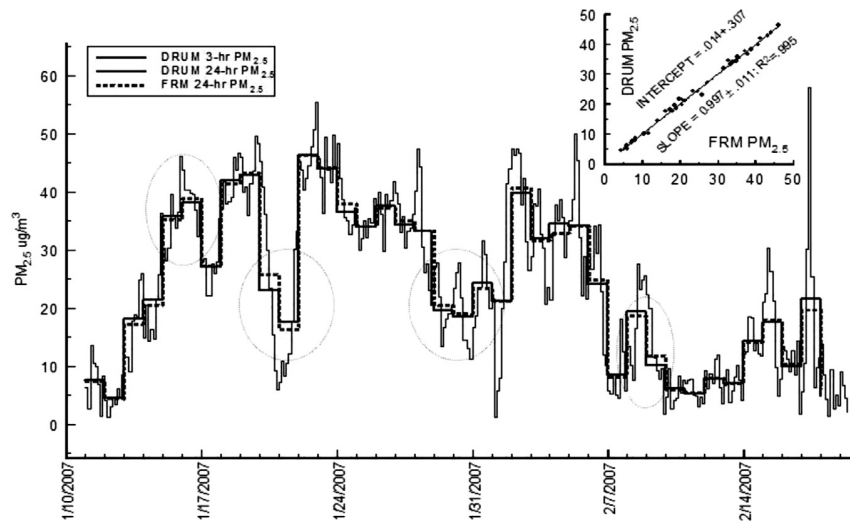


Fig. 2. Comparisons of the UC Davis 8 DRUM with ultra-fine filters, and FRM $PM_{2.5}$ data. The correlation was $R^2 = 0.995$, slope 0.997 ± 0.011 , and intercept, $<0.5\%$ of mean mass.

Mass measurements for the DRUM strips deposits, necessary for the $PM_{2.5}$ Federal Reference Method (FRM) comparisons, was accomplished by soft beta ray transmission using a Ni^{63} source and NIST mass standards. Ni^{63} has a long half-life, 101 years, and decays via a β ray, with a 67 keV maximum energy and 17.4 keV average energy. The average range is such that about 1/3 of the β intensity is lost passing through the typical $250 \mu\text{g}/\text{cm}^2$ aerosol deposit on the $480 \mu\text{g}/\text{cm}^2$ Mylar foil used to coat the drums (DQAP, 2011).

Elemental analysis was provided by UC Davis DELTA Group elemental analysis protocol via synchrotron induced X-ray fluorescence (S-XRF) at the Advanced Light Source, Lawrence Berkeley National Laboratory. S-XRF analyses are performed using the intense beams of polarized X-rays with an energy range of 3–14 keV (Bench et al., 2002; Barberie et al., 2013). Modern high count rate Si(Li) VORTEX detectors (Barkan et al., 2003) achieved adequate sensitivity and precision for the small amounts of mass present on the drum strips and Teflon filters. The key advantage of the S-XRF analysis is the fact that the polarized beams allow rejection of $>95\%$ of all background X-rays, allowing use of the very intense multi-energy “white” beams. The X-ray beam is collimated into a 0.5 mm by 2 mm spot, yielding sensitive analysis on the limited mass available. For filters, 5 steps are made across the filter to establish spatial uniformity. For the continuous DRUM strip rotating at 4 mm/day, each 0.5 mm step is equivalent to a 3 h time bin. Typically, we recorded data on 28 elements, with sensitivities of $\sim 0.1 \text{ ng}/\text{m}^3$. Numerous standards were analyzed for each sample batch, including many of the following; NIST SRMs 1832 and 1833, and ~ 65 thin elemental standards from Micromatter, Inc., Seattle, WA.

2.2. Validation of the sampling and analysis

Two methods were used to validate the accuracy of ultra-fine mass and elemental values on the DRUM $<0.09 \mu\text{m}$ after-filter. The first involved comparisons of 6 stages of the DRUM sampler, 2.5 to $0.09 \mu\text{m}$ plus ultra-fine mass, 0.09 to $0.0 \mu\text{m}$, with Federal Reference Method (FRM) $PM_{2.5}$ filters from an Anderson RAAS 2.5–200 dichotomous filter sampler. The second involved mass closure on ultra-fine particles by comparison of gravimetric mass to the sum of all species. These were investigated in parallel with the Watt Avenue studies for a year-long collocated study of DRUM mass versus $PM_{2.5}$ FRM samplers at the California Air Resources Board

test site at 13th and T Street in downtown Sacramento. A UC Davis slotted 8 DRUM was operated in parallel with FRM samplers for a total duration of 6 months in the period from January, 2007 to December, 2007. Measurements were made in 6 size modes, 2.5 to $0.09 \mu\text{m}$ and 3 h resolution, except for the $<0.09 \mu\text{m}$ integrating ultra-fine filters.

In the high mass winter periods, very good comparisons between DRUM and FRM data were achieved; $23.2 \pm 1.0 \mu\text{g}/\text{m}^3$ DRUM, $22.1 \mu\text{g}/\text{m}^3$ ARB FRM, supporting the accuracy of ultra-fine measurements. This was despite the fact that the DRUM mass measurements required 49 separate values for the DRUM for the comparison to each single 24 h FRM mass value. For the entire study, the ratio, DRUM/FRM, was 1.01 ± 0.21 .

Our data were submitted to the ARB staff, who with access to hourly mass data, made a slight change in the starting time of the DRUM (Fig. 2) and greatly improved the fit, $r^2 = 0.995$, slope = 0.997 ± 0.011 , intercept = 0.014, for January 10 to Feb 21, 2007 (Cahill and Barnes, 2009; Nichols, 2009).

For the second validation, compositional data were required, especially S-XRF data on elements. Validation of the S-XRF system has been accomplished in five multi-elemental quality assurance comparisons, including blind comparisons S-XRF to PIXE (IMPROVE) and to XRF (IMPROVE, DRI), with a mean ratio of 0.98 ± 0.15 (DQAP, 2011). A recent blind inter-comparison was performed against standard XRF and ICP/MS (Jenniskens et al., 2012), with our S-XRF values for 24 elements agreeing to a ratio of 1.005 ± 0.31 with one standard XRF and three ICP/MS laboratories (Supplemental Materials 1).

With the availability of compositional data, a second validation was performed at the end of the ARB collocated study in December 2007. The ultra-fine component of the system was validated by direct comparison of ultra-fine gravimetric mass, using the Cahn microbalance, and the reconstructed mass, the sum of all species (Malm et al., 1994). To obtain sufficient mass, the filter was exposed for a total of 30 days, following the protocol used in the Watt Avenue transects, so as to increase the mass and improve precision. In this comparison, the elemental species were compared by adding the typical oxides (Malm et al., 1994). For the organic mass, we used the IMPROVE organic-equivalent mass (OMH) via the proton–proton scattering (H(p,p)H) reaction with 4.5 MeV protons from a cyclotron (Cahill et al., 1987, 1989). This method measures organic matter by directly measuring in vacuum the hydrogen atoms bound

ITEM 11.1.

176

T.A. Cahill et al. / Atmospheric Environment 94 (2014) 173–179

into non-volatile compounds after correcting for hydrogen in sulfates and nitrates. This has been validated for PM_{2.5} filters by tens of thousands of inter-comparisons of OMH with organics measured from combustion from quartz filters (OMC) as part of the integral redundancy quality assurance protocols used by IMPROVE (Malm et al., 1994).

For the Watt ultra-fines study, the samplers were continuously deployed from the winter, February 7, to the late spring, June 13, 2007 (Cahill et al., 2007). Table 1 shows the schedule of aerosol collection for the DRUM used for mass and elemental analysis (3 h averages, plus 4 week averages ultra-fine filters). Another component of the study was done in parallel with the organics collected and speciated using an 8 stage and after filters DRUM (both reduced to 4 week averages) (Cahill and Cahill, 2013). As much as possible, the periods were designed to overlap each other, but some differences occurred. The most important was caused by a railroad trestle fire, of March 14, 2007, which sent a black plume of smoke from a creosote soaked railway trestle 5.8 km east towards the Watt Avenue sites (see Table 2).

3. Results

The current study was designed to monitor from winter into spring and summer conditions. However, early termination of typical winter inversions in 2007 severely limited the number of days the study operated in typical cool, hazy winter conditions. The PM_{2.5} mass distributions (Fig. 3) are shown for the downtown CA Air Resources Board site at 13th and T Street, 10 km SW of Arden Middle School, and the suburban Del Paso Manor site, 1.2 km NE of the site. Thus even the “winter” conditions in the current study were less impacted by aerosols mass than are typical of the most polluted part of the year (ADAM, 2010). Note that the regional nature of the PM_{2.5} mass is well illustrated, as the two sites are over 11 km apart and in very different conditions of the urban complex.

While most of the mass at both sites comes from ammonium nitrate, the excess mass at Del Paso Manor is often associated with residential wood smoke (Sharpless, 2012). Therefore, much of the current study occurred during a time of extremely good air quality with only a slight overlap with winter conditions.

The winds were overwhelmingly from the western quadrant for the entire study, and the mean velocity was relatively constant throughout the entire period – roughly 10 km/h in winter to 12 km/h in spring. From these data, it is clear that the sudden reduction of PM_{2.5} aerosol mass at downtown Sacramento and Del Paso Manor (Fig. 3) was not a function of either mean wind velocity or direction. However, the masses correlated well if qualitatively with visual observations of thin (<100 m) surface based inversions common in winter.

Table 1

Mass closure for ultrafine mass, $D_p < 0.09 \mu\text{m}$. There is excellent agreement between the gravimetric mass and the reconstructed mass, generated by the sum of all measured species. Note the dominance of the non-soil iron, nickel, copper, and zinc in the transition metals.

Major components	$\mu\text{g}/\text{m}^3$	Minor components	ng/m^3
Mass (gravimetric)	2.04 ± 0.2	Phosphorus	2.4 ± 0.2
Mass (reconstructed)	2.15 ± 0.35	Vanadium	0.15 ± 0.01
		Chromium	0.45 ± 0.04
Major components	$\mu\text{g}/\text{m}^3$	Iron (non-soil)	38.0 ± 6
Organic mass (OMH)	1.72 ± 0.2	Nickel	3.5 ± 0.4
Ammonium Sulfate	0.34 ± 0.15	Copper	8.3 ± 0.8
Salt	0.04 ± 0.004	Zinc	11.5 ± 1.2
Soil (IMPROVE)	0.048 ± 0.005	Arsenic	0.6 ± 0.2
K non	0.053 ± 0.005	Selenium	0.3 ± 0.1
Metals (-iron)	0.035 ± 0.002	Bromine	3.7 ± 0.4
		Lead	4 ± 0.4

Table 2

Schedule of aerosol sampling. Data from March 15 through March 19 were excluded from the ultra-fine averages because of a large fire on a wooden train trestle could bias the data, and especially the parallel organic study. The dates are for the Watt Ave site. The May Sebastian Way organics sampler was switched on May 23.

Sampling periods	Start – elements	Stop – elements	Start – organics	Stop – organics
Winter 1	Feb 7	Mar 7	Feb 7	Mar 7
Winter 2	Mar 7	Mar 15		
Trestle Fire	Mar 15	Mar 19	Mar 15	Mar 19
Spring A	Mar 18	Apr 17	Mar 18	Apr 17
Spring B	Apr 17	May 18	Apr 17	May 23
Spring C	May 18	June 13	May 23	June 13

After mid-March, coarser soil derived aerosols increased at Watt Avenue as compared to Sebastian Way, with the inclusion of zinc data from tire wear identifying the excess as resuspended roadway soils. Strong diurnal patterns were seen in the time resolved data, correlated with daytime traffic peaks and weekday-weekend differences.

3.1. Data on ultra-fine inorganic species – 4 week averages

The primary goal of the study was the development of quantitative data on ultra-fine inorganic aerosols, especially metals. Because of the low masses involved, and to match the companion organics study (Cahill and Cahill, 2013), 4-week averages were calculated.

The seasonal pattern of ultra-fine metals was clear. During the winter period, the site downwind of Watt Avenue had much higher concentrations of almost all monitored transition metals compared to Sebastian Way (Table 3). The average ratio for all measured ultra-fine elements, expressed as downwind Watt Ave versus upwind Sebastian Way sites was 17.9 in winter. This highlights that the near roadway site had much higher concentrations of ultra-fine metals compared to the control site. Thus, with the prevailing west to east wind pattern and the lack of any industrial activity between the two sites, the time-resolved data uniquely identifies Watt Avenue roadway traffic as the key source of enhancement. It is also important to note that the dramatic difference observed in the concentrations between ultrafine metals between the two sites are not seen in the fine or coarse size fractions.

As spring and summer progressed, the differences in ultra-fine metals between the two sites decreased. By early summer, the ratio for all elements approached unity, 1.09 ± 0.09 , which underscores the essentially negligible impact from Watt Avenue in ultra-fine particles during summer. The average concentrations during this period are shown below in Table 3 and selected metals in Fig. 4.

Clear enhancements downwind of Watt Avenue are seen in sulfur and calcium. Calcium is an anti-acid used in sulfur-containing diesel fuel (Zielinska et al., 2004). Potassium, chromium, manganese, iron, nickel, copper, and zinc all show enhanced levels of ultra-fine mass and high downwind/upwind ratios in winter.

It is important in these comparisons to recall that Sebastian Way was downwind of Watt Avenue only in a few hours each night, at times when Watt Avenue traffic was very low.

We regret that we were unable to get consistent ultra-fine mass measurements at Watt avenue sites because of variable field blanks. One possible difference is that the 13th and T site had the filter assembly in the DRUM shelter, where it was slightly warmed by the pump. At the Watt avenue sites the filter assembly was protected from rain by plastic bags but operated at ambient temperatures and relative humidity.

ITEM 11.1.

T.A. Cahill et al. / Atmospheric Environment 94 (2014) 173–179

177

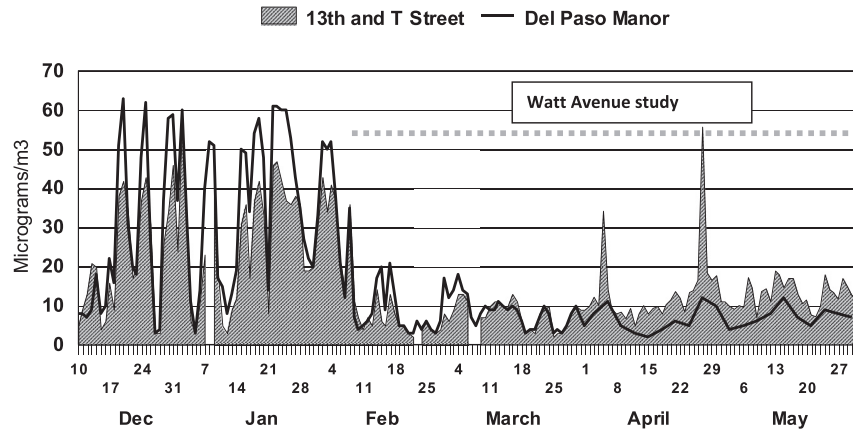


Fig. 3. PM_{2.5} mass data from the ARB downtown site at 13th and T Street and Del Paso Manor sites, Dec 10, 2006 to May 31, 2007. The period of the Watt Ave study is shown in the dotted line.

An earlier companion paper has addressed size and compositionally resolved organic matter taken at the same locations and times as the present study. Size resolved organic species (PAHs, n-alkanes, sugars, and fatty acids) were measured as a function of size, including ultra-fine species, at the same time as the ultra-fine metals were analyzed (T.M. Cahill and T.A. Cahill, 2013). The data showed that most heavy PAHs were in the ultra-fine mode.

4. Analysis and interpretation

4.1. Sources of the metals

The generation of metals in the ultra-fine mode requires high temperatures and/or pressures. Thus, many sources of metals from vehicles, such as zinc from tire wear, are not candidates for sources of ultra-fine aerosols. This was confirmed in the present study by very fine and ultra-fine zinc that peaked in winter versus coarse zinc, >1.15 μm , that correlated with vehicle polluted roadway and that peaked in spring. Two potential sources of ultra-fine particles are engines, and especially diesel engines because of the high temperatures and pressures involved, and the braking systems in vehicles, as described in more detail in Cahill et al. (2011). While there is considerable information on the total particulate emissions from vehicles, the information on ultra-fine metals from vehicular exhaust is limited. In terms of vehicle exhaust, a study (Zielinska et al., 2003, 2004) involved detailed analysis of diesel aerosols, and identifies sulfur (from the fuel), phosphorus and zinc (from

zinc thio-phosphate in lubricating oil), and, calcium (an antacid) in the ultrafine modes. However, negligible levels of the ultra-fine transition metals iron, nickel, and copper were observed.

A second potential source of very fine and ultra-fine metals is the braking systems of cars and trucks, since high temperatures and/or pressures are involved in this process. The brake drums have evolved from the massive iron, heat-conductive structures and asbestos-containing brake pads to "grey iron" drums, roughly 90% iron with the admixture of a few percent carbon, plus copper, silicon, and other metals in smaller amounts, making them, like brake pads, an erodible surface. Brake pads are far more complex in composition and are traditionally designed to erode. Information on brake pad composition was reviewed by Kennedy et al. (2002) and Chan and Stachowiak (2004) (Table 4).

While there is enormous variability in the data, as shown by the percentile distributions, the four main elements are usually iron, copper, zinc, and nickel. In summary, there are a wide variety of very fine and ultra-fine metals that may arise from brake drums and pads, but iron, copper, zinc, and nickel are clearly major components. Thus, in summary, the ultra-fine metals seen downwind of Watt Avenue are consistent with a mixture of zinc from lubricating oil and ultra-fine aerosols from brake drums and pads.

4.2. Spatial extent of ultra-fine particles

As seen above in Table 3, Sebastian Way has little if any impact from Watt Avenue, and routinely very low concentrations of traffic

Table 3

Ultra-fine species at Watt Avenue at Arden Middle School (ARMI) and Sebastian Way (SEWA), Winter 1 and 2 (Feb 7–March 15), and averaged spring (March 19–June 23), 2007. The values in bold have both high downwind concentrations and high downwind/upwind ratios. Potassium has many sources.

	Winter avg. 1 and 2	Winter avg. 1 and 2	ARMI/SEWA	Spring avg A, B, C	Spring avg A, B, C	ARMI/SEWA
	Downwind	Upwind	Ratio	Downwind	Upwind	Ratio
	ARMI (ng/m ³)	SEWA (ng/m ³)		ARMI (ng/m ³)	SEWA (ng/m ³)	
Calcium	10.3	1.9	5.4	1.65	1.51	1.09
Sulfur	39.1	9.0	4.3	129	161	0.8
Potassium	20.0	2.8	7.1	11.6	9.7	1.2
Chromium	0.83	0.04	20.7	0.05	0.045	1.1
Manganese	1.3	0.09	14.4	0.16	0.38	0.42
Iron	29.1	3.9	7.5	4.8	2.1	2.3
Nickel	11.5	0.18	63.9	0.3	0.37	0.80
Copper	8.1	0.62	13.1	0.4	0.36	1.1
Zinc	12.8	0.84	15.2	2.0	2.0	1.0
Arsenic	0.41	0.08	5.1	0.32	0.27	1.2
Selenium	0.14	0.10	1.4	0.23	0.21	1.1
Bromine	1.17	0.67	1.7	1.8	2.0	0.9
Lead	1.63	0.50	3.3	1.4	1.27	1.1

ITEM 11.1.

178

T.A. Cahill et al. / Atmospheric Environment 94 (2014) 173–179

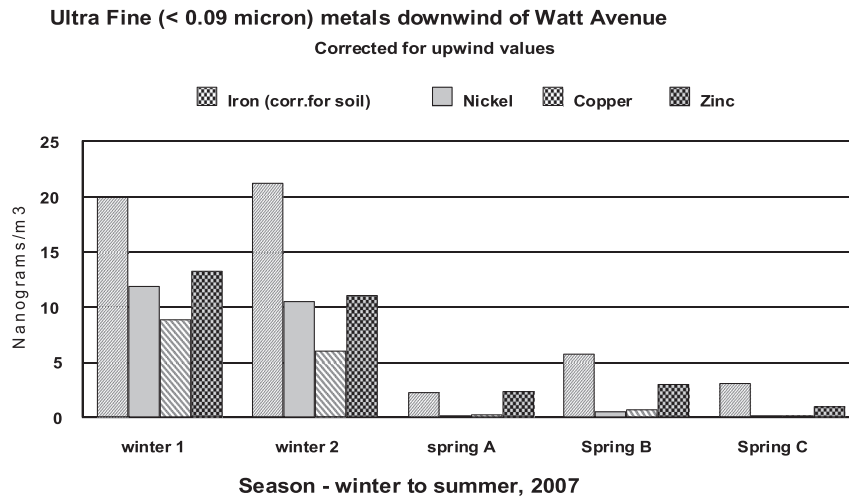


Fig. 4. Plot of selected elements from Table 3. In this plot, the winter and spring values were not averaged.

Table 4

Summary of concentrations of elements in New Zealand brake pads (Kennedy et al., 2002), from largest to smallest concentrations of transition metals plus heavier elements. The distributions are shown to emphasize the wide variability between manufacturers. The S-XRF analysis did not cover barium. Values in bold were major components of ultra-fine aerosols seen downwind of Watt Avenue in winter.

Element (ppm)	10th Percentile	Median	90th Percentile
Iron	11,700	18,300	190,000
Copper	29	5000	116,000
Zinc	127	1630	37,400
Nickel	44	342	652
Manganese	143	315	1088
Lead	6	50	949
Barium	558	3195	6144

derived ultra-fine metals. However, Sebastian Way is also 10.2 km downwind of Sacramento, and specifically the ARB 13th and T Street test site. The data show that the downtown site is routinely impacted by ultra-fine traffic derived aerosols (Table 1) which is not surprising considering that the area is ringed in all directions by heavily traveled freeways and secondary streets. Since the prevailing winds are southwest to northeast much of the time, the lack of ultra-fine particles at Sebastian Way indicates effective removal mechanisms, even in winter when most trees are without leaves. It is also probable that if measurements had been made earlier in winter, when the inversions were stronger and more common (Fig. 3), the concentrations downwind of Watt Ave would be higher.

A recent paper (Cahill et al., 2011) find the same very fine and ultra-fine transition metals at urban sites in the California Central valley. The relatively high levels in the southern San Joaquin Valley are associated with increases in ischemic heart disease mortality.

5. Conclusions

We have examined the impact of a heavily traveled secondary road, located at a stop light controlled intersection with traffic braking, idling, and accelerating, on an adjacent (20 m) downwind school. The study was designed to extend from winter to summer conditions, measuring aerosols from 10 to 0.09 μm equivalent diameter in 8 size modes every 3 h, and later adding time integrated ultra-fine ($D_p < 0.09 \mu\text{m}$) aerosol measurements from after filters. Compositional analyses were made by synchrotron-induced X-ray fluorescence for all samples, with typically 28 elements examined with sensitivities of $\sim 0.1 \text{ ng/m}^3$. Ultra-fine aerosols were very low at an upwind residential site, but high downwind of Watt

Avenue in winter. These ultra-fine aerosols included metals derived from both brake wear (Fe, Zn, Cu, Ni and Mn) and zinc in lubricating oil. The potential for health impacts of ultra-fine metals associated with cars braking and accelerating in winter conditions is a serious health concern based on recent epidemiological studies. These ultra-fine aerosol components faded to insignificance in spring, while coarse roadway resuspended dust increased in that period. The net result is that the roadway impact on the school was far less in spring conditions than Emfac2007 model predictions. Other examples of ultra-fine metals associated with braking and lubricating oil are in the California Central valley are discussed, showing that the presence of these ultra-fine metals is common in urban areas.

Acknowledgments

The DELTA Group (Detection and Evaluation of Long-range Transport of Aerosols) of the University of California, Davis, develops and applies high technology to aerosol sampling and analysis, primarily for studies of global atmospheric aerosols (<http://delta.ucdavis.edu>). The same techniques have proven useful in aerosol studies and potential health impacts.

The authors wish to acknowledge the input and oversight of the Health Effects Task Force (HETF) of Breathe California of Sacramento-Emigrant under Jananne Sharpless, Chair; Betty Turner, consultant to the HETF, and especially members Ralph Propper and Earl Withycombe. Helpful suggestions and review were provided by William Wilson, US EPA, who also funded the development of the continuous ultra-fine sampler.

The continual support of the principal and staff of Arden Middle School, and the steps they have taken to mitigate the impacts, are deeply appreciated, as was the support of the Harding family on Sebastian Way.

The work could not have been done without the DELTA Group S-XRF team working at Advanced Light Source, LBNL; Steve Cliff, Yongjing Zhao, Donna (Jun) Hamamoto, and Kevin Perry (U. Utah). The Advanced Light Source is supported by the Director, Office of Science, Office of Basic Energy Sciences, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.atmosenv.2014.05.025>.

ITEM 11.1.

References

- ADAM, 2010. California Environmental Protection Agency – Air Resources Board. ADAM data summaries. www.arb.ca.gov/ADAM.
- Baldauf, Richard, McPherson, Greg, Wheaton, Linda, Zhabg, Max, Cahill, Tom, Bailey, Chad, Hemphill-Fuller, Christina, Withycombe, Earl, Titus, Kori, 2013. Integrating Vegetation and Green Infrastructure into Sustainable Transportation Planning. Transportation Research Bulletin, National Academy of Sciences.
- Barberie, S.R., Cahill, T.A., Cahill, C.F., Cahill, T.M., Iceman, C.R., Barnes, D.E., 2013. UC Davis XIPline (“zipline”) end-station at the Stanford Synchrotron Radiation Lightsource: Development and experimental results. Nucl. Instrum. Meth. Phys. Res. A: Accelerators, Spectrometers, Detectors and Associated Equipment 729, 930–933.
- Barkan, S., Iwanczyk, J.S., Patt, B.E., Feng, L., Tull, C.R., Vilkelis, G., 2003. Vortex-a new high performance silicon drift detector for xrd and xrf applications. Adv. X-Ray Anal. 46, 332–337.
- Bench, Graham, Grant, Patrick, Ueda, Dawn, Cliff, Steven, Perry, Kevin, Cahill, Thomas A., 2002. The use of STIM and PESA to measure profiles of aerosol mass and hydrogen content, respectively, across mylar rotating drums impactor samples. Aerosol Sci. Technol. 36, 642–651.
- Cahill, T.A., Feeney, P.J., 1973. Contribution of Freeway Traffic to airborne Particulate Matter. Final Report of the California Air Resources Board, Contract ARB-502(1973).
- Cahill, Thomas A., 1979. Comments on surface coatings for lundgren-type impactors. In: Lundgren, Dale A. (Ed.), Aerosol Measurement. University Presses of Florida, pp. 131–134.
- Cahill, T.A., Goodart, C., Nelson, J.W., Eldred, R.A., Nasstrom, J.S., Feeney, P.J., 1985. Design and evaluation of the drum impactor. In: Ariman, Teoman, Nejat Veziroglu, T. (Eds.), Proceedings of International Symposium on Particulate and Multi-phase Processes, vol. 2. Hemisphere Publishing Corporation, Washington, D.C., pp. 319–325.
- Cahill, Thomas A., Eldred, Robert A., Wallace, Don, Kusko, Bruce H., 1987. The hydrogen-sulfur correlation, by PIXE plus PESA, and aerosol source identification. Fourth International PIXE Conference. Tallahassee, FL, June 9–13, 1986 Nucl. Instrum. Methods Phys. Res. B22, 296–300.
- Cahill, T.A., Eldred, R.A., Motallebi, N., Malm, W.C., 1989. Indirect measurement of hydrocarbon aerosols across the United States by nonsulfate hydrogen-remaining gravimetric mass correlations. Aerosol Sci. Technol. 10, 421–429.
- Cahill, T.A., Roumie, M., Portnoff, L., Ray, V., Martin, J., Miller, R., Cliff, S.S., Perry, K.D., Williams, C., Turner, B., Withycombe, E., 2003. The Sacramento/Interstate-5 Aerosol Transect Study, December, 2002–January, 2003. Final Report to the American Lung Association – Sacramento Emigrant Trails Health Effects Task.
- Cahill, T.A., Roumie, M., Portnoff, L., Ray, V., Martin, J., Miller, R., Cliff, S.S., Perry, K.D., Williams, C., Turner, B., Withycombe, E., 2005. Aerosol Impacts at Arden Middle School, Sacramento, An Addendum to the Final Report American Lung Association – Sacramento Emigrant Trails Health Effects Task Force. In: The Sacramento/Interstate-5 Aerosol Transect Study, December, 2002 – January, 2003, the DELTA Group. University of California, Davis. <http://delta.ucdavis.edu>.
- Cahill, T.A., Cahill, T.M., Spada, N.J., Barnes, D.E., 2007. Organic and Elemental Aerosols Near Watt Avenue, Late Winter – Spring, 2007. Final Report to the Sacramento Metropolitan AQMD (2007).
- Cahill, T.A., Barnes, D.E., 2009. Comparison of Fine Mass, UC Davis DRUM versus FRM, at the ARB 13th and T Street Site. Final Report to the California ARB (2009).
- Cahill, T.A., Barnes, David E., Spada, Nicholas J., Lawton, Jonathan A., Cahill, Thomas M., 2011. Very fine and ultra-fine metals and ischemic heart disease in the California Central Valley 1: 2003–2007. Aerosol Sci. Technol. 45, 1125–1134.
- Cahill, Thomas M., Cahill, Thomas A., 2013. Seasonal variability of particle-associated organic compounds near a heavily traveled secondary road. Aerosol Sci. Technol. <http://www.tandfonline.com/loi/uast20>.
- CalTrans, www.dot.ca.gov, Business, Traffic Operations (2002, 2007); Data on Watt Avenue from a Sacramento County Traffic Monitor, With the Truck (3 Axles and Greater) Fraction From Observations and Logs of the School Crossing Guard.
- Chan, D., Stachowiak, G.W., 2004. Review of automotive brake friction materials. Proc. Inst. Mech. Eng. 218 D, 953–966.
- Davidson, Cliff I., Phalen, Robert F., Solomon, Paul A., 2005. Airborne particulate matter and Human health: a review. Aerosol Sci. Technol. 39 (8), 737–749.
- DRUM Quality Assurance Protocols, Ver 1/011 (2011) at <http://delta.ucdavis.edu>.
- Emfac2007 California Air Resources Board (2007).
- Feeney, P.J., Cahill, T.A., Flocchini, R.G., Eldred, R.A., Shadoan, D.J., Dunn, T., 1975. Effect of roadbed configuration on traffic derived aerosols. J. Air Pollut. Control Assoc. 25, 1145–1147.
- Fruin, S., Westerdahl, D., Sax, T., Sioutas, C., Fine, P.M., 2007. Measurements and predictors of on-road ultrafine particle concentrations and associated pollutants in Los Angeles. Atmos. Environ. 09, 057.
- Gauderman, W. James, Avol, Edward, Gilliland, Frank, Vora, Hita, Thomas, Duncan, Berhane, Kiro, McConnell, Rob, Kuenzli, Nino, Lurmann, Fred, Rappaport, Edward, Margolis, Helene, Bates, David, Peters, John, September 9, 2004. The effect of air pollution on lung development from 10 to 18 years of age. N. Engl. J. Med. 351, 1057–1067 <http://dx.doi.org/10.1056/NEJMoa040610>.
- Gertler, Alan, Mahmoud, Abu-Allaban, William, Coulombe, Gillies, John A., Pierson, William R., Fred Rogers, C., Sagebiel, John C., Tarnay, Leland, Cahill, Thomas A., 2001. Measurements of mobile source particulate emissions in a highway tunnel. Int. J. Veh. Des. 27, 86–93 <http://dx.doi.org/10.1504/IJVD.2001.001954>.
- Health Effects Institute, 2009. Traffic Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects, HEI 17, Boston, MA.
- Jenniskens, Peter, Fries, Marc D., Yin, Qing-Zhu, Zolensky, Mike, Krot, Alexander N., Sandford, Scott, Sears, Derek, Beauford, Robert, Ebel, Denton S., Friedrich, Jon M., Nagashima, Kazuhide, Wimpenny, Josh, Yamakawa, Akane, Nishiizumi, Kunihiko, Hamajima, Yasunori, Caffee, Marc W., Welten, Kees C., Laubenstein, Matthias, Davis, Andrew M., Simon, Steven B., Heck, Philipp R., Young, Edward D., Kohl, Issaku E., Thiemens, Mark, Nunn, Morgan H., Mikouchi, Takashi, Hagiya, Kenji, Ohsumi, Kazumasa, Cahill, Thomas A., Lawton, Jonathan A., Barnes, David, Rochette, Pierre, Verosub, Kenneth L., Gattacceca, Jérôme, Cooper, George, Glavin, Daniel P., Burton, Aaron S., Dworin, Jason P., Elsil, Jamie E., Pizzarello, Sandra, Oglione, Ryan, Schmitt-Kopplin, Philippe, Harir, Mourad, Hertkorn, Norbert, Verchovsky, Alexander, Grady, Monica, Nagao, Keisuke, Okazaki, Ryuji, Takechi, Hiroyuki, Hiroi, Takahiro, Smith, Ken, Silber, Elizabeth A., Brown, Peter G., Albers, Jim, Klotz, Doug, Hankey, Mike, Matson, Robert, Fries, Jeffrey A., Walker, Richard J., Puchtel, Igor, Lee, Cin-Ty A., Erdman, Monica E., Eppich, Gary R., Roeske, Sarah, Gabelica, Zelimir, 2012. Radar enabled recovery of Sutter's Mill, a carbonaceous chondrite regolith breccia. Science 338, 1583–1587.
- Karner, A.A., Eisinger, D.S., Neimeier, D.A., 2010. Near roadway air quality: synthesizing the findings from real world data. Environ. Sci. Tech. 44, 5334–5344.
- Kennedy, Paul, Gadd, J., Moncrieff, I., 2002. Emission Factors for Contaminants Released by Motor Vehicles in New Zealand. Ministry of Transport, New Zealand.
- Lawton, J.A., Cahill, C.F., 2010. Private Communication.
- Lippmann, Morton, 2009. Semi-continuous speciation analyses for ambient air particulate matter: an urgent need for health effects studies. J. Expo. Sci. Epidemiol. Stud. 19, 235–247.
- Malm, W.C., Sisler, J.F., Huffman, D., Eldred, R.A., Cahill, T.A., 1994. Spatial and seasonal trends in particle concentration and optical extinction in the United States. J. Geophys. Res. 99 (D1), 1347–1370.
- Nichols, M., 2009. Letter and Appended Report From the Staff of the California Air Resources Board.
- Oberdorster, Gunter, Stone, Vicki, Donaldson, Ken, March 2007. Toxicology of nanoparticles: a historical perspective. Nanotoxicology 1 (1), 2–25.
- Peters, John M., Avol, Edward, Navidi, William, London, Stephanie J., James Gauderman, W., Lurman, Fred, Linn, William S., Margolis, Helene, Rappaport, Edward, Gong Jr., Henry, Thomas, Duncan C., 1999a. A study of twelve southern California communities with differing levels and types of air pollution I. Prevalence of respiratory morbidity. Am. J. Respir. Crit. Care Med. 159 (3), 760–767.
- Peters, John M., Avol, Edward, Navidi, William, London, Stephanie J., James Gauderman, W., Lurman, Fred, Linn, William S., Margolis, Helene, Rappaport, Edward, Gong Jr., Henry, Thomas, Duncan C., 1999b. A study of twelve southern California communities with differing levels and types of air pollution II. Effects on pulmonary function. Am. J. Respir. Crit. Care Med. 159 (3), 768–775.
- Raabe, O.G., Braaten, D.A., Axlebaum, R.L., Teague, S.V., Cahill, T.A., 1988. Calibration studies of the drum impactor. J. Aerosol Sci. 19 (2), 183–195.
- Sharpless, J., 2012. The 2009–2010 Del Paso Manor Winter PM_{2.5} Study, the Health Effects Task Force, Breathe California of Sacramento – Emigrant Trails.
- Wallenborn, J., Grace, Kovalecik, Kasey, D., McGee, John K., Landis, Matthew S., Kodavanti, Urmila P., 2009. Systemic translocation of 70Zinc: kinetics following intratracheal instillation in rats. Toxicol. Appl. Pharmacol. 234, 25–32.
- Wesolowski, J.J., John, W., Devor, W., Cahill, T.A., Feeney, P.J., Wolfe, G., Flocchini, R., 1978. Collection surfaces of cascade impactors. In: Dzubay, T. (Ed.), X-ray Fluorescence Analysis of Environmental samples. Science, Ann Arbor, pp. 121–130.
- Wilhelm, Michelle, Ritz, Beate, 2003 February. Residential proximity to traffic and adverse birth outcomes in Los Angeles county, California, 1994–1996. Environ. Health Perspect. 111 (2), 207–216.
- Zhang, K. Max, Wexler, Antony S., Zhu, Yi Fang, Hinds, William C., Constantinos, Sioutas, 2004. Evolution of particle number distribution near roadways. Part II: the ‘Road-to-Ambient’ process. Atmos. Environ. 2004.06.044.
- Zielinska, B., Goliff, W., McDaniel, M., Cahill, T., Kittelson, D., Watts, W., 2003. Chemical Analyses of Collected Diesel Particulate Matter Samples in the E-43 Project. National Renewable Energy Laboratory.
- Zielinska, B., Sagebiel, J., McDonald, J.D., Whitney, K., Lawson, D.R., 2004. Emission rates and comparative chemical composition from selected in-use diesel and gasoline fueled vehicles. J. Air Waste Manag. Assoc. 54, 1138–1150.
- Zhu, Y., Hinds, W.C., Kim, S., Shen, S., Sioutas, C., 2002. Study of ultra-fine particles near a major highway with heavy duty diesel traffic. Atmos. Environ. 36, 4323–4335.

ITEM 111
This article downloaded by: [University of California Davis]

On: 13 July 2011, At: 15:43

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Aerosol Science and Technology

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/uast20>

Very Fine and Ultrafine Metals and Ischemic Heart Disease in the California Central Valley 2: 1974-1991

Thomas A. Cahill^{a b}, David E. Barnes^a, Earl Withycombe^b & Mitchell Watnik^c

^a DELTA Group, University of California, Davis, California, USA

^b The Health Effects Task Force, Breathe California of Sacramento-Emigrant Trails, Sacramento, California, USA

^c The Statistical Laboratory, University of California, Davis, California, USA

Available online: 12 May 2011

To cite this article: Thomas A. Cahill, David E. Barnes, Earl Withycombe & Mitchell Watnik (2011): Very Fine and Ultrafine Metals and Ischemic Heart Disease in the California Central Valley 2: 1974-1991, Aerosol Science and Technology, 45:9, 1135-1142

To link to this article: <http://dx.doi.org/10.1080/02786826.2011.582196>

PLEASE SCROLL DOWN FOR ARTICLE

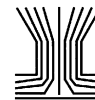
Full terms and conditions of use: <http://www.tandfonline.com/page/terms-and-conditions>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan, sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

ITEM 11.1.

Aerosol Science and Technology, 45:1135–1142, 2011
 Copyright © American Association for Aerosol Research
 ISSN: 0278-6826 print / 1521-7388 online
 DOI: 10.1080/02786826.2011.582196



Very Fine and Ultrafine Metals and Ischemic Heart Disease in the California Central Valley 2: 1974–1991

Thomas A. Cahill,^{1,2} David E. Barnes,¹ Earl Withycombe,² and Mitchell Watnik³

¹*DELTA Group, University of California, Davis, California, USA*

²*The Health Effects Task Force, Breathe California of Sacramento-Emigrant Trails, Sacramento, California, USA*

³*The Statistical Laboratory, University of California, Davis, California, USA*

The southern part of Central Valley of California in winter has long had high PM₁₀ mass, which until about 1990 included sulfate, vanadium, and nickel from the burning of crude oil used to generate steam to enhance heavy petroleum recovery. In roughly 1990, natural gas became the major energy source used for steam generation. In 1989–1991, data were collected throughout California on the mortality from strokes and ischemic heart disease (IHD). Although no spatial variability was seen for strokes, the southern San Joaquin Valley was found to have IHD mortality rates roughly 60% greater than the rest of the valley. PM₁₀ was statistically identified as the major factor associated with the IHD mortality. However, when the rate of IHD was reexamined in the 2003–2007 period, a sharp reduction, about 30%, was seen in the relative rates for southern San Joaquin Valley as compared with the northern Sacramento Valley. We have measured very fine and ultrafine vanadium and nickel aerosols in a winter experiment in 2009, which shows an order of magnitude reduction in vanadium and nickel aerosols as compared with the pre-1990 data, which is a consequence of the switch from burning crude oil to natural gas to generate the steam. The inference of a causal relationship between the reduced vanadium and nickel and the improved IHD rate is supported by a growing body of laboratory and epidemiological work on the toxicity of vanadium and nickel, including from oceangoing ships burning crude or residual oil.

Received 14 October 2010; accepted 27 November 2010.

The authors wish to gratefully acknowledge the input and oversight of the project by the ALASET Health Effects Task Force under Jananne Sharpless, Chair, and Betty Turner, ALASET liaison, HETF members Tom Cahill, Mel Knight, Michael Lipsett, Ralph Propper, Marc Schenker, Steve Van den Eden, and Earl Withycombe, as well as the suggestions of William Wilson, US EPA. The authors also wish to gratefully acknowledge the financial support of the Sacramento Metropolitan Air Quality Management District under its CEO, Norm Covell, and the Yolo-Solano AQMD, under its CEO, Larry Greene. Finally, the authors wish to thank Ms. Jeanette Martin for her untiring assistance in designing and assembling the original report.

Address correspondence to Thomas A. Cahill, DELTA Group, University of California-Davis, One Shields Ave., Davis, CA 95616, USA. E-mail: tacahill@ucdavis.edu

INTRODUCTION

The Central Valley of California is well known for exhibiting in much of its area serious violations of federal PM₁₀, PM_{2.5}, in winter, and ozone standards, in summer, matching or exceeding those seen for any commensurate area of the United States. Yet other parts of the valley share agriculturally based land uses and meteorology and do not exhibit serious violations of these standards. Although efforts continue to control particulate matter (PM) and ozone violations, this pollutant gradient offers an ideal situation to examine the effects of pollutants on health. Many of the confounding variables seen in comparison studies, such as meteorology, land use patterns, and cigarette smoking, are very similar throughout the Valley, and a wealth of data exists on the pollutants and their sources from district air monitoring and Air Resources Board (ARB) studies. The presence of detailed analysis of mortality from ischemic heart disease (IHD) and stroke during 1989–1991 reported by the Cardiovascular Disease Outreach and Epidemiology (CORE) Program (Kao et al. 1994) and the California Department of Health Services (CADHS 2010) provides a natural opportunity to compare the pollutant data and mortality data for the identical time ranges. While this article focuses on PM effects, the original report (Cahill et al. 1998) also examined the effects of ozone and carbon monoxide (CO) on IHD and stroke mortality; some of which are presented in this article for completeness. However, complexities in the spatial and temporal gradients of ozone require further interpretation, and thus, they are not examined in any detail in this article.

BACKGROUND

The northwest-southeast trending 550 km by 100 km Central Valley of California is one of the richest agricultural areas in the world (Figure 1). In addition, there are two major metropolitan areas in the Valley, the Sacramento-Fresno regions each with about 1 million residents, and otherwise towns are generally medium (circa a few 100,000) to small and spread

ITEM 11.1.

1136

T. A. CAHILL ET AL.



FIG. 1. Map of the Central Valley of California. The northern part is referred to as the Sacramento Valley while the southern part is called the San Joaquin Valley. The areas within the dotted circumference vary in altitude from almost sea level in the Delta to a few 100 m in elevation. The small arrows denote the typical winter wind patterns (Hayes et al. 1984).

throughout the Valley. The mean population density is about 60 people/km².

High summer temperatures in the Valley (mean daily high, July, 36°C ± 1°C) lower the surface pressure and draw massive inputs of cool air into the Valley from the San Francisco Bay area, bringing with it oceanic aerosols and typical urban pollutants enhanced by the major petrochemical industrial sites at the Carquinez Strait. These latter sources lie directly in the path for the cold, dense winds from the San Francisco Bay. These winds funnel down the entire San Joaquin Valley, south of the strait, but rarely penetrate north very far in the Sacramento Valley, north of the strait. Rainfall in the Valley is rare during the period from May through October.

In winter, there is slow drainage of cold air off the Sierra Nevada to the Valley floor (mean daily low, January, 3°C ± 1°C) and then, at the rate of about 50 km/day, the air drains toward the lowest point, the Sacramento–San Joaquin Delta, directly east of the Carquinez Strait. Thus, little impact from the San Francisco Bay area is seen on most winter days in the Central Valley beyond the immediate Delta region. Winter rainstorms and strong northwest winds periodically clean out the Valley. Thus, the Valley tends to fall into two distinct and very different conditions: hot, dry summers with strong diurnal winds, and cool, foggy winters with long periods of stagnation. This results in two very different aerosol types: summer and winter (Figure 2).

In Figure 2, 24 h, one day in six PM₁₀ mass at the Fresno 1st Street “Super-site” is shown (ADAM 2010). The site is in a largely residential neighborhood roughly 1 km east of the

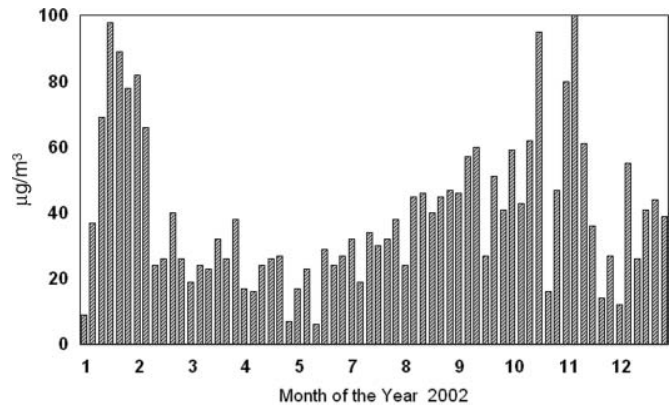


FIG. 2. PM₁₀ mass at the Fresno “Super-site”, 2002.

nearest major freeway, well away from agricultural operations. It is thus a good representation of what the average Fresno resident inhales. The annual pattern of PM₁₀ mass has been consistent in the valley for many years, but this data only really became available around 1997, hence why Figure 2 uses more recent data to demonstrate the traditional annual cycle of particulate mass.

The health effects data are derived from CORE (Kao et al. 1996) and CADHS (2010). CORE collected city (>20,000 inhabitant) and countywide data on mortality from stroke and IHD; the latter is the largest source of mortality in the California Central Valley accounting for about one fourth of all deaths. The CORE data were corrected for age, >35 years, and reduced to incidence per 100,000 residents. The results were then presented as a ratio to the California average values the both males and females. Individual city data were weighted and averaged to obtain countywide averages in order to match the air pollution data.

The effect of race was examined over the entire California dataset. The data were available only in three classifications: “White,” “Black,” and “Other,” with “Other” in the Central Valley being largely Latinos. No statistically significant difference was seen in the IHD rates for the dominant >75 years age group, but a slight enhancement of the rates for Blacks was seen in the 64- to 75-year cohort. For all ages, the mortality/100,000, 95% confidence limit, was 196 ± 3 for white males, 212 ± 9 for black males, and 199 ± 4 for other males; the corresponding values for females were 127 ± 3, 166 ± 5, and 135 ± 3. The stroke deaths, on the contrary, while only roughly one third of the rate of IHD mortality, showed stroke rates roughly twice as high for the “Black” and “Other” cohorts than the “White” cohort. Consideration was given to cigarette-smoking patterns, but no significant difference was seen along the length of the Valley (Table 1).

Four metrics for air pollution were studied, each with very different cardiovascular impacts: ozone (top 30 h and hours above 0.09 ppm), annual average CO, and annual average PM₁₀. The approximate cigarette-smoking patterns were calculated

ITEM 11.1.

TABLE 1
Ischemic heart disease (IHD) and stroke mortality versus air pollutants in the Central Valley of California, 1989–1991

County (north to south)	IHD rate vs. CA average (%)	Stroke rate vs. CA average (%)	Ozone top 30 h (ppm)	Ozone hours >0.09 (h)	CO annual average (ppm)	PM ₁₀ annual average (μg/m ³)	Smoking rate average (%)
Shasta	−14	+9	0.095	20	0.54	30	22.4
Butte	−27	−3	0.078	6	0.93	38	22.4
Sutter	−4	+26	0.090	4		44	22.8
Placer	−17	−4		125		30	22.8
Sacramento	−6	+2	0.107	153	1.29	44	23.4
Yolo	+2	+13		16		30	22.4
San Joaquin	+15	+17	0.096	36	1.13	51	22.8
Stanislaus	−7	−3	0.102	119	0.75	48	22.0
Madera	+11	−23		30		53	22.0
Fresno	+3	−12	0.129	369	0.87	77	22.0
Kings	+17	+20	0.106	21		61	22.5
Tulare	+22	+8	0.093	192	0.88	67	22.5
Kern	+33	−11	0.111	605	0.80	68	22.5

from cigarette sales data. Correlations were calculated for all parameters and are presented in Table 2 and Figures 3 and 4. At some sites, measurements were lacking. No data were deleted.

To further investigate the statistical robustness of these data, we used “proc glm” on SAS version 9.1 for the analyses. Because there are only 13 observations in total, we did not feel that imputation would prove fruitful. Therefore, we ran multiple regression models with “percentage change of IHD” and “percentage change of stroke” as the outcome variables. The possible explanatory variables were “number of hours of ozone above 0.09 ppm” (“ozone”), “annual average PM less than 10 μm, measured in micrograms per cubic meter” (“PM₁₀”), and “percentage rate of smoking” (“smoking”). We checked the assumption of normality of the errors by formally using the Shapiro–Wilk test and the assumption of homoskedasticity informally using residual plots.

The overall stroke model was not significant ($p = 0.1108$). We did not proceed further for that outcome. However, the overall IHD model was significant ($p = 0.0330$). We used backward elimination as the model selection strategy, for example, that of Neter et al. (1996). Ozone and smoking were eliminated—in that order—leaving PM₁₀ as the sole significant explanatory variable ($p = 0.0026$). The resulting linear regression is given

by

$$\text{estimated percentage change of IHD} = -41.5 + 0.87 \times \text{PM}_{10},$$

and the corresponding r -squared value is 0.576. It is noteworthy that Fresno appears to be an outlier. If this point is removed, the slope and r -squared values jump dramatically. We have no cause to remove that point and we therefore use the model, as indicated earlier, as our finding. However, the Fresno value includes semirural sampling sites at the urban fringe that are not present in other San Joaquin Valley cities, which had at that time only a single city center site.

However, the strong association between aerosol mass and IHD posed a problem. As additional data were developed in the Central Valley from the IMPROVE program (Malm et al. 1994) and from extensive California studies (CRPAQS 2001, Cahill et al. 2003), it became clear that the major aerosol species that dominated fine mass was ammonium nitrate, with much smaller contributions from organic matter, including a wood smoke component, and ammonium sulfate. These are however water soluble and have not been closely linked to IHD in animal and laboratory studies. (Devlin 2003; Lippmann 2009).

TABLE 2
Correlation of air pollution to mortality by IHD and stroke in the Central valley of California, 1989–1991

Mortality	Ozone average top 30 h (ppm)	Ozone number hours > 0.09 (ppm)	CO (ppm)	PM ₁₀ (μg/m ³)
Correlation to IHD	$r^2 = 0.18$	$r^2 = 0.27$	$r^2 < 0.05$	$r^2 = 0.56$
Correlation to stroke	$r^2 = 0.21$	$r^2 = 0.19$	$r^2 < 0.05$	$r^2 < 0.05$

ITEM 11.1.

1138

T. A. CAHILL ET AL.

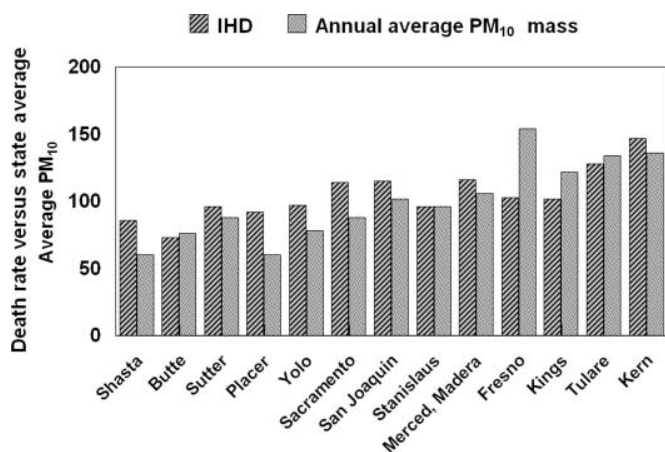


FIG. 3. Comparison of death rate from IHD, compared to the California average, and annual PM_{10} inhalable aerosol mass. Shasta County is at the very northern end of the California Central Valley, and Kern County is at the southern end.

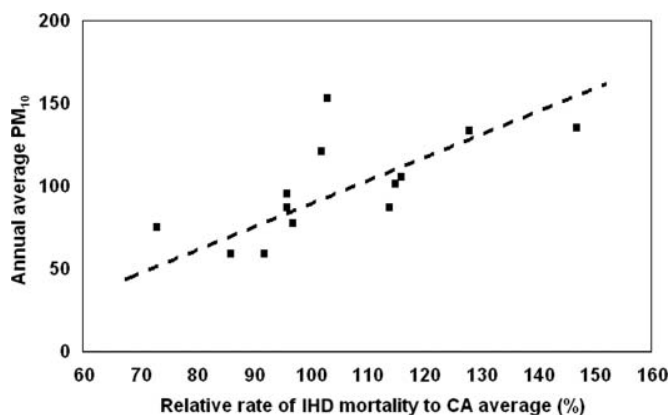


FIG. 4. IHD mortality rate relative to the California average versus PM_{10} . The parameters are associated by a regression $r^2 = 0.56$.

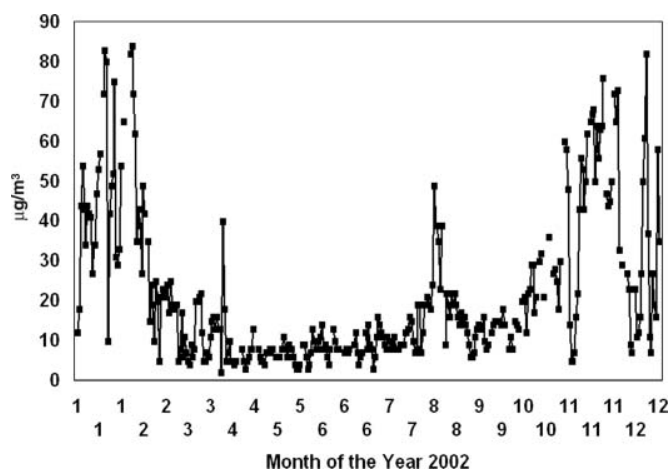


FIG. 5. $PM_{2.5}$ mass at the Fresno "Super-site," 2002, the same period used in Figure 2.

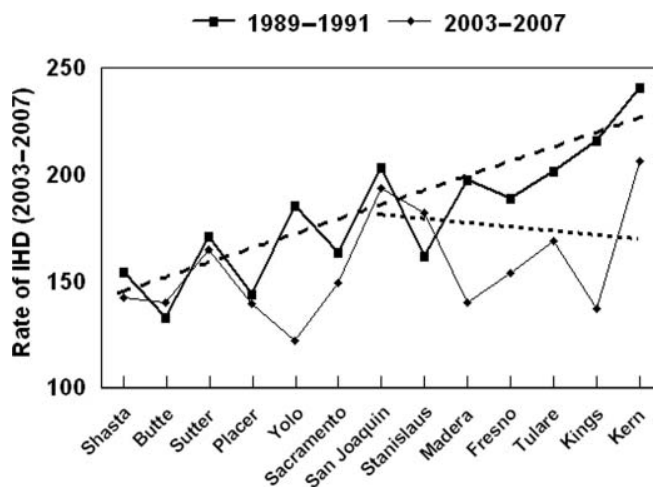


FIG. 6. IHD in the California Central valley, 1989–1991 versus 2003–2007. The 1989–1991 data are scaled to match the Shasta–Butte data, 2003–2007, as diagnostic protocols differed.

Reduction of IHD Rates: 2003–2007 Versus 1989–1991

Beginning around 1999, data on aerosol in the Central Valley were enhanced by the availability of $PM_{2.5}$ mass and chemical speciation at some San Joaquin Valley sites. In Figure 5, the same period for the Figure 2, one day in six PM_{10} mass is shown for 24 h daily fine $PM_{2.5}$ mass (ADAM 2010). The old federal 24-h $PM_{2.5}$ standard was $65 \mu g/m^3$ and the current 24-h standard is $35 \mu g/m^3$, which is routinely violated in winter. The annual average standard is $15 \mu g/m^3$.

The question of IHD and aerosols was revisited for the period 2003–2007 (Cahill et al. 2010). From the recent data, it became

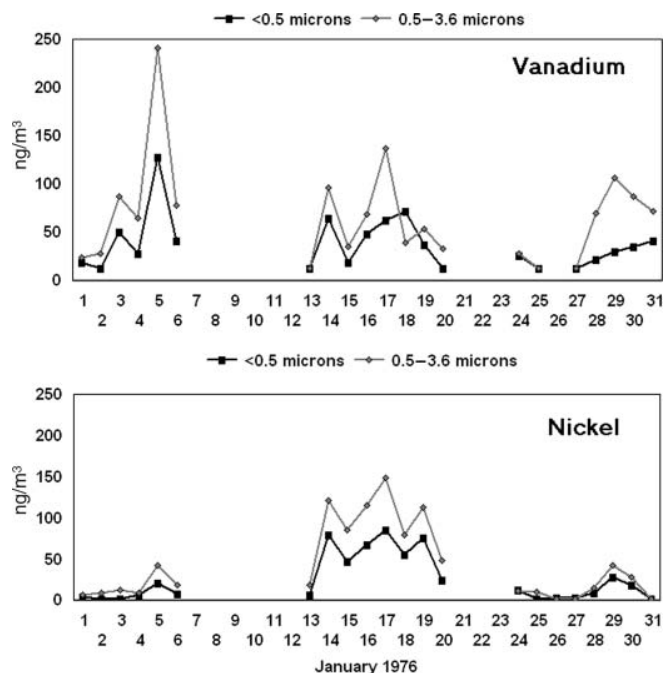
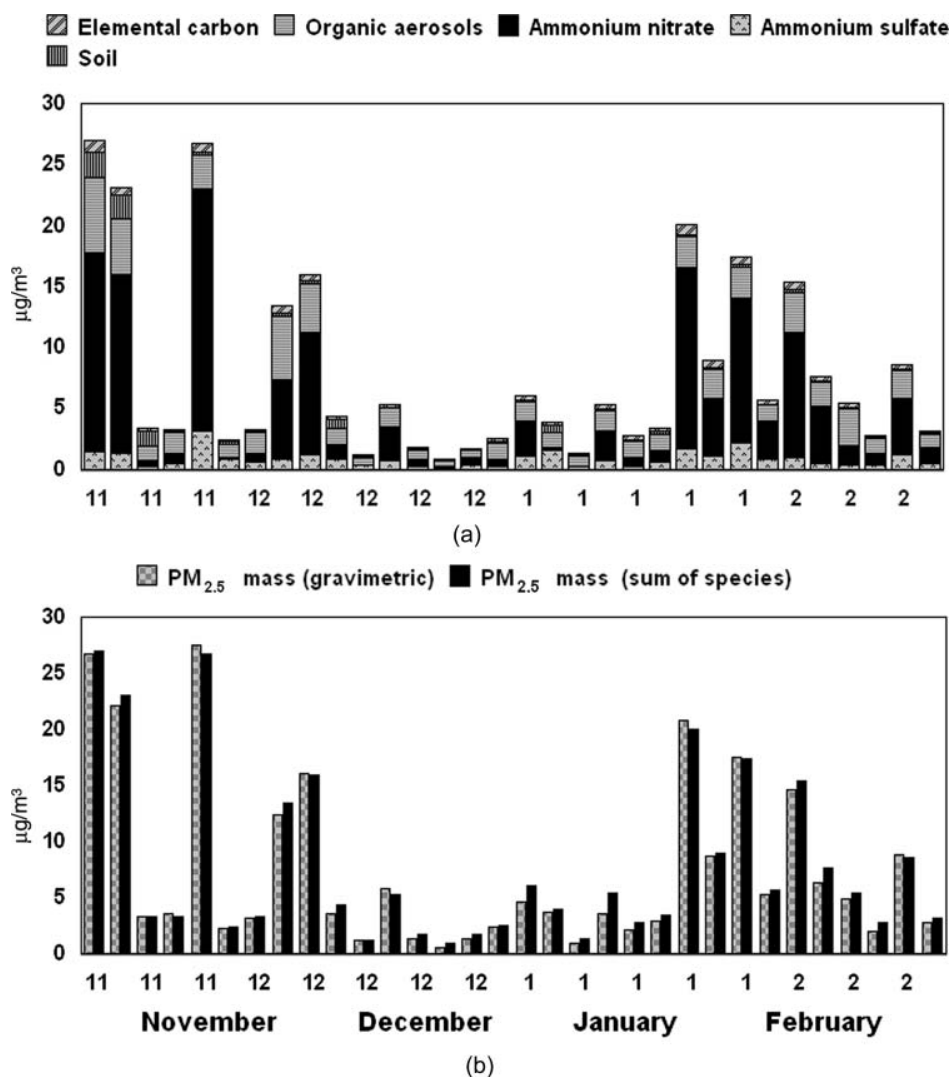


FIG. 7. Vanadium and nickel aerosols in Bakersfield, January 1976.

ITEM 11.1.

METALS AND ISCHEMIC HEART DISEASE 2

1139

FIG. 8. (a) and (b) showing PM_{2.5} mass closure and major species.

clear that a comparison of the IHD mortality, 1989–1991 versus 2003–2007, shows a major reduction, roughly 30%, that occurs in 2003–2007 for the counties north of Bakersfield (Figure 6). The trend for the northern half of the Central Valley is similar, while Bakersfield in Kern County is only slightly reduced. Thus, the question arises as to the causes for the improvement in the IHD rate.

The compositional analysis of Central Valley aerosols dates back to the early 1970s, including an innovative program of UC Davis for the California Air Resources Board (CARB), 1973–1977 (Cahill et al. 1974; Flocchini et al. 1976; Barone et al. 1978; Motallebi et al. 1990a, 1990b). A total of 14,100 daily aerosol measurements were taken in three size modes (15–3.5 µm, 3.5–0.50 µm, and 0.50–0.0 µm) and analyzed for elemental content by particle-induced x-ray emission (PIXE) (Cahill 1995) at about fourteen separate sites, including the

valley sites of Chico, Sacramento, Visalia, (100 km NNE of Bakersfield), and Bakersfield. Bakersfield had one of the highest levels of vanadium and nickel aerosols in California, but port areas (Oakland, Richmond, and Los Alamitos) were also high (Figure 7).

Neither vanadium nor nickel was seen in sizes above 3.5 µm diameter. The radically different vanadium/nickel ratios occurred when winds came from the western (Taft, 40 km SW) or northern (Oildale, 5 km N) oil fields periods of stagnation, giving the highest pollution levels, favored sources in the much closer northern oil fields, some of which were within Bakersfield itself (Motallebi et al. 1990b). In addition, there was an oil refinery in Oildale, with potentially different emissions than the crude oil burned for enhanced oil recovery (EOR). Also it is noteworthy that while the vanadium and nickel concentrations can vary by over an order of magnitude, the lead levels were relatively

ITEM 11.1.

1140

T. A. CAHILL ET AL.

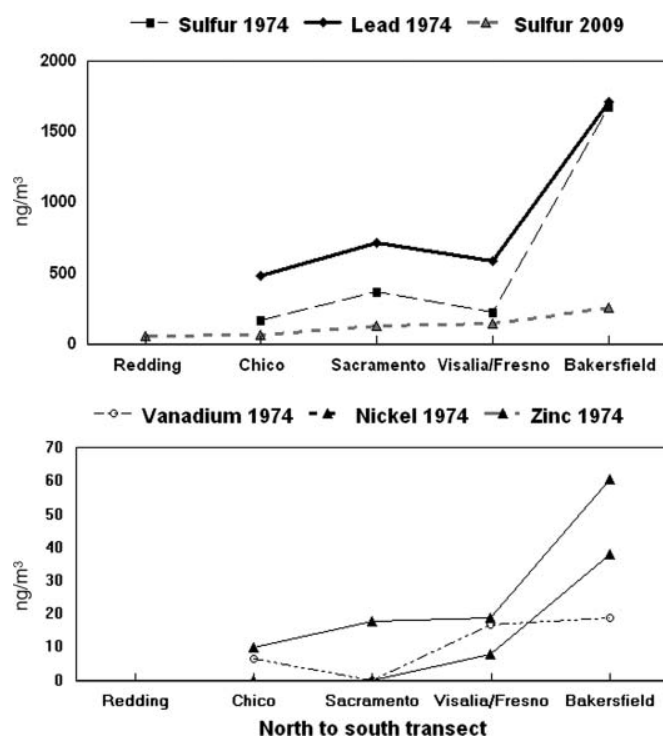


FIG. 9. Lead and sulfur, 1974–1976, versus sulfur, 2009, and vanadium, nickel, and zinc 1974–1976. Visalia lies between Bakersfield and Fresno.

constant, indicating a continuous impact of traffic-derived aerosols at Bakersfield.

Recent compositional analysis of the $PM_{2.5}$ aerosols in the southern San Joaquin Valley also became available through the IMPROVE site at Sequoia National Park (NP) starting in 1992 (Malm et al. 1994). The Sequoia NP Ash Mountain site was at low elevation, near 600 m, and thus received aerosols from the valley floor whenever the inversion lifted to that level.

IMPROVE had anticipated the value of $PM_{2.5}$ mass and full speciation, using quality assurance protocols of “integral redundancy” to measure major parameters by two or more independent methods. Sulfur from PIXE on Teflon in Channel A (Cahill 1995) is compared with sulfates after a denuder on Nylon filters in Channel B. Organic matter measured by combustion from tandem quartz filters in Channel C is compared to organic matter estimates by nonvolatile hydrogen of Teflon in Channel A (Cahill et al. 1989). Iron was measured by both PIXE and x-ray fluorescence (XRF) on the Teflon filters of Channel A. Thus, the gravimetric mass can be directly compared to the sum of all species (Figure 8b) and all major components (Figure 8a).

Figure 8 shows periodic incursions of high aerosol levels throughout the winter whenever the valley inversion rises to the altitude of Ash Mountain. Other than during these incursions, aerosol mass levels are very low, a few $\mu g/m^3$. By choosing an arbitrary concentration of $10 \mu g/m^3$, we can be assured that we are seeing San Joaquin Valley aerosols diluted by the high inversion levels necessary for the Ash Mountain incursions.

Finally, the excellent agreement between the mass of aerosol measured gravimetrically and the sum of species for all three IMPROVE channels (Figure 8a) shows that we are not missing any major component of the $PM_{2.5}$ mass.

Figure 5 showed that the violations of the annual and 24-h $PM_{2.5}$ standards in the San Joaquin Valley are driven by the winter aerosols. The high $PM_{2.5}$ values generally correspond to stable conditions with low inversions, and the clean periods to synoptic rainstorms passing through the Valley. Figure 8b shows that winter composition is dominated by fine $D_p < 2.5 \mu m$ nitrates with smaller contributions from organic matter, wood smoke and vehicular exhaust, and some sulfates (IMPROVE 2010). The IMPROVE data also include fine metals, thus aiding our intercomparisons.

Winter data from the earlier efforts (Cahill et al. 1974, 2003; Flocchini et al. 1976) can be roughly compared with the current work (Cahill et al. 2010) by summing the four finest DRUM stages to obtain $<0.56 \mu m$ particles (Table 3 and Figure 6).

Addressing the potential health impacts of these data, vanadium and nickel have the highest mortality risk coefficients of seventeen fine particulate matter (FPM) components (Lippmann et al. 2006). The elevated levels seen in 1974–1976 were sharply reduced as early as 1992–1993, using the vanadium and nickel levels in the southern San Joaquin Valley from the Sequoia IMPROVE site, although the Sequoia NP site’s $PM_{2.5}$ data are not directly comparable to the valley floor’s very fine ($<0.5 \mu m$) particle data. These data are shown in Figure 9. For comparison’s sake, vanadium and nickel have current annual averages in FPM of $1.9 \text{ ng}/m^3$ across sixty metropolitan areas (MSAs) (Lippmann et al. 2006).

Examining the potential sources for the very fine (in this case $<0.5 \mu m$) particles (Table 3 and Figure 6), we see sulfur plus metals associated with crude oil combustion (vanadium and nickel), as well as lead and other vehicular metals. Kern County has very large reserves of crude oil, most of which lie just north and west of Bakersfield, although there was and is some oil extraction within the city itself. The Kern County oil fields have a heavy crude oil that requires EOR techniques such as steam injection to extract. Initially, the steam was generated by burning the crude oil itself, resulting in high pollution levels. In 1979, violations of federal air quality standards required Kern County to apply strict controls on sulfur dioxide, nitrogen dioxide, and particulate emissions, which included metals vanadium and nickel. EOR by crude oil combustion dropped slowly, 1980–1990, and then dramatically with the increasing availability of natural gas, with an immediate improvement in air quality by the early 1990s (CA Almanac). Thus, the population subject to IHD mortality in Bakersfield 1989–1991 had at least two decades of exposure to elevated high levels of very fine to ultrafine transition metals, specifically vanadium and nickel at 10–20 times the current US averages.

Laboratory data on the impact of vanadium and nickel aerosols has become more extensive (Zhang et al. 2009). Thus, we can hypothesize that the effective control of the

ITEM 11.1.

METALS AND ISCHEMIC HEART DISEASE 2

1141

TABLE 3

Comparison between January 1974–1976, averaged, and January 2009. The four finest DRUM stages of the 2009 data have been summed to be $PM < 0.56 \mu m$ to better match the $PM < 0.5 \mu m$ data of the earlier ARB/UCD aerosol network. The Sequoia NP and Fresno winter 2002–2003 data are of $PM_{2.5}$

	Sulfur	Vanadium	Nickel	Zinc	Lead
Valley transect 2009 [January 2009 (ng/m^3) $< 0.56 \mu m$]					
Redding	88.8	0.2	1.0	13.9	2.5
Chico	136.9	0.5	0.4	5.2	2.1
Sacramento	246.0	0.4	0.1	6.9	1.6
Fresno	261.4	0.3	0.5	40.3	4.9
Bakersfield	505.0	0.2	2.3	32.0	9.4
Fresno $PM_{2.5}$ (ng/m^3)					
Winter 2002	266.2	0.47	0.22	12.7	1.2
Sequoia NP ($\sim 600 m$), 10 episodes $PM_{2.5} > 10 \mu g/m^3$					
Winter 2002–2003 (ng/m^3)	194	0.2	0.1	4.7	1.0
Winter 1992–1993 (ng/m^3)	562	0.7	0.1	6.0	2.0
Valley transect 1974–1976 [January 1974–1976 (ng/m^3) average, $< 0.5 \mu m$ diameter]					
Redding	na	na	na	na	na
Chico	170	7	1	10	483
Sacramento	375	0	1	18	720
Visalia	225	17	8	19	593
Bakersfield	1685	19	38	61	1714
Port of Los Angeles					
August–September, 2008	2565	16	4	13	6

crude-oil-derived metals in the late 1980s may be responsible for the decreased IHD death rate at sites north of Bakersfield in the 1990s and beyond. This hypothesis is supported by other studies, such as the sharp drop in mortality after a sharp drop in sulfur, vanadium, and nickel in Hong Kong when the sulfur levels in fuels were lowered by edict (Hedley et al. 2002; Lippmann et al. 2006). The presence of high levels of nickel in New York City from residual oil combustion in buildings is hypothesized to be a causal factor in the enhanced mortality

associated with $PM_{2.5}$ (Peltier et al. 2009; Peltier and Lippmann 2010).

The current data also have relevance to the emission of sulfur, vanadium, and nickel by oceangoing ships. Recent data in New York and New Jersey (Peltier et al. 2009), and the Port of Los Angeles (Cahill et al. 2009), show the impacts of oceangoing ships burning residual or bunker oil. In the Los Angeles study, the average concentrations of fine sulfur, vanadium, and nickel in the coastal town of Wilmington in August 2008 were 2565, 16, and 4.4 ng/m^3 , respectively (Table 3). Southern winds bring aerosols from the Port of Los Angeles into Wilmington routinely during part of each day (Figure 10). Ultrafine particles were not collected in this study, so the actual values could have been significantly higher than these values. Thus, on the basis of the Bakersfield data, the enhanced rates of IHD are predicted in the area.

CONCLUSION

IHD mortality in the Central Valley of California, corrected for age, race, sex, and smoking, was almost 60% greater at the more polluted southern end of the Central Valley than the less polluted northern end in 1989–1991 despite similar meteorology and land use patterns throughout the Valley. A significant association, $r^2 = 0.56$, is seen between IHD mortality and PM_{10} , but negligible correlation, $r^2 < 0.05$, is seen with stroke mortality. When PM_{10} data are converted to an estimated $PM_{2.5}$ mass

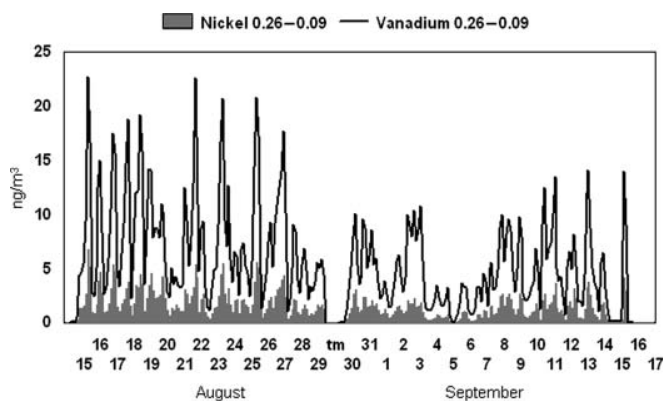


FIG. 10. Very fine ($0.26 > D_p > 0.09 \mu m$) vanadium and nickel in Wilmington, CA, downwind during daylight hours at the Port of Los Angeles.

ITEM 11.1.

1142

T. A. CAHILL ET AL.

by using more recent measurements, these results are similar to other studies such as the “6 Cities” study (Dockery et al. 1993) in mortality increase per particulate mass; 1.9% mortality increase per $\mu\text{g}/\text{m}^3$ of $\text{PM}_{2.5}$ for “6 Cities,” while 1.8% mortality increase per $\mu\text{g}/\text{m}^3$ of estimated $\text{PM}_{2.5}$ for this study, despite major differences in meteorology and pollutant mix. No association was seen between CO and any health impact. Ozone was only weakly correlated with IHD and stroke. However, strong east-west ozone gradients were not corrected for in this work, and thus, these results for ozone must be viewed as merely indicative of the possible impacts.

The sharp reduction seen, when the IHD data were reexamined in the period 2003–2007, was coincident with a reduction in the high levels of vanadium ($19 \text{ ng}/\text{m}^3$) and nickel ($38 \text{ ng}/\text{m}^3$) due to oil field operations from before 1974 to after 1990, when new protocols were adopted. The vanadium and nickel levels in 2009 were close to the national average values, both roughly $1.9 \text{ ng}/\text{m}^3$. The relatively smaller reduction in IHD rate in Bakersfield itself is associated with the continuing impacts of vehicular very fine and ultrafine metals (Cahill et al. 2010, this issue).

REFERENCES

- ADAM. (2010). ADAM California Environmental Protection Agency—Air Resources Board, ADAM Data Summaries. Retrieved from www.arb.ca.gov/adam
- Barone, J. B., Cahill, T. A., Eldred, R. A., Flocchini, R. G., Shadoan, D. J., and Dietz, T. M. (1978). A Multivariate Statistical Analysis of Visibility Degradation at Four California Cities. *Atmos. Environ.*, 12:2213–2221.
- Cahill, T., Cliff, S. S., Jimenez-Cruz, M., and Perry, K. (2003). *Aerosols by Size, Time, and Composition in Support of the Fresno Asthmatic Children's Environment Study, 2001*. Final Report to the California Air Resources Board, Sacramento, CA.
- Cahill, T., Dutcher, D., Clark, C., Martin, J., McCarthy, T., and Lipnick, D. (1998). *Comparison of Cardiac and Stroke Mortality to Carbon Monoxide, Ozone, and Particulate Air Pollutant Concentrations in the Sacramento Valley Region*. Report to the Health Effects Task Force, American Lung Association Sacramento Emigrant Trails, Sacramento, CA.
- Cahill, T. A. (1995). Compositional Analysis of Atmospheric Aerosols, in *Particle-Induced X-Ray Emission Spectrometry (Chemical Analysis Series, Vol. 133)*, S. A. E. Johansson, J. L. Campbell, and K. G. Malmqvist, ed., John Wiley & Sons, Hoboken, NJ, pp. 237–311.
- Cahill, T. A., Barnes, D., and Smeltzer, K. (2009). *Deposition of Coarse Toxic Particles in Wilmington, CA*. Final Report for the Department of Toxic Substances Control (DTSC), Sacramento, CA.
- Cahill, T. A., Barnes, D. E., Spada, N. J., Lawton, J. A., and Cahill, T. M. (2010). Very Fine and Ultra-Fine Metals and Ischemic Heart Disease in the California Central Valley 1: 2003–2007. *Aerosol Sci. Technol.*, 45:1124–1134.
- Cahill, T. A., Eldred, R. A., Motallebi, N., and Malm, W.C. (1989). Indirect Measurement of Hydrocarbon Aerosols Across the United States by Non-Sulfate Hydrogen-Remaining Gravimetric Mass Correlations. *Aerosol Sci. Tech.*, 10:421–429.
- Cahill, T. A., and Flocchini, R. G. (1974). *Regional Monitoring of Smog Aerosols, Annual Reports to the California Air Resources Board, Contract 2-006, 1974, 1975, 1976, 1977*, Sacramento, CA.
- California Department of Health Services. (2010). *California Department of Health Services: Center for Health Statistics Office of Health Informa-*
- tion and Research (OHIR)*. Retrieved from <http://www.dhs.ca.gov/hisp/chs/OHIR/vssdata/Tables.htm>
- CORE. (September 1994). *Cardiovascular Disease Outreach and Epidemiology Program. The Local Burden of Cardiovascular Disease; Death from Heart Disease and Stroke in California Cities*. Report No. 1. Kao, C., Gazzinaga, J. M., Cowling, D. W., Cohen, R. D., Fox, P., Kaplan, G. A. California Department of Health Services and the University of California, San Francisco, CA.
- California Regional Particulate Air Quality Study (CRPAQS). (2001). *California Regional Particulate Air Quality Study*. Retrieved from <http://www.arb.ca.gov/airways>
- Devlin, R. (2003). *What We Know and What We Think We Know About Health Effects of Fine Particles: Is It Enough?* Annual Meeting. American Association of Aerosol Research (AAAR), Charlotte, NC.
- Dockery, D. W., Pope, C. A. III, Hu, X. P., Spengler, J. D., Ware, J. H., Fay, M. E., Ferris, B. G., and Speizer, F. E. (1993). An Association Between Air Pollution and Mortality in Six US Cities. *N. Engl. J. Med.*, 329:1725–1759.
- Flocchini, R. G., Cahill, T. A., Shadoan, D. J., Lange, S. J., Eldred, R. A., Feeney, P. J., Wolfe, G. W., Simeroth, D. C., and Suder, J. K. (1976). Monitoring California's Aerosols by Size and Elemental Composition. *Environ. Sci. Technol.*, 10:76–82.
- Hayes, T. P., Kinney, J. J. R., and Wheeler, N. J. M. (1984). California Surface Wind Climatology, State of California Air Resources Board, Aerometric Data Division, Sacramento, CA.
- Hedley, A. J., Wong, C.-M., Thach, T. Q., MStat, S. M., Lam, T.-H., and Anderson, H. R. (2002). Cardiorespiratory and All-Cause Mortality After Restrictions on Sulfur Content of Fuel in Hong Kong: An Intervention Study. *Lancet*, 360(9346):1646–1652.
- Interagency Monitoring of Protected Visual Elements (IMPROVE). (2010). Retrieved from <http://vista.cira.colostate.edu/IMPROVE/>
- Kao, C., Gazzinaga, J. M., Cowling, D. W., Cohen, R. D., Fox, P., and Kaplan, G. A. (1994). *Cardio Vascular Disease Outreach and Epidemiology Program. The Local Burden of Cardiovascular Disease; Death from Heart Disease and Stroke in California Cities*. Report No. 1. California Department of Health Services and the University of California, San Francisco, CA.
- Lippmann, M. (2009). Semi-Continuous Speciation Analyses for Ambient Air Particulate Matter: An Urgent Need for Health Effects Studies. *J. Expo. Sci. Epidemiol. Stud.*, 19:235–247.
- Lippmann, M., Ito, K., Hwang, J. S., Maciejczyk, P., and Chen, L. C. (2006). Cardiovascular Effects of Nickel in Ambient Air. *Environ. Health Perspect.* 114(11):1662–1669.
- Malm, W. C., Sisler, J. F., Huffman, D., Eldred, R. A., and Cahill, T. A. (1994). Spatial and Seasonal Trends in Particle Concentration and Optical Extinction in the United States. *J. Geophys. Res.*, 99(D1):1347–1370.
- Motallebi, N., Cahill, T. A., and Flocchini, R. G. (1990a). Influence of Particulate Size on Statistical Studies of Visibility at California Regions. *Atmosfera*, 3(2):111–126.
- Motallebi, N., Flocchini, R. G., Myrup, L. O., and Cahill, T. A. (1990b). A Principal Component Analysis of Visibility and Air Pollution in Six California Cities. *Atmosfer*, 3(2):127–141.
- Neter, J. W., Kutner, M. H., Nachtsheim, C. J., and Wasserman, W. (1996). *Applied Linear Statistical Models* (4th ed.). Irwin, Chicago, IL, p. 353.
- Peltier, R. E., Hsu, S.-I., Lall, R., and Lippmann, M. (2009). Residual Oil Combustion: A Major Source of Airborne Nickel in New York City. *J. Expo. Sci. Epidemiol.*, 19:603–612.
- Peltier, R. E., and Lippmann, M. (2010). Residual Oil Combustion: 2. Distribution of Airborne Nickel and Vanadium Within New York City. *J. Expo. Sci. Epidemiol.*, 20:342–350.
- Zhang, Z., Chau, P. Y., Lai, H. K., and Wong, C. M. (2009). A Review of the Effects of Particulate Matter-Associated Nickel and Vanadium Species on Cardiovascular and Respiratory Systems. *Int. J. Environ. Health Res.*, 19(3):175–185.

ITEM 111
This article downloaded by: [University of California Davis]

On: 13 July 2011, At: 15:46

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Aerosol Science and Technology

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/uast20>

Very Fine and Ultrafine Metals and Ischemic Heart Disease in the California Central Valley 1: 2003-2007

Thomas A. Cahill^{a b}, David E. Barnes^a, Nicholas J. Spada^a, Jonathan A. Lawton^a & Thomas M. Cahill^c

^a DELTA Group, University of California, Davis, California, USA

^b The Health Effects Task Force, Breathe California of Sacramento—Emigrant Trails, Sacramento, California, USA

^c Division of Mathematical and Natural Sciences, Arizona State University West Campus, Phoenix, Arizona, USA

Available online: 04 Jul 2011

To cite this article: Thomas A. Cahill, David E. Barnes, Nicholas J. Spada, Jonathan A. Lawton & Thomas M. Cahill (2011): Very Fine and Ultrafine Metals and Ischemic Heart Disease in the California Central Valley 1: 2003-2007, Aerosol Science and Technology, 45:9, 1123-1134

To link to this article: <http://dx.doi.org/10.1080/02786826.2011.582194>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.tandfonline.com/page/terms-and-conditions>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan, sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

ITEM 11.1.

Aerosol Science and Technology, 45:1123–1134, 2011
 Copyright © American Association for Aerosol Research
 ISSN: 0278-6826 print / 1521-7388 online
 DOI: 10.1080/02786826.2011.582194



Very Fine and Ultrafine Metals and Ischemic Heart Disease in the California Central Valley 1: 2003–2007

Thomas A. Cahill,^{1,2} David E. Barnes,¹ Nicholas J. Spada,¹ Jonathan A. Lawton,¹ and Thomas M. Cahill³

¹DELTA Group, University of California, Davis, California, USA

²The Health Effects Task Force, Breathe California of Sacramento—Emigrant Trails, Sacramento, California, USA

³Division of Mathematical and Natural Sciences, Arizona State University West Campus, Phoenix, Arizona, USA

The enhancement of mortality associated with cardiovascular and specifically ischemic heart disease (IHD) has been observed in the southern California Central Valley since at least 1990, and it continues to be a major source of mortality. While there is a strong statistical association of IHD with wintertime PM_{2.5} mass, the causal agents are uncertain. Medical studies identify some potential causal agents, such as very fine and ultrafine metals, but they have not been fully characterized in most Central Valley regions. To provide improved information on specific and potentially causal agents, a five site aerosol sampling transect was conducted from Redding to Bakersfield during a 17-day period of strong stagnation, January 5–22, 2009. Mass and elemental components were measured every 3 h in eight particle size modes, ranging from 10 to 0.09 μm , while the ultrafine particles ($<0.09 \mu\text{m}$) were collected on Teflon filters. Ancillary studies were performed including direct upwind–downwind profiles across a heavily traveled secondary street near a stoplight. Very fine and ultrafine iron, nickel, copper, and zinc were identified as vehicular, with the most probable sources being brake drums and pads and the lubrication oil additive zinc thiophosphate. High correlations, many with $r^2 >$

0.9, were found between these vehicular metals and IHD mortality, enhanced by the meteorology, terrain, and traffic patterns of the southern Central Valley. The braking systems of cars and trucks must now be considered along with direct exhaust emissions in estimating the health impacts from traffic.

[Supplementary materials are available for this article. Go to the publisher's online edition of *Aerosol Science and Technology* to view the free supplementary files.]

INTRODUCTION

The task of determining the causal factors that lie behind the statistically sound association of mortality with aerosols continues to labor under severe difficulties. Reliance on Federal Reference Method (FRM) methodologies, even if enhanced by periodic compositional analysis, does not provide enough information to allow health research scientists to identify causal factors (Lippmann 2009). Intensive research studies, which can provide such data, are so expensive as to limit their scope in space and time and thus pose problems with statistical significance. An alternative is to identify regions with persistent and specific health impacts of suspected aerosol origins and then augment monitoring data and special studies to provide a suite of data from which causal factors may be identified. However, other factors such as meteorology, land use, and socioeconomic factors can often weaken the significance (Pope et al. 1995). The California Central Valley, however, is a region of such homogeneity that such efforts there might be fruitful.

The southern part of the California Central Valley, the San Joaquin Valley, is the largest contiguous area of the United States in serious violation of both ozone (summer) and PM_{2.5} (winter) ambient air quality standards. While the summer ozone levels are relatively uniform over the Central Valley, the winter PM₁₀ and PM_{2.5} concentrations vary strongly, from low in the northern Sacramento Valley to high in the southern San Joaquin Valley. During individual winter stagnation episodes, the south to north

Received 7 August 2010; accepted 27 November 2010.

The authors first wish to gratefully acknowledge the support of the Resources Legacy Fund of Sacramento, California, for encouragement and financial support for this study.

The staff of all of the Air Resources Board (ARB) sampling sites were key to successful execution of the project.

The authors also wish to gratefully acknowledge the financial support of the Sacramento Metropolitan Air Quality Management District under its CEO, Larry Greene.

The authors wish to acknowledge the input and oversight of the Health Effects Task Force (HETF) of Breathe California of Sacramento—Emigrant under Jananne Sharpless, Chair; Betty Turner, consultant to the HETF, and especially members Ralph Propper and Earl Withycombe. Helpful suggestions and review were provided by William Wilson, US Environmental Protection Agency (EPA).

Address correspondence to Thomas A. Cahill, DELTA Group, University of California–Davis, One Shields Ave., Davis, CA 95616, USA. E-mail: tacahill@ucdavis.edu

ITEM 11.1.

1124

T. A. CAHILL ET AL.

(Bakersfield to Redding) mass ratio is up to a factor of 8 for PM_{10} , and a factor of 5 for $PM_{2.5}$.

In addition to improving monitoring data, a series of extensive research studies by and through the California Air Resources Board (ARB), such as California Regional Particulate Air Quality Study (CRPAQS 2001), Central Coast Ozone Study (CCOS), and Fresno Asthmatic Children's Environment Study (FACES), were initiated in 1999 through 2001 that greatly added to our knowledge of San Joaquin Valley aerosols. However, most field data were taken before the current understanding of aerosols and cardiovascular impacts was achieved (Devlin 2003, Lippmann 2009) and thus lack some critical measurements, especially ultrafine metals (Chow et al. 2006, 2007, 2008; Chen et al. 2007; Kleeman et al. 2009). One of the major results of these studies is an understanding that most of the $PM_{2.5}$ mass in the winter in the San Joaquin Valley is ammonium nitrate and wood smoke, neither of which are a known cardiovascular threat.

The mortality data in the entire Central Valley are relatively uniform for three of the four major causes of mortality, pulmonary disease, stroke, and cancer, but the 4th and most important, heart attacks from all causes, is higher by about 20% in the central and extreme southern California Central Valley [California Department of Health Services (CA DHS) 2010] and especially in Bakersfield. For one specific and major component of heart disease, ischemic heart disease (IHD), the incidence rises to about 35% (CA DHS 2010). In this research, we have measured some of the components of aerosols found by recent health studies most likely to be causal factors in this statistically strong association to cardiovascular disease, namely very fine and ultrafine metals, and size and compositionally-resolved organics (Cahill 2010), over the entire Central Valley, with the goal to enhance data from the earlier studies and provide additional material for future epidemiological analyses.

EXPERIMENTAL METHODS

Study Region Geography and Climatology

The Central Valley of California (Figure 1) has remarkable uniformity in terrain and meteorology. It is one of the richest agricultural areas in the world, with two major metropolitan areas, the Sacramento–Stockton and Fresno, with smaller cities of a few 100,000 to small towns spread throughout the Valley. The Valley is a major transportation corridor for road and rail traffic but generally lacks strong industrial sources. There are active areas of oil extraction near and north of Bakersfield. The Central Valley offers an ideal situation to examine the effects of pollutants on health since many potential confounding factors, such as meteorology, land use patterns, socio-economic factors, and cigarette smoking, are very similar throughout the Valley (Cahill et al. 1998; note that the values in that report are slightly different in the present report since we have now available CORE Report #2 (1996), while the original report used CORE Report #1 (1994)).



FIG. 1. Map of the Central Valley of California. The northern part is referred to as the Sacramento Valley while the southern part is called the San Joaquin Valley. The areas within the dotted circumference vary in altitude from almost sea level in the Delta to a few hundred feet in elevation. The small arrows denote the typical winter wind patterns (Hayes et al. 1984). The cities marked were used in this study.

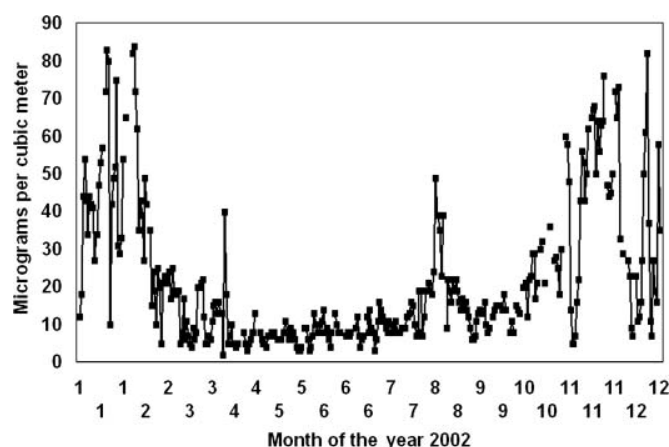
In summer, high temperatures in the Valley (mean daily high, July, $36^{\circ}\text{C} \pm 1^{\circ}\text{C}$) lower the surface pressure and draw massive inputs of marine air into the Valley from the San Francisco Bay, bringing with it oceanic aerosols and typical urban pollutants enhanced by the major petrochemical industrial sites at the Carquinez Strait, between Sacramento and San Francisco. These winds often funnel south down the entire San Joaquin Valley, south of the strait, but less often funnel north up the entire Sacramento Valley, north of the strait. Rainfall in the Valley is rare during the period from May through October (Hayes et al. 1984).

In winter, the Central Valley air basin tends to become stagnant due to its flat valley floor and circumferential mountains, except at the Straits (Figure 1). There is slow drainage of cold air from the Sierra Nevada Mountains each night to the Valley floor (mean daily low, January, $3^{\circ}\text{C} \pm 1^{\circ}\text{C}$). The air drains slowly, at the rate of about 50 km/day, from both the northern and southern ends of the valley towards the lowest point, the Sacramento–San Joaquin Delta, southwest of Sacramento and directly east of the Carquinez Strait. This pattern results in persistent stagnation episodes that are periodically interrupted by synoptic storms.

Typical Pollution Patterns

The annual pattern of $PM_{2.5}$ mass reflects the effects of the winter stagnation, with elevated levels from about November through February (Figure 2). All valley sites have similar annual

ITEM 11.1.

FIG. 2. Annual pattern of PM_{2.5} mass as seen at Fresno.

patterns, high in winter and low in summer. The PM_{2.5} peak seen in August was from a forest fire in Oregon. While the southern reaches of the Central Valley have serious violations of federal and state mass standards (ADAM 2010), other parts of the valley that share agriculturally based land uses and meteorology do not exhibit serious violations of these standards. For PM₁₀ mass, the ratio from Bakersfield in the south to Redding in the north can be as high as a factor of 9 in winter stagnation events, while for PM_{2.5}, the ratio can be as high as a factor of 5 (ADAM 2010). The pattern of winter air movement makes the high aerosol mass levels at Bakersfield difficult to explain, since the nighttime airflow into Bakersfield is from the mountains to the south, southeast, and east of the city. There is essentially no influence from the Los Angeles basin due to the blocking mountains. The air at Bakersfield then flows slowly north towards Fresno, which has generally lower PM_{2.5} mass levels despite greater population and industry.

Epidemiological Data

Greatly improved data on mortality and morbidity became available circa 2001 from the California Department of Health Services (CA DHS 2010), which allow detailed analyses of death by hundreds of cause on an annual basis. These data show a persistent enhancement, 2003–2007, of IHD mortality of roughly 50% in the central region and at Bakersfield, at the extreme southern edge of the San Joaquin Valley, as compared with the northern valley (Figure 3).

Aerosol Sampling Methods

Aerosol samples were collected along a transect in the Central Valley to investigate the causal factors behind the increased mortality due to IHD in the Central Valley of California. Since routine air quality measurements were available in this region, we collected and analyzed aerosols not routinely measured by existing monitoring programs that were known or suspected to be causal factors in cardiovascular disease. Further, we selected a period of stagnation that maximizes winter particulate mass

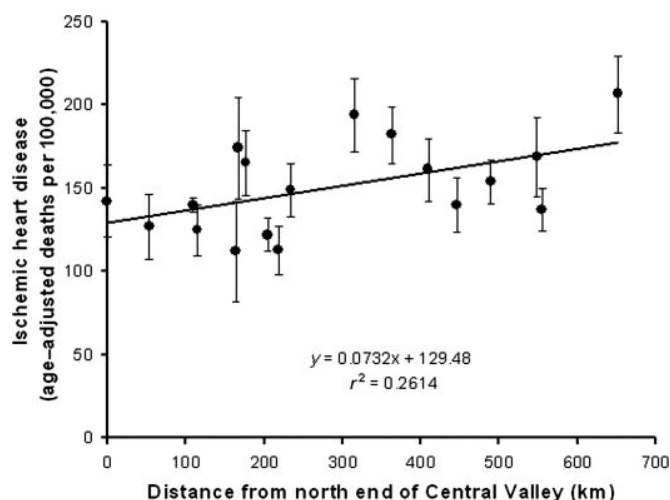


FIG. 3. IHD in the Central Valley of California, 2003–2007. Distances span from Redding in the north (0 km) through Chico (170 km), Sacramento (220 km), Fresno (400 km) to Bakersfield (680 km).

concentrations, avoiding the synoptic fronts and rain that periodically clean out the valley in winter. Using meteorological predictions, we simultaneously sampled continuously by size, time, and composition for 17 days starting on Jan 5, 2009, at five sites from the extreme north, Redding, to the extreme south, Bakersfield.

Rotating drum impactors (DELTA Group 8 DRUMs; Cahill et al. 1985; Raabe et al. 1988) were used at all sites to provide continuous samples capable of 3-h data in eight impaction size modes from 10 to 0.09 μm diameter plus an integrating Teflon after filter. The impaction samples were collected onto Apiezon-L greased Mylar stages (Wesolowski et al. 1977). Analyses were made for mass and elements from aluminum to molybdenum plus lead by synchrotron-induced x-ray fluorescence (Bench et al. 2002). The quality assurance validations, including a year-long inter-method comparison to ARB's FRM particular samplers, are summarized in the supplemental information. For the ARB side-by-side over the entire year, agreement for PM_{2.5} mass was better than $\pm 10\%$, DRUM versus FRM, with the winter agreement much better than that, a few percent, probably because of higher winter mass values. Note that 49 individual mass values from a DRUM with 3-h time resolution and 6 sub-2.5- μm size cuts plus a $<0.09 \mu\text{m}$ after-filter were required to match a single 24-h PM_{2.5} mass value.

Aerosols destined for organic analyses were likewise collected with DRUM samplers at the same time and locations as the elemental samplers. However, the organic samples were analyzed averaging over the entire 17-day study, and the aerosols were collected onto fired aluminum substrates (Cahill 2010).

The study included three components, all conducted in winter conditions and using the same equipment, including integrating ultrafine Teflon filters: (1) an initial year-long study of the DRUM sampler side-by-side with the ARB's FRM at the

ITEM 11.1.

1126

T. A. CAHILL ET AL.

Sacramento test site at 13th and T Street to establish equivalency of the sampling and analysis (Cahill and Barnes 2009), (2) a simultaneous transect across a heavily traveled secondary street to identify very fine and ultrafine aerosols from roadways, and (3) the main transect study in winter, 2009. Summaries of these studies are included in supplemental information.

For the transect study, samples were collected at five existing ARB and district monitoring sites covering the entire Central Valley (Figure 1):

Redding (roof of Health Department),
Chico (ARB Manzanita Avenue site),
Sacramento (ARB 13th and T Street site),
Fresno (ARB First Street site), and
Bakersfield (ARB California Street site).

Paired UC Davis DELTA Group 8 DRUM samplers were used at all sites except Sacramento, which had to use a PM_{2.5} 3 DRUM for lack of equipment. One 8 DRUM was used at each site for mass and elements (3-h time resolution), sampling onto lightly greased Mylar, and the other for organic matter (17-day average), sampling onto fired aluminum foils. All included identical Teflon ultrafine filters that integrated the entire 17-day period. The parameters measured at all sites include but are not limited to

1. time-averaged ultrafine particulate elemental composition, Al to Mo, plus lead, and mass, $0.09 > D_p > 0.0 \mu\text{m}$ aerodynamic diameter,
2. time-dependent (3 h) mass and elements (see above) for the eight particle sizes 10.0–5.0, 2.5, 1.15, 0.75, 0.56, 0.34, 0.26–0.09 μm aerodynamic diameter,
3. time-averaged organic matter by size, 10.0–5.0, 2.5, 1.15, 0.75, 0.56, 0.34, 0.26–0.09 and $<0.09 \mu\text{m}$ diameter, including polycyclic aromatic hydrocarbons (PAHs), sugars (including levoglucosan), fatty acids, and *n*-alkanes have been published (Cahill 2010).

RESULTS

Meteorology

After the sites were selected, deployment was delayed until weather predictions indicated at least a 10-day period of low winds and stagnation, conditions that produce the highest PM_{2.5} mass. The prediction was accurate and the meteorology was favorable and allowed us to extend the study to a 17-day period characterized by high mass values and persistent hazes (Table 1).

Aerosol Mass Values

PM₁₀ mass values were available at all sites on January 19, while all sites except Redding had daily PM_{2.5} mass values collected by the ARB and local agencies (ADAM 2010). The PM_{2.5} values were averaged over the entire 17-day study period

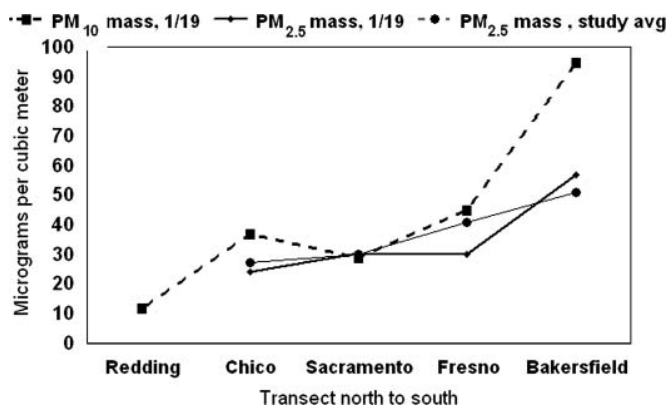


FIG. 4. PM_{2.5} mass values were available every day, but only January 19th had PM₁₀ mass at all valley sites. The high PM₁₀ to PM_{2.5} ratio on January 19 is unusual and unexplained.

and were typical of prior winter stagnation events (Table 2 and Figure 4). Looking in more detail, we can see that the north to south increase in average PM_{2.5} mass is driven not as much by the increase in mass on a given day but the number of days that saw the high mass values.

Aerosol monitoring by state and local agencies with compositional data for PM_{2.5} aerosols was only available at the Fresno site via the IMPROVE sampler (Malm et al. 1994). The evolution of the aerosol event is shown in Figure 6, showing that the study period would represent a winter day in violation of the PM_{2.5} mass standard. The important role ammonium nitrate plays during these aerosol episodes is clearly indicated.

Size-Resolved Mass and Inorganic Aerosols

For the period from January 5 through 22, over 6400 measurements were made of mass and inorganic elements in nine size modes, measured every 3 h except for the integrating ultrafine filters. In addition, a simultaneous study (Cahill 2010) measured organic aerosols in four classes (alkanes, PAHs,

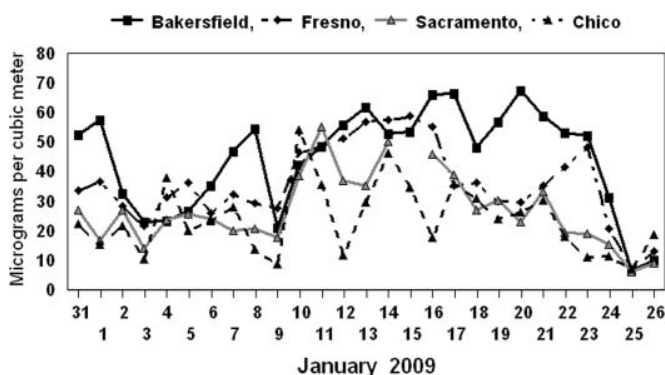


FIG. 5. PM_{2.5} mass values before, during, and after the study period of January 5–22, 2009.

ITEM 11.1.

TABLE 1

Summary of meteorological parameters during sample collection period of January 5–22, 2009. The values reported are the average over the entire aerosol sampling period except for rainfall, which includes the rain on the days of setup and take down, January 5 and 22

Parameter	Redding	Chico	Sacramento	Fresno	Bakersfield
Average temperature (°C)	11.3	9.6	9.0	9.4	10.6
Average high (°C)	19.3	15.5	16.1	15.4	16.5
Average low (°C)	3.0	3.7	1.7	3.2	4.4
Relative humidity (%)	56.4	71.6	73.4	71.8	66.4
Average wind speed (m/s)	1.92	1.27	0.47	0.62	1.17
Rain (cm)	1.2	2.2	2.5	1.2	0.1
Number of rain events	4	3	3	2	2
Number of fog events	0	2	11	2	2
Average visibility (km)	14.6	12.3	7.1	6.9	6.6

sugars, and organic acids) in nine size modes at all sites. In this article, we focus on those particles that have the best support from the health literature as having the potential for causing or exacerbating IHD. Thus, we focus on only those insoluble particles in the very fine (0.26–0.09 μm) and ultrafine (<0.09 μm) modes that are able to penetrate deeply into the lung and pass into the cardiovascular system. However, before we focus on these particles, we need to examine the overall aerosol behavior important to eventually isolate the sources of these particles.

Using the well-studied Fresno site, we can see that the size distribution roughly matches expectations with a few differences (Figure 7). In Figure 7, three points stand out. First, the DRUM sampler with its coated substrates operated well, with negligible soil mass penetrating into the accumulation mode as shown by the calcium results. Second, there is a distinct deviation in the size profile of iron, which shows an enhancement in the 1.15–2.5 μm size mode not seen in other soil elements. Third, potassium becomes enhanced in the finest modes, clearly from non-soil sources. It is also much finer in size than typical wood smoke, which almost always peaks in the 0.34–0.75 μm mode.

Examining the non-soil iron anomaly (Figure 8), the size and 3-h time data show enhancement in the 2.5–1.15 μm mode each night not seen in other soil elements and not seen at any other valley site. The very fine iron often tracks the fine iron, but sharp deviations occur, indicating complex source behavior.

Bakersfield lacks time information due to a system failure, and thus its behavior in time is unknown.

Further insight on zinc in Fresno can be obtained by examining zinc over most of a year (Cahill et al. 2003). The persistent presence of very fine zinc occurs throughout the entire year and becomes dominant in wintertime, closely associated with other vehicular aerosols. The zinc to very fine mass ratio was close to that seen in laboratory diesel tests (Zielinska et al. 2003).

Data on Very Fine and Ultrafine Aerosols

Very fine aerosols were collected on DRUM stage 8, 0.26 to 0.09 μm , and integrated over the 17-day study period to match the integrating ultrafine filters. Ultrafine aerosols were collected on the same 47-mm Teflon filters as the organic samples and averaged over the same 17-day period. The filters were analyzed by scans of S-XRF every 0.5 mm across the filter diameter. All filters were uniform except for Chico, which had contamination on one edge. This was easily avoided by modifying the averaging program. Two different averages were generated: one by summing the spectra, then analyzing and the other by averaging the typical eighteen individual elemental results.

In Table 3a, we show a summary time averaged DRUM very fine data and, in Table 3b, the integrated ultrafine filter data for the study period.

TABLE 2

Mass values for PM_{10} on January 19 and $\text{PM}_{2.5}$ averaged from January 5 through January 22, 2009. The value of ~ 9 for $\text{PM}_{2.5}$ is estimated assuming the same $\text{PM}_{10}/\text{PM}_{2.5}$ ratio as the other cities

Site	Redding	Chico	Sacramento	Fresno	Bakersfield
Size (μm)	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}
Mass (1/19) ($\mu\text{g}/\text{m}^3$)	12	37	29	46	95
Size (μm)	$\text{PM}_{2.5}$	$\text{PM}_{2.5}$	$\text{PM}_{2.5}$	$\text{PM}_{2.5}$	$\text{PM}_{2.5}$
Mass average ($\mu\text{g}/\text{m}^3$)	~ 9	27.3	30.2	40.9	51.0

ITEM 11.1.

1128

T. A. CAHILL ET AL.

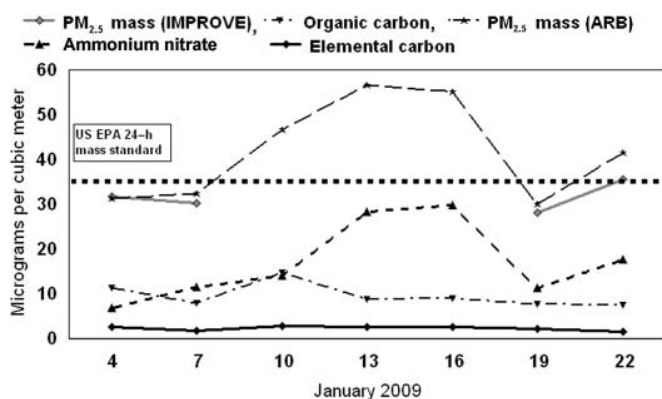


FIG. 6. IMPROVE and ARB $PM_{2.5}$ data at the Fresno site during the study. Note the dominance of ammonium nitrate in the mass maxima.

The values in bold represent vehicular sources identified in the next section of this article. The copper ultrafine values are suspect from contamination by copper containing filter holders. K_{non} is non-soil potassium, corrected by the Calcium content, and a standard IMPROVE tracer of wood smoke (Malm et al. 1994). MDL is minimum detectable limit. Uncertainties are nominally $\pm 5\%$, and detailed quality assurance and uncertainties are in the supplemental information.

The correlations of sulfur (ammonium sulfate) and selenium are driven by the oil extraction and refining near Bakersfield (Figure 10). But there are strong associations between many metals and IHD in both the very fine and ultrafine modes. Although mass levels in the very fine and ultrafine modes are low, the concentration of metals was significant. Thus metals are a major contributor to particle numbers, many presumably in insoluble compounds. Examining spatial trends for very fine metals with known vehicular origins, we see at Bakersfield a clear north to south enhancement of many very fine metals that far exceeds the $\times 1.6$ increase in $PM_{2.5}$ mass for the same period (Figure 9).

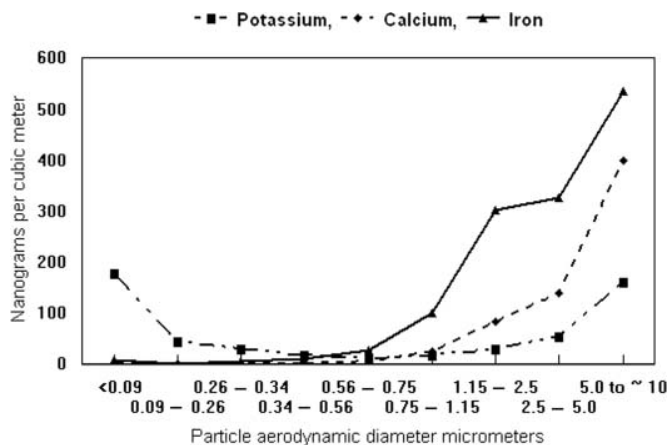


FIG. 7. Size distribution for Fresno aerosols.

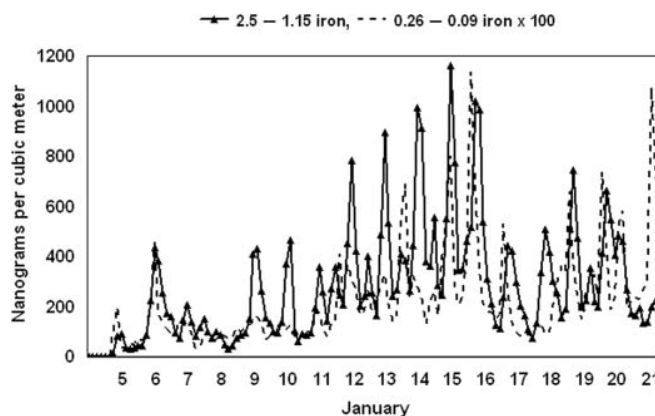


FIG. 8. Fine and very fine nonsoil iron at Fresno. Recall that the study began directly after a rainfall event and had almost no winds to stir up dust. Thus we propose that most of the iron is roadway and vehicle derived.

The upward trend of sulfur must be interpreted in accord with the meteorology, which moves air from Bakersfield towards the Delta. Typical elements associated with vehicles include non-soil iron, phosphorus, zinc, nickel, and copper. From the ratio present in the zinc thiophosphate in lubricating oil, there are clearly additional zinc sources present at all sites except perhaps Bakersfield.

In summary, there are significant contributions of metals in the very fine and ultrafine mode, many of which rise to their highest levels at Bakersfield (Figures 11 and 12) and correlate strongly with the IHD mortality data.

DISCUSSION

Sources of the Metals

The generation of metals in the ultrafine mode requires high temperatures and/or pressures. Thus, many sources of metals from vehicles, such as zinc from tire wear, are not candidates for sources of ultrafine aerosols. Two potential sources are engines, and especially diesel engines because of the high temperatures and pressures involved, and the braking systems in vehicles.

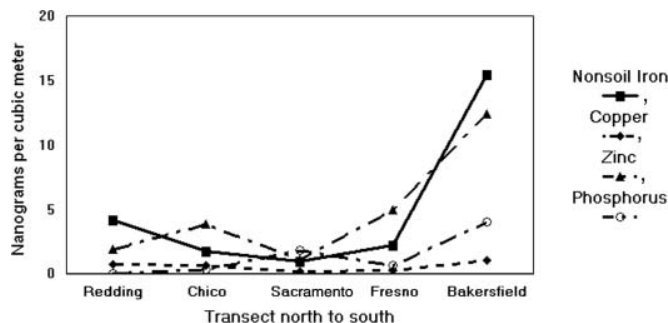


FIG. 9. Very fine transition metals with known vehicular sources, zinc and phosphorus from zinc thiophosphate in lubricating oil, iron, copper, and zinc potentially from braking systems.

ITEM 11.1.

METALS AND ISCHEMIC HEART DISEASE 1

1129

TABLE 3a

Aerosol mass data from the study and their correlation to IHD mortality. Uncertainties are nominally $\pm 5\%$, and detailed quality assurance and uncertainties are in the supporting materials. Concentration (ng/m^3) of very fine (0.09 to $0.26 \mu\text{m}$) aerosols

Site	Redding	Chico	Sacramento	Fresno	Bakersfield	Correlation r^2 to IHD
Ammonium sulfate	45	82	75	120	580	0.98
Chlorine	<0.4	2.5	1.8	0.7	2.6	0.22
Phosphorus	<0.1	0.4	0.8	0.7	4.0	0.98
Potassium (non-soil)	18.0	54.1	10.9	45	32.7	0.00
Vanadium	<0.1	0.03	0.04	0.2	<0.1	0.04
Chromium	<0.1	0.01	0.01	0.6	0.2	0.04
Iron (non-soil)	2.2	1.8	1.0	2.3	15.5	0.95
Nickel	<0.03	0.03	0.07	0.05	0.16	0.95
Copper	0.7	0.6	0.16	0.27	1.1	0.47
Zinc	1.9	3.9	1.1	4.9	12.5	0.88
Arsenic	0.15	0.2	0.07	0.54	1.07	0.87
Selenium	<0.1	<0.1	0.09	0.10	0.24	0.95
Bromine	0.5	0.7	1.3	1.1	4.2	0.98
Lead	0.1	0.4	0.4	0.55	2.0	0.97

While there is considerable information on the total particulate emissions from vehicles, the information on ultrafine metals from vehicular exhaust is limited (Kleeman et al. 2000; Zielinska et al. 2003, 2004). The Zielinska et al.'s (2003) study involved detailed analysis of diesel exhaust. As part of the study, we analyzed for 32 elements collected in 11 tests with a 14-stage nano-MOUDI (lowest stage $0.01 \mu\text{m}$). Sulfur, phosphorus and the metals zinc, calcium, and, in one of the 11 tests, lead, all peaked generally in the 0.10 – $0.056 \mu\text{m}$ modes (Zielinska et al. 2003). In addition to elemental and organic carbon, the tracer elements were assigned to sources: sulfur was from the fuel

(CA low sulfur), the zinc and phosphorus from the zinc thio-phosphate stabilizer in the lubricating oil, and calcium from an antacid additive. No other transition metals were seen in statistically significant amounts.

A second potential source of very fine and ultrafine metals is the braking systems of cars and trucks, since high temperatures and/or pressures are involved in this process. The brake drums have evolved from the massive, heat-conductive structures and generally well cooled in the past and now are often made of "grey iron," roughly 90% iron with the admixture of a few percent carbon, plus copper, silicon, and other metals in

TABLE 3b
Concentration (ng/m^3) of ultrafine ($<0.09 \mu\text{m}$) aerosols

Site	Redding	Chico	Sacramento	Fresno	Bakersfield	Correlation r^2 to IHD
Ammonium sulfate	122	215	270	470	999	0.95
Chlorine	2.5	5.1	0.6	3.0	0.5	–0.38
Phosphorus	1.3	0.6	4.0	3.3	10.5	0.96
Potassium (non-soil)	40.7	138.1	76.9	176.1	70.9	–0.05
Vanadium	0.05	0.15	0.10	0.21	0.02	0.00
Chromium	0.13	0.04	0.75	0.28	0.32	0.03
Iron (non-soil)	3.9	3.9	14.3	7.7	27.7	0.88
Nickel	0.9	0.1	0.6	0.3	1.6	0.70
Copper	na	na	na	na	na	na
Zinc	8.6	11.2	14.3	22.4	12.3	0.00
Arsenic	0.41	0.64	1.1	2.6	1.5	0.12
Selenium	0.47	0.64	0.62	1.1	0.9	0.05
Bromine	11.2	12.4	13.7	25.3	18.9	0.16
Lead	1.7	2.2	2.5	3.6	2.6	0.06

na: not available.

ITEM 11.1.

1130

T. A. CAHILL ET AL.

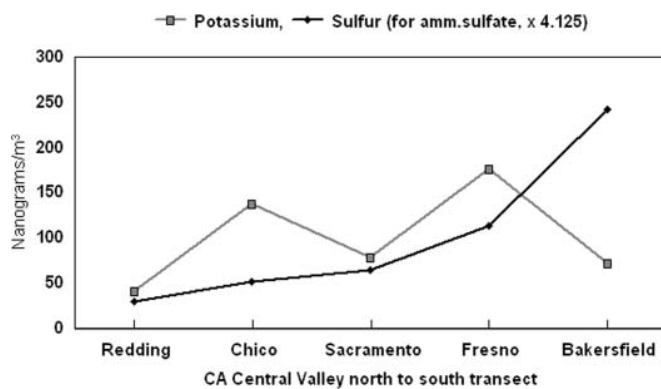


FIG. 10. Ultrafine potassium and sulfur.

smaller amounts, making them like brake pads an erodible surface. Brake pads are far more complex in composition and are traditionally designed to erode.

Limited information is available on a complete inventory of vehicular expendables. An early one was developed as a part of the extensive California freeway lead and particulate studies in the 1970s. In Cahill and Feeney (1973), the UC Davis vehicle fleet was studied for all forms of expendables, including fuel, oil, brake wear, exhaust train erosion, tires, etc., by directly measuring mass loss at replacement intervals. While many of the results are uncertain due to technological changes in the fuels and engines, measurements of brake drums and brake pads gave ~5 and 108 gm, respectively, at a replacement cycle of 58,400 km, or <1 and 15 mg/km. However, these data were based on asbestos-containing brake pads and may not be reliable, which also impacts the US Environmental Protection Agency (EPA) PART5 model estimate of 20.6 mg/km, based on 1985 data. In terms of brake drums, changes in brake drums from iron to "grey iron" containing graphite could materially increase that source of particles from prior values. Even with the uncertainties, it is clear that brakes contribute a significant component of typical vehicle total emission rates. However, averages are misleading because braking is only used for limited times. Thus the emission rates at stoplights and especially extensive mountain

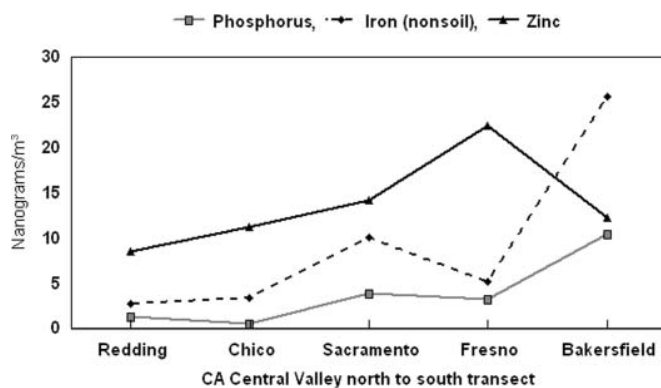


FIG. 11. Typical vehicular ultrafine metals.

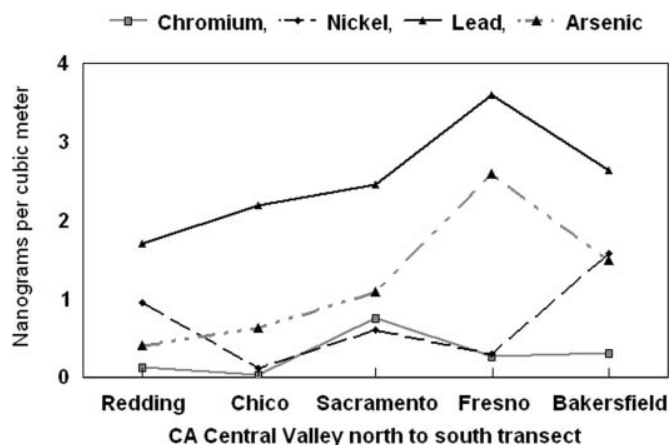


FIG. 12. Additional ultrafine elements.

down grades will be much higher than these values. It is worth noting that traditional dynamometer studies and roadside side studies near freeways are likely to miss brake wear as an emission source, thus these emissions may be largely unrecognized by the majority of vehicle emission and assessment studies.

Information on brake pad composition was reviewed by Kennedy et al. (2002) and Chan and Stachowiak (2004). The latter report, "A multitude of different brake pads have sprung onto the market in the post-asbestos brake pad revolution, each with their own unique composition," often proprietary. Brake pads comprise four subcomponents: (1) frictional additives, abrasives, and lubricants; (2) fillers; (3) a binder; and (4) reinforcing fibers for strength. The brake pads are described as metallic, semimetallic, with organic components, and organic. Asbestos to be used mainly as a reinforcing fiber in brake pads, and after its removal, a variety of materials have been used, including iron fibers. Some of them include potentially hazardous materials potassium titanate and sepiolite, a magnesium-silicon compound, both of which have potential health hazards. Organic aramid fibers (e.g., Kevlar) and ceramics such as alumina and carbides are becoming more popular as prices decline. Fillers include a wide variety of organic (cashew hulls, old tires) and inorganic materials (barium sulfate is popular). The frictional components include graphite and metal sulfides including copper, antimony, tin, zirconium, and lead. Copper in particular has been identified as a problem in aquatic systems, and legislation to remove it from brake pads has been passed in the states of Washington and California.

While there is enormous variability in the data, as shown by the percentile distributions, the four main elements are iron, copper, zinc, and nickel (Table 4). In summary, there is a wide variety of very fine and ultrafine metals that may arise from brake drums and pads, but iron and copper are clearly two major components.

Information on ambient and near source very fine and ultrafine metals was derived from two additional studies in Sacramento. The first was a complete analysis of ultrafine (<0.09 μm)

ITEM 11.1.

TABLE 4

Summary of concentrations of elements in New Zealand brake pads, from largest to smallest concentrations of transition metals plus heavier elements. The distributions are shown to emphasize with wide variability between manufacturers

Element (ppm)	10th percentile	Median	90th percentile
Iron	11,700	18,300	190,000
Copper	29	5000*	116,000
Zinc	127	1630	37,400
Nickel	44	342	652
Manganese	143	315	1088
Lead	6	50	949
Barium	558	3195	6144

*Preferred interim median for copper due to high variability. Barium (median = 3100 ppm) was not resolved in our data due to interferences.

aerosols over a 2-week period, November–December, 2007, as part of an 8-month DRUM to FRM intercomparison with the California ARB in central Sacramento at the 13th and T Street ARB site (Cahill and Barnes 2009, supplementary materials), and the second was a 2007 study directly measuring aerosols across a heavily traveled (65,000 v/day, 1.5% diesels) secondary street in Sacramento, Watt Avenue (Cahill et al. 2007, supplementary materials).

One period in the Sacramento ARB intercomparison in November and December was chosen for mass closure through addition of surrogate organic measurements (Cahill et al. 1989; Malm et al. 1994). As anticipated, most of the ultrafine mass is organic (Table 5). Note also that the only nondetermined major species, nitrate, could not have been a major factor in Sacramento or the agreement would not have been as robust. Farther south in the San Joaquin Valley, nitrates are always a major factor. The presence of the fine transition metals in these quantities represents a very large number of particles. Note that the zinc value seen in Sacramento in 2007, 11.5 ng/m³, is similar to the transect zinc value in 2009, 14 ng/m³.

The second study was performed at Watt Avenue, the site of several studies on the impact of Watt Avenue on Arden Middle School (Cahill et al. 2007, supplementary materials). The Watt Avenue study utilized the same sampler as the ARB study, with two identical eight stage DRUM samplers with greased Mylar substrates and a 47-mm stretched Teflon after filter for the <0.09 μ m ultrafine mode. The school sampler was 15 m downwind from the nearest traffic lane on the roof of the one story building and 50 m south of a stoplight on Arden Way that backed traffic up to and south of the Arden Middle School site. Thus considerable braking occurred directly upwind of the Arden Middle School sampler. The far upwind sampler was 500 m away in a residential neighborhood. Samples were collected continuously

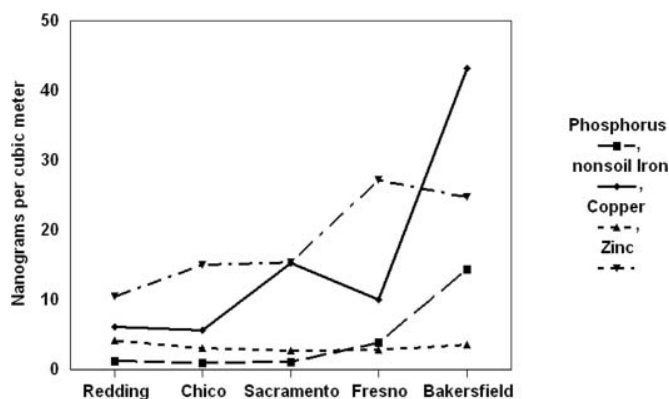


FIG. 13. Very fine plus ultrafine aerosols with known vehicular sources.

over 8 weeks in February and March, 2007. The results of these studies are shown in Table 5.

Through the direct upwind downwind measurements across Watt Avenue, the source of the metals seen in downtown Sacramento can also be shown to be largely derived from traffic sources despite the fact that the nearest freeway to the 13th and T Street site is over 1 km away.

Almost identical values of the same four elements are seen in Sacramento and especially in Bakersfield (Table 6 and Figure 13).

Since the ultrafine four elements, non-soil iron, nickel, copper, and zinc, and a few others, are traffic related, we can examine the mass levels in the Central Valley to see how the levels correspond to traffic. Since the wind flows downslope across Bakersfield from the south, where I-5 descends from the Grapevine and Hwy 58 descends from Tehachapi Pass, we used the sum of the cars plus 10 times the trucks, to roughly match to emission rates, and compared the ratio of traffic to PM_{2.5} at the ends of the Valley and across the Chico and Fresno lateral transects for I-5 plus Hwy. 99. For the valley ends, the traffic ratio was 4.6 and the aerosol ratio 4.4, while for the central lateral transect, traffic was 2.1 and the aerosol was 1.4. Therefore the PM_{2.5} mass values in the study were similar to the local traffic volumes, and the ultrafine metals at Bakersfield are from the two major highways south of Bakersfield climbing and descending the mountain passes.

Support for this hypothesis comes from historical data taken in Bakersfield in winter, 1974–1976 (Cahill and Flocchini 1974; Flocchini et al. 1976). The historical data show that particulate pollution from cars was high in Bakersfield in the 1970s data. Lead levels at Bakersfield, population circa 75,000 in 1975, in the average winter period were higher on average than in parts of the Los Angeles urban area. This is a clear indication that the local meteorology and geographical setting of Bakersfield results in it being highly impacted by vehicular sources, most likely vehicles on I-5 and Hwy 58 as they climb out of or descend into the valley.

ITEM 11.1.

1132

T. A. CAHILL ET AL.

TABLE 5

Measured and reconstructed ultrafine mass and elemental components in two studies in Sacramento, 2007. Watt 0.5 km is 500 m upwind; Watt 15 m is downwind. Sac Center is the ARB 13th and T Street site. There are no elemental carbon data or nitrate data, so the reconstructed mass is incomplete

	Watt ave. upwind (~ 0.5 km)	Watt ave. downwind (15 m)	Sacramento center
Major components	$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$
Mass (gravimetric)	Na	Na	2.04
Mass (recon.)	Na	Na	2.15
Organics (H)	Na	na	1.72
Sulfur (ammonium sulfate)	0.09	0.18	0.34
Chlorine (NaCl)	0.00	0.00	0.04
Soil	0.04	0.08	0.048
K non-soil (wood smoke)	0.04	0.14	0.053
Metals	0.01	0.09	0.035
Minor components	ng/m^3	ng/m^3	ng/m^3
Phosphorus	1.1	1.0	2.4
Vanadium	0.06	0.18	0.15
Chromium	2.2	1.3	0.45
Iron (non-soil)	5.2	34.9	17.0
Nickel	0.3	16.3	3.5
Copper	0.1	9.8	8.3
Zinc	1.2	17.3	11.5
Arsenic	0.16	0.46	0.6
Selenium	0.10	0.13	0.3
Bromine	0.8	1.1	3.7
Lead	0.5	2.3	4

Examining the current IHD mortality data from Figure 3, we observed that if we remove a totally arbitrary average background IHD mortality rate of 120 from the total rate (about 2/3 of the valley average rate), and matching the Bakersfield result, the excess IHD mortality roughly scales with local truck traffic on the major freeways (CalTrans 2010) and the very fine–ultrafine iron (Figure 14).

The pattern reflects the pattern that the two major north–south freeways, I-5 and Hwy 99, come close to each other only

at Sacramento–Stockton and Bakersfield. Note that car traffic has a very different pattern because of the large automobile traffic on local Sacramento highways. When ultrafine aerosols alone are correlated with IHD mortality for the entire Central Valley, the highest correlations are for phosphorus ($r^2 = 0.96$) and iron ($r^2 = 0.88$), both with known vehicular sources.

The association of IHD with toxic organic contaminants, specifically benzo[a]pyrene (BaP) and coronene (Cahill 2010),

TABLE 6
Very fine and ultrafine metals with known vehicular sources

Site	Redding	Chico	Sacramento	Fresno	Bakersfield
Class	Very fine + ultrafine	Very fine + ultrafine	Very fine + ultrafine	Very fine + ultrafine	Very fine + ultrafine
Size	0.26–0 μm	0.26–0 μm	0.26–0 μm	0.26–0 μm	0.26–0 μm
Species					
Phosphorus	1.3	1.0	1.2	4.0	14.5
Iron	6.1	5.7	15.3	10.0	43.2
Nickel	0.9	0.13	0.67	0.35	1.8
Copper	4.2	3.1	2.8	2.9	3.6
Zinc	10.5	15.1	15.4	27.3	24.8

ITEM 11.1.

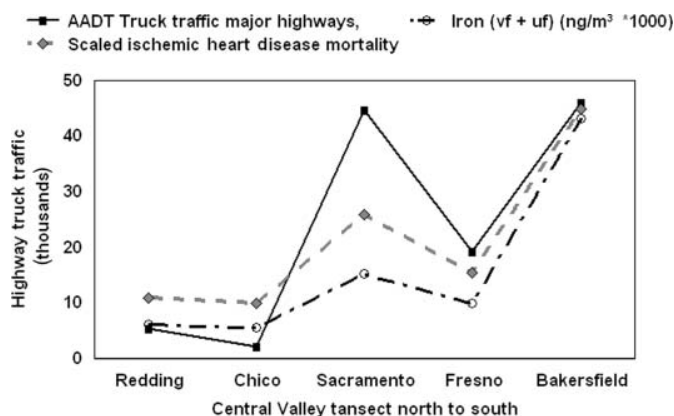


FIG. 14. Association between local average annual daily truck (AADT) traffic on major freeways, scaled ischemic heart disease, and very fine plus ultrafine iron.

was examined but the pattern did not produce a fit to the IHD increase (Figure 15). The relatively high values of BaP at Chico in winter, observed for years in prior CARB toxics data reported in the ADAM database (ARB ADAM 2010), was traced to the burning of primarily pine wood.

Coronene is normally associated with the exhaust of automobiles, while BaP has known vehicular sources (diesels and cars) as well as wood smoke (Fujita et al. 2007; Riddle et al. 2007; Kleeman et al. 2009; Cahill 2010). The non-soil, nonwood smoke potassium was also observed by Gertler et al. (2003) in the Tuscarora Tunnel studies from light duty vehicles, but not from diesels. Thus, there appears to be a spark emission source of potassium and coronene in the very fine/ultrafine. A south valley enhancement was also seen in petroleum derived alkanes (Cahill 2010), which were present in the largest amounts in Fresno, lesser amounts in Bakersfield, and negligible elsewhere. In summary, it does not appear that organic aerosols from wood smoke, diesels, and automobiles are a component in the IHD excess.

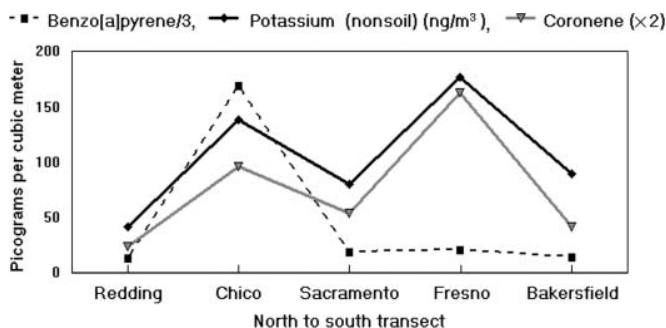


FIG. 15. Comparison of ultrafine BaP, potassium, and coronene.

CONCLUSIONS

Persistent enhancement of mortality associated with cardiovascular and specifically IHD has been observed in the southern San Joaquin Valley since 1990, yet while there is a strong statistical association with mass, most of the mass is known to be relatively innocuous to the cardiovascular system. Most of the mass is ammonium nitrate, which is soluble in lung fluid. This makes ammonium nitrate unlikely as a source of cardiovascular disease. In order to examine potential causal agents, a profile was made of mass, inorganic, and organic components of mass in nine size modes, including ultrafines $<0.09 \mu\text{m}$, at five sites from Redding to Bakersfield during a 3-week period of strong stagnation, January 5–22, 2009. The strongest correlations to IHD mortality were found in very fine ($0.26\text{--}0.09 \mu\text{m}$) to ultrafine metals, with most tied to vehicular sources. This result is supported by several independent lines of reasoning. First, there is an association with truck traffic and IHD throughout the Valley. Second, the four key transition elements, non-soil iron, nickel, copper, and zinc, are closely tied to vehicular sources through upwind–downwind measurements at Watt Avenue, a secondary artery in suburban Sacramento. Third, the same four elements are found at the downtown ARB 13th and T Street site. Fourth, there are known diesel sources of zinc and phosphorus, from zinc thiophosphate in lubricating oil, plus calcium as an antacid. No iron, nickel, or copper were seen in the diesel dynamometer tests, so these elements are not coming from engine wear. Conversely, brake pads include many elements, including iron, nickel, copper, and zinc. The Watt Avenue data were taken just south of a stoplight, so braking was occurring. Heavy braking also occurs on the I-5 “Grapevine” and Highway 58 downgrades, each more than a 1000 m descent, and both carry heavy truck traffic into Bakersfield, where the same elements are seen again correlating with increased rates of IHD.

Thus, in summary, we present here evidence that, while not conclusive, strongly supports the hypothesis that very fine and ultrafine transition metals are a causal factor in IHD in the Central Valley of California. Removal of zinc thiophosphate from lubricating oil could greatly reduce the zinc concentration, while changes in brake drums and pads could reduce the non-soil iron, copper, zinc, and nickel concentrations in ambient air. After a 15-year fight that surfaced with concerns about the San Francisco Bay, on October 5, 2010, Governor Arnold Schwarzenegger signed SB346, which requires brake pad manufacturers to reduce the use of copper to not more than 5% by 2021 and no more than 0.5% by 2025. The reasons were based on the toxicity of copper in water run-off from roads and follows similar action by Washington State.

Finally, it is clear that the lack of correlation between $\text{PM}_{2.5}$ (or $\text{PM}_{1.0}$) composition and very fine and ultrafine aerosol composition makes measurements of the composition of very fine and ultrafine particles critical for obtaining causal relations to health impacts, both for organic and inorganic species.

ITEM 11.1.

1134

T. A. CAHILL ET AL.

REFERENCES

- ADAM. (2010). *California Environmental Protection Agency—Air Resources Board*. Retrieved from <http://www.arb.ca.gov/ADAM>
- Bench, G., Grant, P., Ueda, D., Cliff, S., Perry, K., and Cahill, T. A. (2002). The Use of STIM and PESA to Measure Profiles of Aerosol Mass and Hydrogen Content, Respectively, Across Mylar Rotating Drums Impactor Samples. *Aerosol Sci. Technol.*, 36:642–651.
- California Department of Health Services. (2010). *Web Based Inquiry for Mortality Data*. Retrieved from <http://www.applications.dhs.ca.gov/vsq/default.asp> accessed 3 May, 2011.
- CalTrans. (2010). *CA Transportation Authority, Average Daily Truck Traffic on the California Highway System*. Retrieved from <http://www.dot.ca.gov/hq/traffops/saferes/trafdata/truck2008final.pdf>
- Cahill, T., Cliff, S. S., Jimenez-Cruz, M., and Perry, K. (2003). *Aerosols by Size, Time, and Composition in Support of the Fresno Asthmatic Children's Environment Study, 2001*. Final Report to the California Air Resources Board, Sacramento, CA.
- Cahill, T., Dutcher, D., Clark, C., Martin, J., McCarthy, T., and Lipnick, D. (1998). *Comparison of Cardiac and Stroke Mortality to Carbon Monoxide, Ozone, and Particulate Air Pollutant Concentrations in the Sacramento Valley Region*. Report to the Health Effects Task Force, American Lung Association Sacramento Emigrant Trails, Sacramento, CA.
- Cahill, T. A., and Barnes, D. E. (2009). *Comparison of Fine Mass, UC Davis DRUM versus FRM, at the Air Resources Board 13th and T Street Site*. Final Report to the California ARB, Sacramento, CA.
- Cahill, T. A., Cahill, T. M., Spada, N. J., and Barnes, D. E. (2007). *Organic and Elemental Aerosols near Watt Avenue, Late Winter—Spring, 2007*. Final Report to the Sacramento Metropolitan Air Quality Management District, Sacramento, CA.
- Cahill, T. A., Eldred, R. A., Motallebi, N., and Malm, W. C. (1989). Indirect Measurement of Hydrocarbon Aerosols Across the United States by Non-sulfate Hydrogen-Remaining Gravimetric Mass Correlations. *Aerosol Sci. Technol.*, 10:421–429.
- Cahill, T. A., and Feeney, P. J. (1973). *Contribution of Freeway Traffic to Airborne Particulate Matter*. Final Report of the California Air Resources Board, Contract ARB-502, Sacramento, CA.
- Cahill, T. A., and Flocchini, R. G. (1974). *Regional Monitoring of Smog Aerosols*. Annual Reports to the California Air Resources Board, Contract 2–006, 1974, 1975, 1976, 1977, Sacramento, CA.
- Cahill, T. A., Goodart, C., Nelson, J. W., Eldred, R. A., Nasstrom, J. S., and Feeney, P. J. (1985). Design and Evaluation of the Drum Impactor, in *Proceedings of International Symposium on Particulate and Multi-phase Processes*, T. Ariman and T. Nejat Veziroglu, eds., Hemisphere Publishing Corporation, Washington, DC, Vol. 2, pp. 319–325.
- Cahill, T. M. (2010). Size-Resolved Organic Speciation of Wintertime Aerosols in the California Central Valley. *Environ. Sci. Technol.*, 44:2315–2321.
- Chan, D., and Stachowiak, G. W. (2004). Review of Automotive Brake Friction Materials. *Proc. Instn. Mech. Engrs.*, 218(9):953–966.
- Chen, L. W. A., Watson, J. G., Chow, J. C., and Magliano, K. L. (2007). Quantifying PM_{2.5} Source Contributions for the San Joaquin Valley with Multivariate Receptor Models. *Environ. Sci. Technol.*, 41(8):2818–2826.
- Chow, J. C., Chen, L. W. A., Watson, J. G., Lowenthal, D. H., Magliano, K. A., Turkiewicz, K., and Lehrman, D. E. (2006). PM_{2.5} Chemical Composition and Spatiotemporal Variability During the California Regional PM₁₀/PM_{2.5} Air Quality Study (CRPAQS). *J. Geophys. Res.—Atmos.*, 111: D10.
- Chow, J. C., Watson, J. G., Lowenthal, D. H., Chen, L. W. A., Zielinska, B., Mazzoleni, L. R., and Magliano, K. L. (2007). Evaluation of Organic Markers for Chemical Mass Balance Source Apportionment at the Fresno Supersite. *Atmos. Chem. Phys.*, 7(7):1741–1754.
- Chow, J. C., Watson, J. G., Lowenthal, D. H., and Magliano, K. L. (2008). Size-Resolved Aerosol Chemical Concentrations at Rural and Urban Sites in Central California, USA. *Atmos. Res.*, 90(2–4):243–252.
- Devlin, R. (2003). What We Know and What We Think We Know About Health Effects of Fine Particles; Is It Enough? American Association of Aerosol Research (AAAR), Annual Meeting, Charlotte, NC.
- Flocchini, R. G., Cahill, T. A., Shadoan, D. J., Lange, S. J., Eldred, R. A., Feeney, P. J., Wolfe, G. W., Simeroth, D. C., and Suder, J. K. (1976). Monitoring California's Aerosols by Size and Elemental Composition. *Environ. Sci. Technol.*, 10:76–82.
- Fujita, E. M., Zielinska, B., Campbell, D. E., Arnott, W. P., Sagebiel, J. C., Mazzoleni, L., Chow, J. C., Gabele, P. A., Crews, W., Snow, R., Clark, N. N., Wayne, W. S., and Lawson, D. R. (2007). Variations in Speciated Emissions from Spark-Ignition and Compression-Ignition Motor Vehicles in California's South Coast Air Basin. *J. Air Waste Manage.*, 57(6):705–720.
- Gertler, A., Abu-Allaban, M., Coulombe, W., Gillies, J. A., Pierson, W. R., Rogers, C. F., Sagebiel, J. C., Tarnay, L., and Cahill, T. A. (2003). Measurements of Mobile Source Particulate Emissions in a Highway Tunnel. *Int. J. Vehicle Des.*, 27:86–93.
- Hayes, T. P., Kinney, J. J. R., and Wheeler, N. J. M. (1984). California Surface Wind Climatology State of California Air Resources Board, Aerometric Data Division, Sacramento, California.
- Kennedy, P., Gadd, J., and Moncrieff, I. (2002). *Emission Factors for Contaminants Released by Motor Vehicles in New Zealand*. Ministry of Transport, Auckland, New Zealand.
- Kleeman, M. J., Riddle, S. G., Robert, M. A., Jakober, C. A., Fine, P. M., Hays, M. D., Schauer, J. J., and Hannigan, M. P. (2009). Source Apportionment of Fine (PM_{1.8}) and Ultrafine (PM_{0.1}) Airborne Particulate Matter During a Severe Winter Pollution Episode. *Environ. Sci. Technol.*, 43(2):272–279.
- Kleeman, M. J., Schauer, J. J., and Cass, G. R. (2000). Size and Composition Distribution of Fine Particulate Matter Emitted from Motor Vehicles. *Environ. Sci. Technol.*, 34(7):1132–1142.
- Lippmann, M. (2009). Semi-Continuous Speciation Analyses for Ambient Air Particulate Matter: An Urgent Need for Health Effects Studies. *J. Expo. Sci. Epidemiol.*, 19:235–247.
- Malm, W. C., Sisler, J. F., Huffman, D., Eldred, R. A., and Cahill, T. A. (1994). Spatial and Seasonal Trends in Particle Concentration and Optical Extinction in the United States. *J. Geophys. Res.*, 99(D1):1347–1370.
- Pope, C. A., III, Thun, M., Namboodiri, M. M., Dockery, D. W., Evans, J. S., Speizer, F. E., and Heath, C. W., Jr. (1995). Particulate Air Pollution as a Predictor of Mortality in a Prospective Study of U. S. Adults. *Am. J. Respir. Crit. Care Med.*, 151(3) (Part 1):669–674.
- Raabe, O. G., Braaten, D. A., Axelbaum, R. L., Teague, S. V., and Cahill, T. A. (1988). Calibration Studies of the Drum Impactor. *J. Aerosol Sci.*, 19(2):183–195.
- Riddle, S. G., Jakober, C. A., Robert, M. A., Cahill, T. M., Charles, M. J., and Kleeman, M. J. (2007). Large PAHs Detected in Fine Particulate Matter Emitted from Light-Duty Gasoline Vehicles. *Atmos. Environ.*, 41(38):8658–8668.
- Wesolowski, J. J., John, W., Devor, W., Cahill, T. A., Feeney, P. J., Wolfe, G., and Flocchini, R. (1977). *Collection Surfaces of Cascade Impactors, in X-Ray Fluorescence Analysis of Environmental Samples*. T. Dzubay, ed., Ann Arbor Science Publishers, Ann Arbor, Michigan, pp. 121–130.
- Zielinska, B., Goliff, W., McDaniel, M., Cahill, T., Kittelson, D., and Watts, W. (2003). *Chemical Analyses of Collected Diesel Particulate Matter Samples in the E-43 Project*. National Renewable Energy Laboratory, Golden, COLORADO.
- Zielinska, B., Sagebiel, J., McDonald, J. D., Whitney, K., and Lawson, D. R. (2004). Emission Rates and Comparative Chemical Composition from Selected in-use Diesel and Gasoline Fueled Vehicles. *J. Air Waste Manage. Assoc.*, 54:1138–1150.

ITEM 11.1.

Nishi Submission #1. There will be several sent in sections, each < 10 Mb, so as not to overwhelm your in boxes)

The City of Davis is considering whether to put a new version of onto the June ballot. The new proposal is available on the city web site and I encourage you to review it. The new version proposes a development dedicated entirely to student housing.

My analysis is that the rapid advances in our understanding of the health impacts of freeways and comparisons to similar freeway sites in California and elsewhere makes predictions of the level of the most hazardous pollutants so extreme as to make any residential use at Nishi hazardous. Thus, I recommend Nishi not be put on the June ballot, and if despite all the solid peer reviewed threats to health, it is placed on the June election, that the citizens of Davis will vote it down.

I also recommend that before any use is made of the Nishi site a detailed 2 year study be made at Nishi and nearby sites for comparison focusing on the most dangerous pollutants (ultra-fine transition metals from brakes, diesel exhaust from trains, diesel exhaust from trucks, fine metallic road debris,) in both summer Bay Transport periods and especially winter stagnation events. From such a study, the level of mitigation necessary for safe use at Nishi can be established, with the likelihood that important and highly visible nonresidential use could be supported.

I also believe there are far better university and non-university uses for the valuable and highly visible Nishi site with entities capable of installing and maintaining the ultra-filtration systems I helped develop.

I will now provide the information supporting my opinion, based as it is on 50 years of air quality work in California and about 150 peer reviewed publications on air quality. My academic CV is available on the Department of Physics web site.

#1 Characterization of Exposures to Vehicle-Related Pollutants Near Roadways
ARB Powerpoint overview 2010

#2: A comparison of Nishi to the worst near freeway site in the United States, based on a recent CA Air Resources Board (ARB)/UCLA study.

Summary: Nishi is better in some regards, worse in others, but very similar to the worst near freeway site in the US. More data needed before one dares live there.

#3: Text version of a Dec. 30, 2017 article in the LA Times “Freeway pollution travels farther than we thought. Here's how to protect yourself”, by Tony Barboza, based on the recent ARB/UCLA study

Summary: Strongly supports our results and conclusions that within 1,000 ft of a freeway one has elevated rates “...of asthma, cancer, heart attacks, strokes, reduced lung function, pre-term births and a growing list of other health problems.”

ITEM 11.1.

#4: New paper jointly authored with the US EPA from a major multi-university and multi-agency study (NEXUS) on a Detroit freeway.

Summary: "The concentrations of very fine and ultra-fine metals from brake wear and zinc in motor oil observed in Detroit have the potential of being a significant component in statistically established PM_{2.5} mortality rates."

ITEM 11.1.

Hi, my name is Tom Cahill., a Davis resident since 1967 and professor emeritus of Physics and Atmospheric sciences.

On October 18, I provided the Planning Commission a 31 page report on the hazards to potential residents at Nishi due to its proximity to I-80. It documented via the **peer reviewed literature** the **immediate and well document threats**:

- o **Early heart attacks** from ultra-fine metals from the upwind braking,
- o **Increases in cancer** from the diesels exhaust.

I also shared with the developer and the city my techniques for cleaning indoor air that I am using with the US Embassy in Beijing.

But my assumptions were based on earlier Nishi proposals with a small number of rental units in the far NE corner of the property What I saw in October was an entire village, with thousands of residents and large and unmitigated outdoor spaces suitable for families. For children, the impacts of freeways are far more immediate,

- o High rates of **childhood asthma**
- o **Rapid and permanent loss of lung function** in children from ultra-fine metals, with 18year olds having the lung function of 70 year olds.

And these data were generated on average freeways, not in the extreme conditions at Nishi. In my 45 years of studying freeways in Los Angeles, California and across the nation, **the Nishi site is among the very most impacted. It** hits nearly all the **hot button threats**:

1. **Heavy and growing traffic**, with
2. **trucks and cars braking** on
3. an **elevated overcrossing** just
4. **upwind of the site**, and
5. **excess diesel smoke from accelerating trucks and trains**,

Even the cool Bay Breeze that comes **up I-80 each summer day is a marine inversion** and traps highway pollutants close to the ground, and of course the **winter stagnations** that result in the **highest level of pollutants in near highway sites**.

For these reasons, I recommended then no short term or long term residential use on Nishi.

Finally, you have your own EIR on Nishi, which states that there are “...**significant and unavoidable**” (4.3-33) ...” air quality impacts. That alone should be enough to void all on site housing.

ITEM 11.1.

Now I have learned of **another even more urgent threat**— one that has **hardened my opposition and I hope yours.**

I recently sent you all one paper from a major 6 year study of autism. A leading author was from the UC Davis MIND institute.

It shows that there is **an 86% increase the chances for a woman to have an autistic child if she conceives within 1000 feet of a freeway.** All of Nishi is within 1000 feet of I-80.

And the Nishi site is **3 to 4 times more polluting** that the freeways used in the autism study. Even if you apply **massive indoor mitigation**, it would never be enough at Nishi for **active residents and realistic young adult lifestyles** using unmitigated parks.

How can we in good conscience **doom this unsuspecting woman to a sharply increased chance of a difficult life as she handles her autistic child?**

We are in **California, not Texas.** We are in Davis, not Flint., We have a **university of with serious environmental competence. We are not medical science deniers. We know better.**

So, **Davis, here is our chance to really lead and innovate.** All over California Planning Agencies are trying to put low income housing hard against freeways for energy conservation reasons, hampered by ancient state and federal air quality regulations that are almost criminally unable to assess the know threats of freeways. There is a looming **Environmental Justice** disaster, as the people least able to bear the costs are subjected to some of the worst air in California.

The City of Davis can and must **send a message** to local and state air quality agencies and even US EPA.

Davis chooses to transcend the almost criminally **inadequate regulations** on health impacts of freeways, **adopt the findings of modern health science, and lead the state and nation in protecting our citizens.**

Pull Nishi from the ballot until it can be recrafted in accord to an environmentally preferred option **Alternative 2 in the EIR** as a **vibrant research and innovation center**, well able to protect the health of its workers by high efficiency air filtration, and **without residential housing.**

Thank you.

ITEM 11.1.

Comments on Tom Cahill

Tonight the City Council can take a **key leadership role in a critical environmental issue**. I call upon the City Council to **accept the unanimous judgement of medical science** that living near freeways **can be toxic**, and protect the health of the old, the young, and the unborn by **permanently barring any residential use at Nishi**.

Your DEIR finds that there are “...**significant and unavoidable**” (4.3-33) ...” air quality impacts based on **state and federal air quality regulations**, but the real problem is that **existing regulations and freeway influence models** are almost **criminally inadequate to protect people living near freeways**.

The **peer reviewed medical literature** shows that you can meet **every published air quality regulation**, but still commit residents to **lung damage and early heart attacks** from the debris of brake drums and pads.

This is bad enough for adults, but the Nishi proposal has morphed from **a research and innovation center** into an entire village, with residences and parks for families. For children, the impacts of freeways are far more serious and immediate. Now we additionally have to face

- o High rates of **childhood asthma**
- o **Rapid and permanent loss of lung function**.

And if the health of children was not reason enough, a major 6 year study of autism shows that there is **an 86% increase the chances for a woman to have an autistic child if she gets pregnant while living for a few months within 1000 feet of a freeway**. All of Nishi is within 1000 feet of I-80.

How can we in good conscience **doom this unsuspecting young woman to a sharply increased chance of a difficult life** as she handles her autistic child?

As I showed in detail in my Oct. 18 report, the Nishi site air quality is **3 to 4 times worse** than the freeways used in the autism study. So even if you apply **massive indoor mitigation**, it would never be enough at Nishi for **active residents and realistic young adults** exercising in **the** unmitigated open spaces.

Davis, here is our chance to really lead and innovate.

- Transcend the almost criminally **inadequate regulations** on health impacts of freeways,
- **adopt the findings of modern** health science, and
- show the state and nation **that Davis gets it right in** protecting our citizens.

Pull the existing proposal off the ballot, and only accept proposals that meet your EIR’s environmentally superior **Alternative 2, a pure research and innovation center with no on site housing**. Thank you.

ITEM 11.1.

If there is time.....

Why are Davis' actions so important? Because of the lack of regulations on the special health impacts of freeways, planning agencies all over the state are tempted to jam people next to freeways for energy conservation reasons. This is a looming **Environmental Justice** disaster, as people in low income housing, and with limited health care resources, are forced into some of the worst air in California.

ITEM 11.1.

City of Davis Planning Commission, October 14, 2015

Testimony of Thomas A. Cahill, Prof Emeritus of Physics and Atmospheric Sciences, UC Davis.

My recommendation: If the Planning Commission should decide to support the Nishi proposal, the threats from air pollution are so grave that it should be modified to eliminate all residential housing.

My background: My research for the Air Resources Board 1970 to 1977 supported removal of lead and sulfur from California gasoline, essential to adoption of the catalytic converter. While most of my current work is in global climate change, I returned to the problem of California highway pollution in 1994, working with Breathe California NGO, when it was becoming clear that there were persistent health impacts, especially permanent loss of lung capacity in children living within 1 mile of LA freeways.

Support: Gauderman, W. J., McConnell, R., Gilliland, F., London, S., Thomas, D., Avol, E., Vora, H., Berhane, K., Rappaport, E. B., Lurmann, F., Margolis, H. G. and Peters, J. (2000). **Association between air pollution and lung function growth in southern California children.** *Am. J. Respir. Crit. Care Med.* 162:1383-1390.

We helped pass the law moving schools 500 feet back from freeways. I am currently working with the CA Dept. of Justice on toxic metals in California and the US EPA on freeway impacts in Detroit.

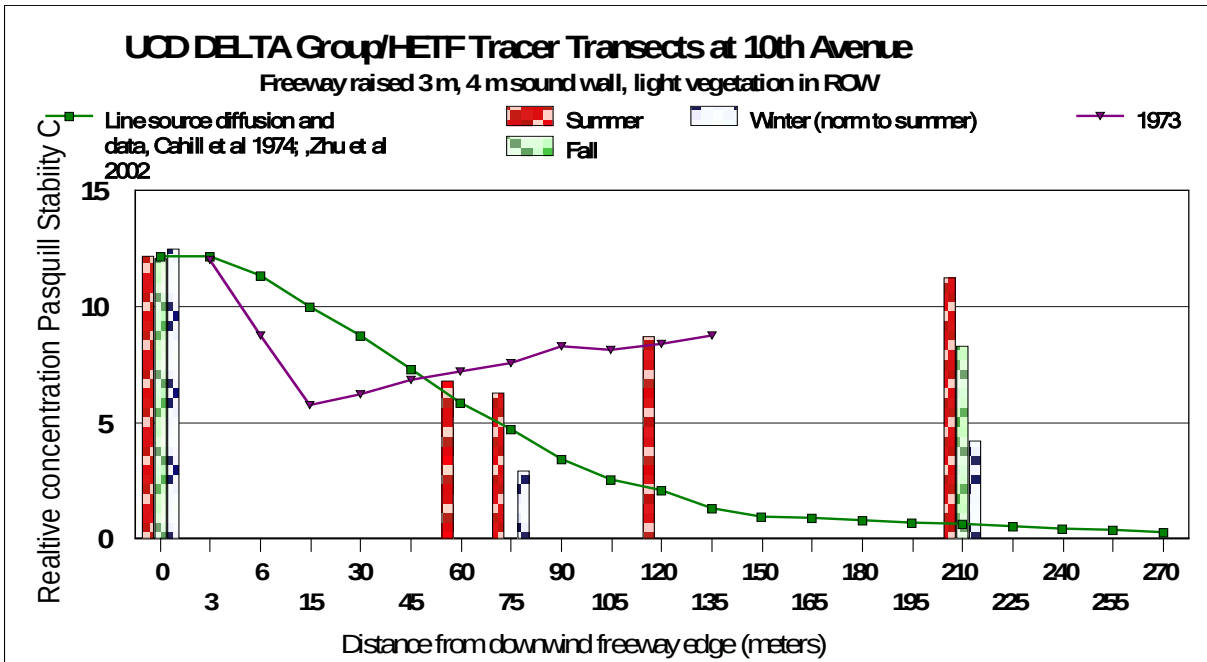
There are a few problems in the DEIR that I will address in my written submission, but the air quality section is pretty good. It raises **“significant and unavoidable” (4.3-33)** air quality impacts and then tries desperately to mitigate what is a “Perfect Storm” of rail and roadway toxics:

1. A heavily traveled elevated freeway directly upwind of the property, (throwing its pollutants over 1,000 feet downwind into the property with little or no dilution,)

Support: Feeney, P.J., T.A. Cahill, R.G. Flocchini, R.A. Eldred, D.J. Shadoan, and T. Dunn. **Effect of roadbed configuration on traffic derived aerosols.** *Journal of the Air Pollution Control Association.* 25:1145-1147 (1975).

Comment: Zhu et al (2002) repeatedly comments that coagulation and growth governed fall off of ultra-fine particles versus distance is refuted in the agreement of uf BC and # with CO, which doesn't coagulate. This point he finally concedes in his final conclusions.

ITEM 11.1.

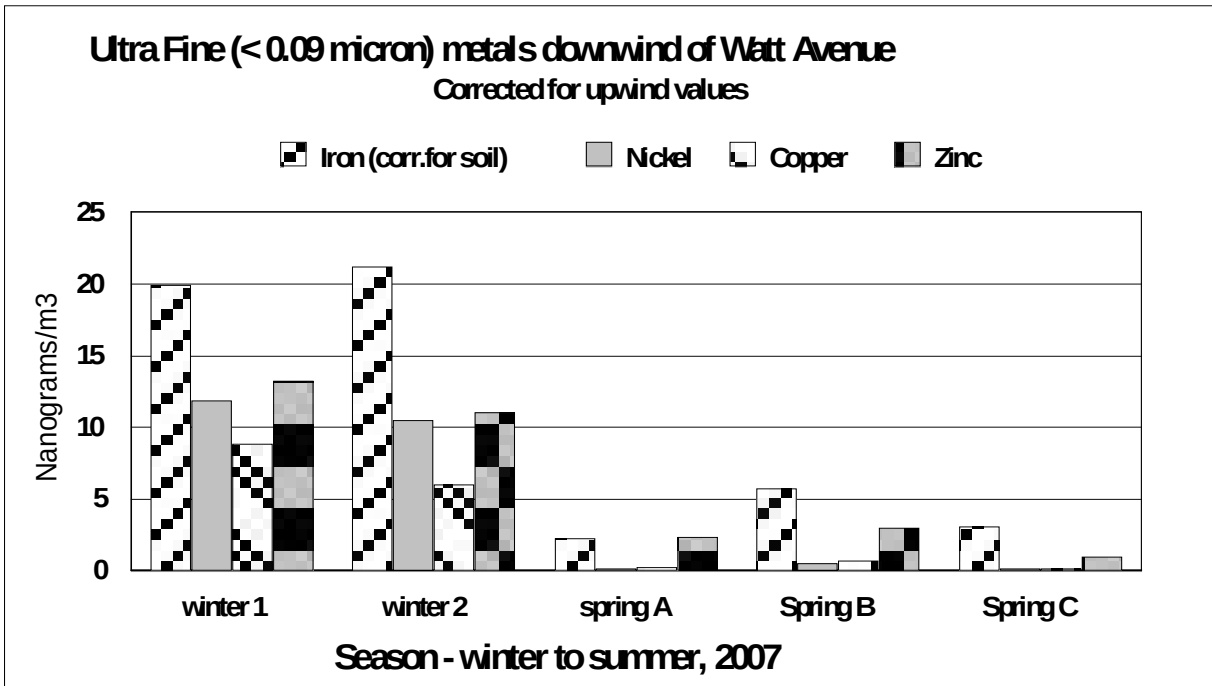


The blue area is 500 ft from freeway, a zone in which schools are not allowed. The read line is 1,000 ft. (300 m)

ITEM 11.1.

2. Extensive braking on the I-80 elevated section, (generating ultra-fine “wear” aerosols with known cardio vascular impact)

Support: Local observations of traffic: **Cahill, Thomas A., , David E. Barnes, Nicholas J. Spada**, Seasonal variability of ultra-fine metals downwind of a heavily traveled secondary road, **Atmospheric Environment** 94 173 - 179 (2014); Barnes et al 2015 (DEIR) , showing the Nishi measurements similar to Watt Ave in spring.



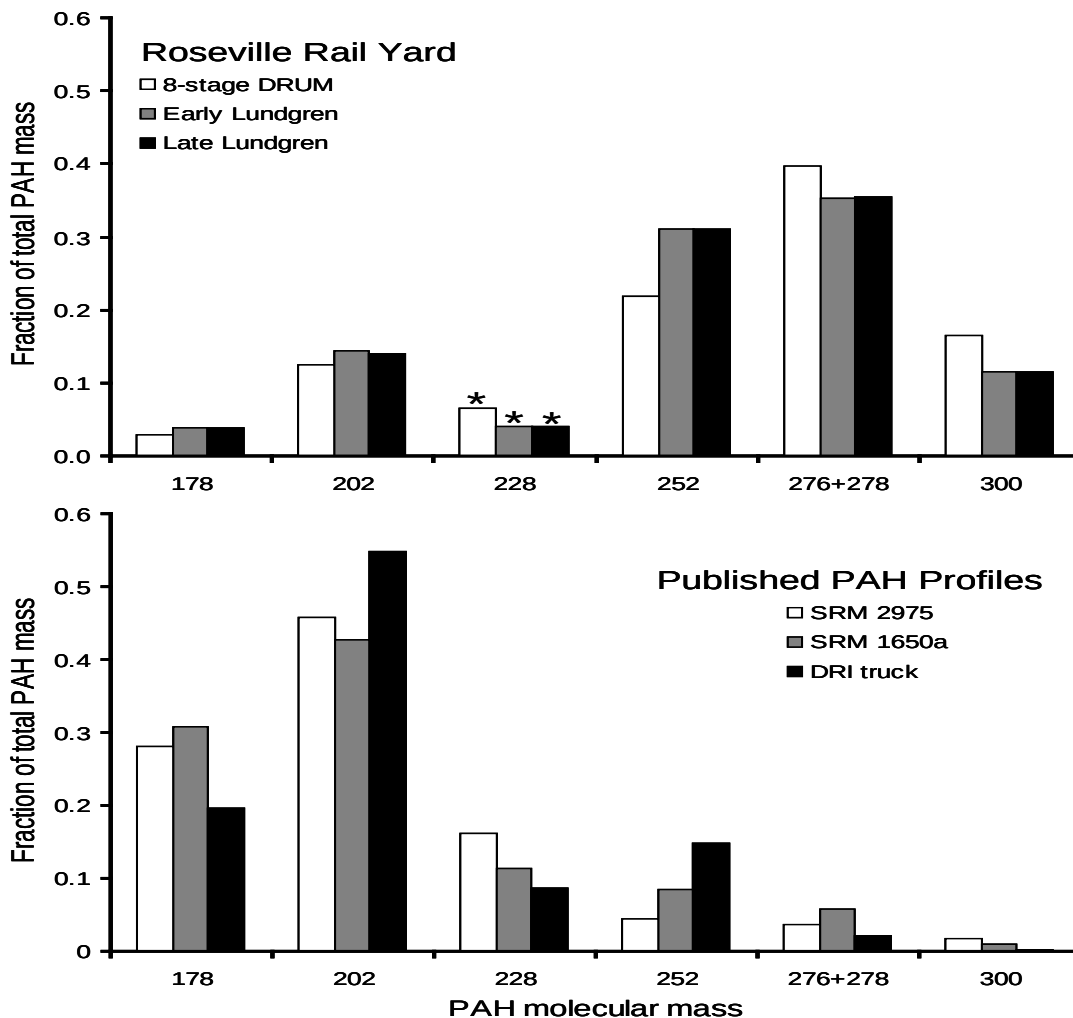
3. Extensive acceleration as the freeway back up clears directly south of Nishi, (with massive increases in diesel exhaust with known carcinogens)

Support: Local observations of traffic

4. A heavily used rail road directly north of the property (with diesel exhaust more toxic than truck diesel exhaust),

Support: **Thomas A. Cahill, Thomas M. Cahill, David E. Barnes, Nicholas J. Spada and Roger Miller.** Inorganic and organic aerosols downwind of California’s Roseville Railyard. **Aerosol Science and Technology** 45:1049-1059 (2011) doi:10.1080/02786826.2011.580796

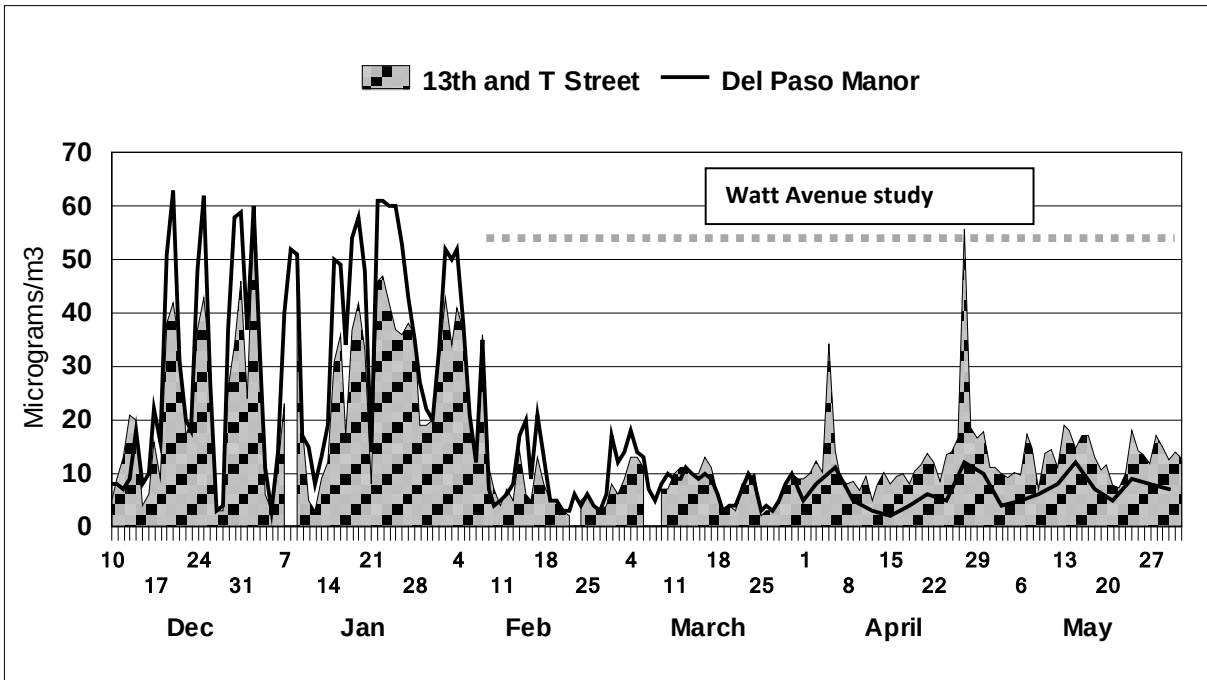
ITEM 11.1.



5. In a region subject to strong and persistent meteorological inversions in winter (which trap pollutants close to the ground) All statements are supported in the peer reviewed literature.

Support: **Cahill, Thomas A., , David E. Barnes, Nicholas J. Spada**, Seasonal variability of ultra-fine metals downwind of a heavily traveled secondary road, **Atmospheric Environment** **94** 173 - 179 (2014)

ITEM 11.1.



6. Figure 3 PM_{2.5} mass data from the ARB downtown site at 13th and T Street and Del Paso Manor sites, Dec 10, 2006 to May 31, 2007. The period of the Watt Ave study is shown in the dotted line.

Concerning the ultra-fine “wear” aerosols, the DEIR correctly states that there is no ambient air quality standard for ultra-fine particles. The US EPA since 2012 has been working on exactly that question, most recently in Feb, 2015. But there also is no current ambient air standard for diesel exhaust, yet it is 70% of all California air toxic impacts.

Support: CA ARB Proposition 65 Toxics

There is no current ambient air standard for Legionnaire’s disease aerosols, yet people are dying on the streets of New York from it. There is no current ambient air standard for Valley Fever fungus aerosols, but thousands are sick and some die from it every year. Lack of a standard does not mean freedom from harm!

Finally, some perspective: Using the fact that about 20% of all deaths are from either cancer or heart attacks, we can estimate the enhanced death rate, deaths/million people/70 year lifetime:

VW diesel cheating (if continued)

~ 900 deaths/million people/70 year lifetime: ~ **0.5% increase in the cancer death rate**

ITEM 11.1.

Downwind of the worst California rail/truck facility in San Bernardino

~ 2700 deaths/million people/70 year lifetime: ARB report, San Bernardino BNSF

~ **1.3% increase in the cancer death rate**

Ultra-fine “wear” aerosols from brakes downwind of I-5 in Bakersfield,

Support: **Thomas A. Cahill, David E. Barnes, Earl Withycombe, and Mitchell Watnik.** Very fine and ultra-fine metals and ischemic heart disease in the California Central Valley 2: 1974 – 1991. *Aerosol Science and Technology* 45:1135-1142 (2011) doi:10.1080/02786826.2011.582196

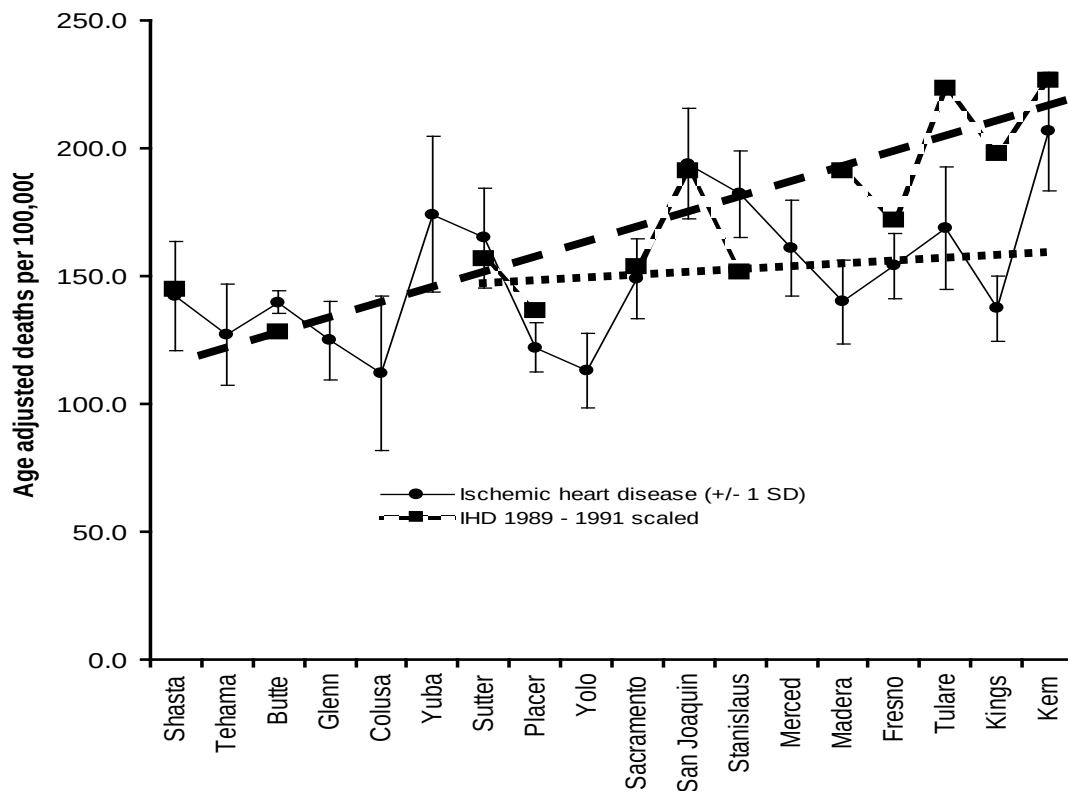


Figure 6 Ischemic heart disease (IHD) in the California Central valley, 1989 -1991 versus 2003 – 2007. The 1989 – 1991 data are scaled to match the Shasta – Butte data, 2003 – 2007, since diagnostic protocols differed. (difference 150 versus 200 deaths/100,000) ~ **25% increase in the heart attack death rate**

ITEM 11.1.

Davis New Harmony Project**Draft Informal analysis by Thomas A. Cahill**

August 6, 2008

1. Summary and authorities

In summary, while the location of the project is such that it lies upwind of Interstate 80 in most prevailing wind conditions, some residual impact can occur, especially in periods of winter stagnation. I propose that these can be mitigated by

1. Potential discussions with CalTrans on revised plantings and sound wall configurations within the right of way,
2. Enhanced vegetation on the north edge of the parking lot, with deodar and redwoods as a preferred type of trees due to their ability to filter out ultra fine diesel particulates,
3. Enhanced filtration within the dwellings using passive electrostatic filters and low face velocities to remove residual free way aerosols.

For my credentials, see my web site <http://delta.ucdavis.edu>.

We also have had a series of reports on Davis and Sacramento since 1995:

PM-10 Aerosols in Davis from Traffic Sources,

Final report to the City of Davis Council, March 15, 1995,

Thomas A. Cahill, Elizabeth A. Gearhart, and K.T. Paw-U

Comparison of Cardiac and Stroke Mortality to Carbon Monoxide, Ozone, and Particulate Air Pollutant Concentrations in the Sacramento Region.

Final Report to the American Lung Association of Sacramento – Emigrant Trails, June, 1998

Thomas A. Cahill, Debrina Dutcher, Chris Clark, Jeanette Martin, Theresa McCarthy, and David Lipnick.

Sacramento/Interstate-5 Aerosol Transect Study

Final Report to the American Lung Association of Sacramento – Emigrant Trails, 2003

Principle Investigator: *Thomas A. Cahill*. Investigators: *M. Roumie, Lee Portnoff, Victor Ray, Jeanette Martin, Roger Miller, Steven Cliff, Kevin D. Perry, the staff of DELTA group University of California Davis, Chinyere Williams, volunteers of the American Lung Association of Sacramento Emigrant Trails Health Effects Task Force.*

Sacramento/Interstate-5 Aerosol Transect Study

Final Report to the American Lung Association of Sacramento – Emigrant Trails, 2005

Principle Investigator: *Thomas A. Cahill*. Investigators: *Lee Portnoff, Steven Cliff, Kevin D. Perry, the staff of DELTA Group University of*

ITEM 11.1.

California Davis, volunteers of the American Lung Association of Sacramento Emigrant Trails Health Effect Task Force.

**Removal Rates of Particulate Matter onto Vegetation
as a Function of Particle Size**

Final Report to Breathe California of Sacramento Emigrant Trails Health Effects Task Force (HETF) and Sacramento Metropolitan AQMD, February 24, 2008

Erin Fujii, Jonathan Lawton, Thomas A. Cahill, David E. Barnes, Chui Hayes (IASTE intern), Nick Spada, and Greg McPherson The DELTA Group, <http://delta.ucdavis.edu>, and the Pacific Southwest USFS Urban Forest Program, Univ. of California, Davis 95616

2. Point of analysis #1

The “New Harmony project lies south of Highway 80, which is in a low probability wind rose patter for highway influence (see local wind rose – Yolo Airport? If not, Sacramento).

- a. Summer winds are predominantly from the southwest, and thus the New Harmony project is upwind of the freeway and has essentially no freeway influence.
- b. New Harmony is south of I-80 and would be influenced by winds from the north, northwest and northeast. North and northwest winds tend to be stronger, diluting highway influence.
- c. Winter stagnation periods are the greatest threat of I-80 influence, but two studies indicate that this is not a problem.

3. Point of analysis #2

The next piece of evidence came as part of my class work (Atmospheric Science 124). “My students and I made a transect across Davis on a cold, hazy day just before Christmas on Friday, Dec 22-23, 1993, a day predicted to have the worst local impact from pre-Christmas shopping and fireplaces on Friday evening. This was included in a report to the City Council on March 15, 1995, **“PM-10 Aerosols in Davis from Traffic Sources”**, dated March 2, 1995, T. A. Cahill, E. A. Gearhart, and K.T. Paw U, from the Air Quality Group and Department of Atmospheric Sciences, UC Davis. This packet also included a reviewer list and an analysis letter on the soundness of the work to the city from the Yolo Solano AQMD.

ITEM 11.1.

Table 1 Transect across Davis, December 22 – 23, 1994 (From Tables 1 and 2, Cahill et al, 1995) **Green** = normally upwind; **Blue** = City of Davis

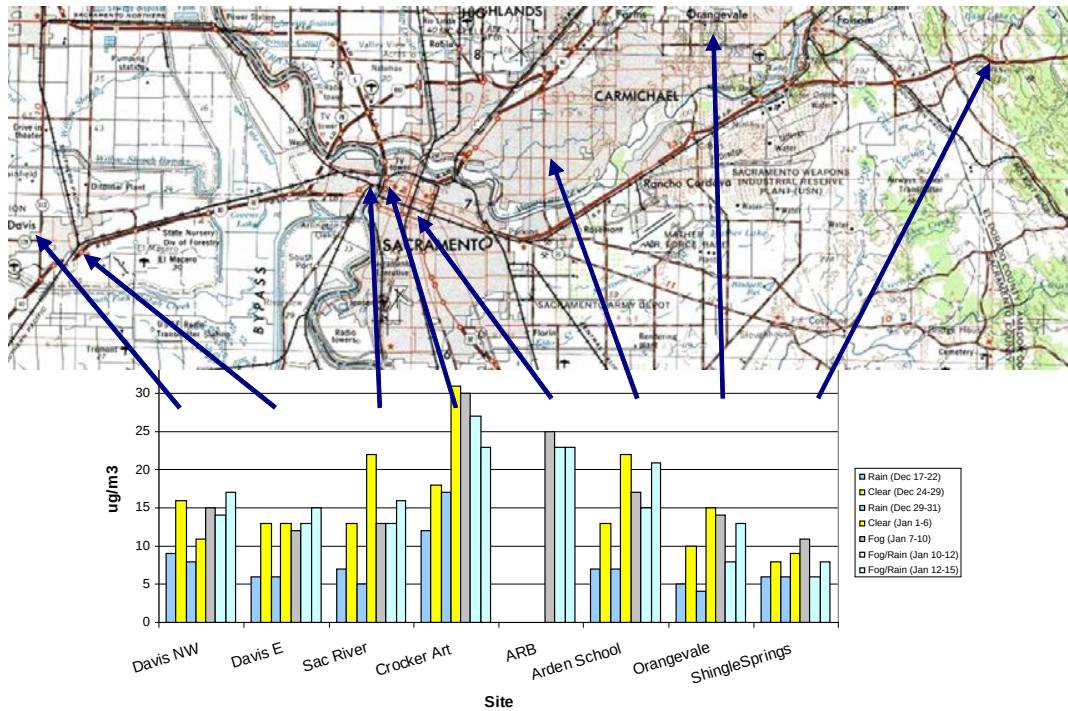
Site	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM _{2.5} K _{non} (wood smoke)	PM _{2.5} Soot (b _{abs})	PM _{2.5} ammonium sulfate	PM _{2.5} Organic mass	PM _{2.5} soil
West of 113	44.4	39.7	0.11	4.0	2.63	19.86	0.91
UCD west field	50.8	40.7	0.11	4.4	3.17	18.24	1.14
Central Park	46.2	41.5	0.18	5.0	3.26	22.82	1.32
Police 3rd and F St	45.2	40.2	0.11	4.9	3.18	22.06	1.35
Chestnut Park	45.3	40.6	0.04	4.4	3.45	22.95	1.52

The first point to note is that the measurements of mass, upon which the state and federal AQI are based, are essentially the same at upwind sites west of town (the average of “West of 113” and “UCD west fields” sites) as in town (average of other three sites). Note that the wind blew from the town to the west sites only 4% of all hours in December.”

The point for the New harmony perspective is that in the winter, Davis is immersed in a valley wide aerosol blanket trapped under the inversion, and thus local influences, in this case in-town traffic, had little additional impact.

The second point is from the 2001 -2002 Sacramento Transect study. The site Davis West was far from any freeway in a residential area off Amador Avenue. The Davis east site, however, was about 50 m south of I-80 and Childs Road at the USFS Nursery. Note that this site, closest to I-80, had the least pollution in the rainy periods because the winds were from the south, and thus the site lay upwind of I-80.

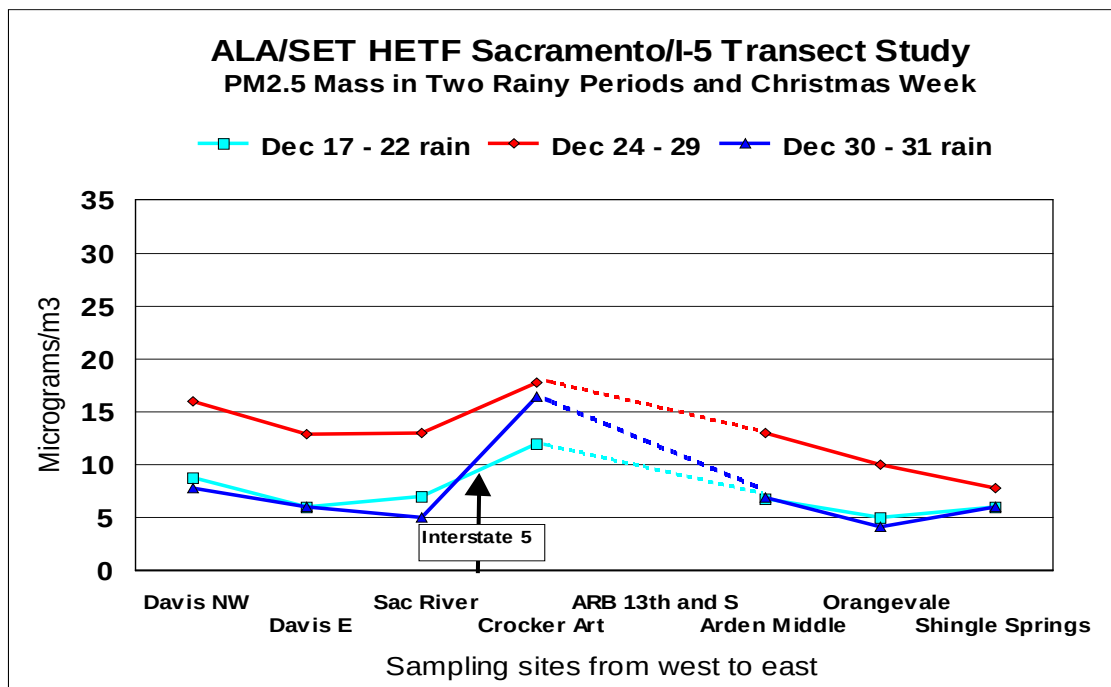
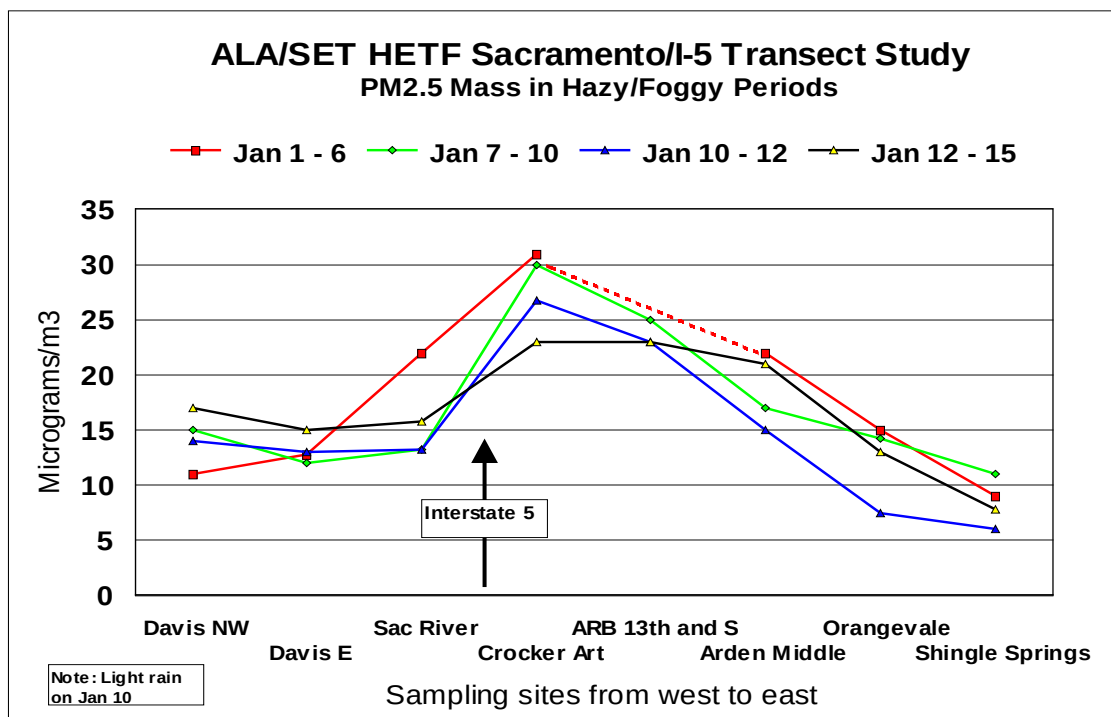
ITEM 11.1.



In the hazy periods that saw maximum $PM_{2.5}$ values, the two Davis sites were essentially identical during the roughly 15 days of this weather type, despite the fact that the Davis East was quite close to the freeway, similar on the average to the New Harmony site. Note also the Davis sites were similar to the freeway impacted Sacramento River site for 3 of the 4 sampling periods. This is despite the fact that the Sacramento River site was only 200 m from the Pioneer Bridge on Highway 50 and 300 m from I-5 and thus had extremely high local levels of truck and car traffic.

“Figure 6a $PM_{2.5}$ mass in two rainy periods and Christmas week

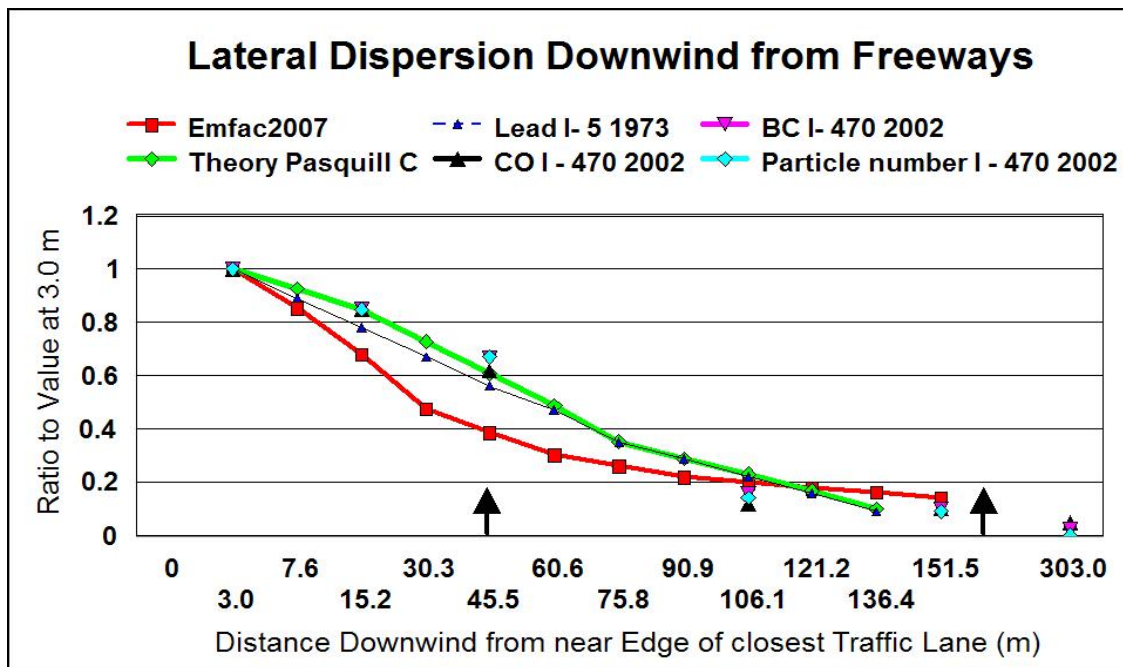
ITEM 11.1.

Figure 6b PM_{2.5} mass in hazy/foggy periods

4. Point of Analysis #3

ITEM 11.1.

Below I show plots of freeway fall off from the lead studies of 1973, The ultra fine studies of 2002, and Emfac 2007. Note that the calculation is done from the edge of the nearest traffic lane, which in the case of New Harmony lies even farther away from the highway than the closet point, 100 feet.



(This section incomplete as of 8/6/2008)

Description

Back Peak Hour	11100
Back Peak Month	133000
Back AADT	126000
Ahead Peak Hour	11500
Ahead Peak Month	143000
Ahead AADT	135000

128000 truck 11226 (22,451) 8.8 %, 2 axel = 29%, 3 = 8%, 4 = 3%, 5+ axel = 61%

ITEM 11.1.

5. Mitigation

The proximity of the New Harmony project to Interstate 80 will result in some modest level of impact, reduced by the fact the New Harmony is generally upwind of I-80 most of the time. Nevertheless, there can be some impact, and thus options for mitigation can be and should be included in the project. There are 4 possible approaches to mitigation:

1. Mitigation via source reduction
2. Mitigation via roadway design
3. Mitigation right of way to receptor
4. Mitigation at the receptor

Of these, the first is not practicable, as the City of Davis has no control over the number, type and fuels of vehicles traveling I-80. The advances in state and federal regulations, however, promise continued reduction in roadway emissions that will probably be to some degree offset by the expected increase of traffic. The second would require an agreement between Davis and CalTrans to modify conditions within the right of way, which could and at other sites has included sound walls, low, and high vegetation. The third right of way to receptor, is completely in the hands of the developers, and options exist to also address the fourth component, air quality at the receptor, via improved air filtration techniques.

a. Mitigation via source reduction

As has been shown above, there are excellent current data for emission rates of vehicles on the open highway and in laboratory conditions, data that allow a good match from vehicles on the highway to aerosols downwind of the highway. From such data, one can easily theoretically modify the source strength by increasing or decreasing the number of cars and trucks, increasing or decreasing the emissions per car or truck. Of special interest is the fact that a small number of automobiles dominate total automobile particulate emissions (“gross emitting or smoking cars”), some but not all of which of which emit visible smoke. Removal of a relatively small number of such cars would result in dramatic reductions in automobile pollution. However, realistically, we have little local control over these factors, which are driven by federal and state mandates more than local planning decisions.

While we support all state and federal actions to lower source emission rates, we believe that much can be accomplished at reasonable cost and in a short time frame by using one or more of the mitigation methods outlined below.

b. Mitigation via roadway design

This area provides important long term possibilities for mitigation, but such concepts are not widely supported by either experiments or models.

a. Nature of the roadway source

Cars and trucks on a highway create a mixed zone due to the turbulence of the vehicles, which is roughly 1.5 times the height of the mean vehicle at freeway speeds,

ITEM 11.1.

less at low speeds. This mixed zone contains emissions from the vehicles, including waste heat. This waste heat tends to make the road pollution slightly buoyant, as was shown in the extensive studies in Cahill et al 1974. It was found that the cut section Santa Monica freeway (at 250,000 vehicles/day) increased in temperature $1.4^{\circ}\text{F}/\text{minute}$, resulting in a cyclic cleaning of the road edge aerosols on a roughly 9 minute cycle. This was one of the major factors (the other being vegetation at the right of way edge) that the aerosols downwind of the Santa Monica freeway were only 20% of what a line source diffusion model would predict (see Table 2). Thus, roadways should be designed to hinder easy lateral transport of pollution and enhance the upward motion the excess heat delivers.

b. Mitigation within the right of way

This buoyant lift can be modeled by adding a vertical vector to the lateral wind velocity. This may also be the reason that the aerosol mass measured downwind of Interstate-5 at the elevated Crocker Art Museum site was higher than the model would predict. This tendency can be enhanced by placing a barrier to direct lateral motion from the roadway, slowing the lateral velocity and allowing the lift to raise the pollution level and entraining cleaner higher altitude air. This heating could, in summer, be enhanced by a hot roadway surface.



Example: I-5 south of Sutterville Road, Sacramento. However, the central area and potential vegetation was removed in a lane addition project.

ITEM 11.1.

Such a barrier can also be included by placing barriers, ideally vegetation, in the median strip. This will slow transport of pollution from the upwind lane in to the downwind lane, and again encourage vertical motion.

The addition advantage of vegetation is that it acts as a deposition surface for the very fine and especially ultra fine particles. HETF studies are in progress to evaluate this effect, especially for the most toxic very fine and ultra fine species generated by diesels and automobiles.

There are also some very expensive mitigations, such as placing the entire roadway in a cut section which we will not consider due to cost.

c. Mitigation from the right-of-way to the receptor

The most important mitigation from the right of way to the receptor is distance. As shown above in Table 2 (Cahill et al, 1974; Feeney et al, 1976, Harrison at al 1997) all the way to recent work, Figure 1 (Zhu et al, 2002), the highway influence for the most toxic materials decreases to about 10% of near highway values at distances between 160 m and 240 m for at grade roads.

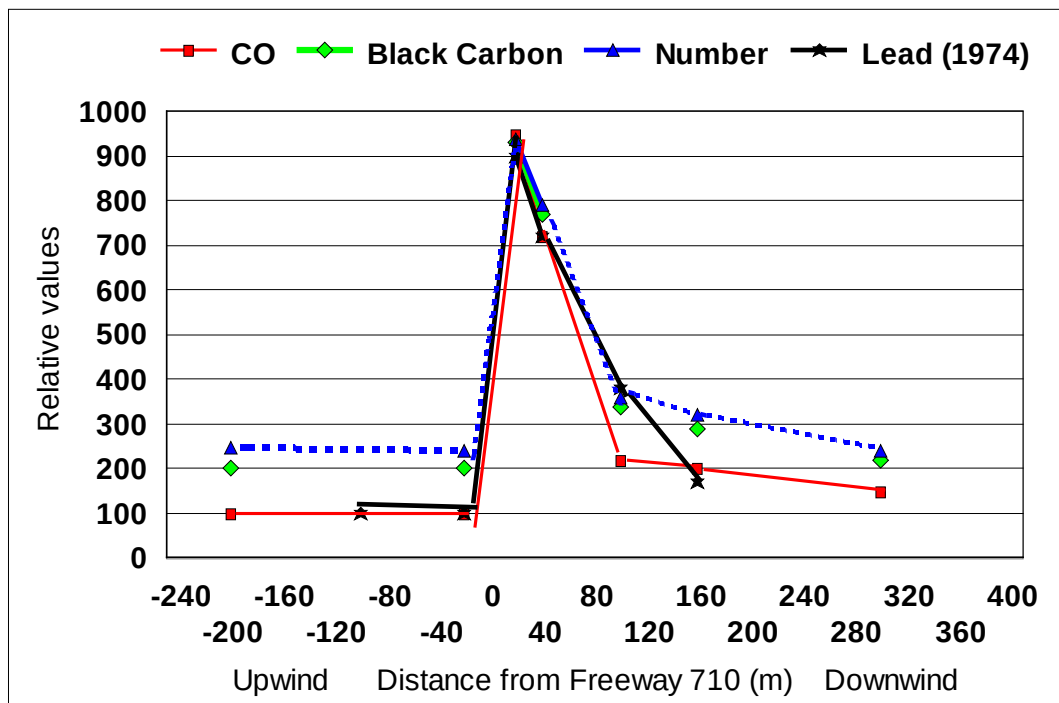


Figure 1 Profiles across the 710 freeway in an at-grade section in Los Angeles for carbon monoxide (CO), black carbon (BC), and particle number, with the data of Cahill et al 1974 superimposed.

Recent data (Harrison at al. 2004) use the distance of 50 m in Birmingham, England, to separate near roadway from far roadway cohorts for health effect studies.

ITEM 11.1.

Conversely, the ARB recently reported (2006) that the number distribution did not meet background values for many hundreds of m in a transect on Highway 50 in stable meteorological conditions in nighttime low velocity winds. However, this result was taken across an elevated freeway section, which has been earlier shown (see Table 2 and Cahill et al, 1974) to disperse freeway particles out to an estimated 2 km. Note that this same plot shows relatively high levels of black carbon and ultrafine particle number upwind of the freeway, and many kilometers downwind of the nearest upwind roadway. Thus, it does little good to reduce the roadway impact to very small levels if there is an important upwind background, such as exists in downtown Sacramento

The second form of mitigation is to impose barriers between the right-of-way and the receptor that can force air up and generate mixing, lowering values by dilution, or removing the particles from the air by providing surfaces for deposition, impaction, and settling.

The literature is weak in this area, but one article (Kim et al, 2005) found that sound walls were not very effective barriers to pollution. There is a considerable literature, however, on urban street canyons, and the effect of tall buildings on local pollution. The result is that there is a mixing of the polluted ground level air with (presumably) cleaner elevated levels, reducing concentrations by dilution. With a line source like a highway, lateral diffusion is little help, so that the mixing must be vertical. Turbulence is induced by a pierced barrier, which allows air to pass at some spots but not others, and this would favor an irregular barrier, not a smooth wall with laminar flow of air (and pollutants).

Support for this form of mitigation is given by the anomalously clean masses measured at the downwind edge of the Arden Middle School complex. The mixture of buildings and trees (without leaves) was adequate to lower the roadway aerosols by a factor of 2 or more (see above). Support is also given by the rapid fall off of lead aerosols at the Santa Monica Freeway site (Cahill et al, 1974), which involved passage through a thick barrier of vegetation. Whatever the effect, the combination of roadway heating and vegetative barrier produced a dramatic reduction in lead, over a factor of 5 at 100 m.

But for ultra fine particles, there is an additional option, These particles are so fine that they have long diffusion lengths and the ability to move to a surface, if it is close enough. Thus, we can make these barriers in such a way that air passes through closely spaced structures. As can be seen below from the summary of Seinfeld and Pandis, 1997, particles below about $0.05\ \mu\text{m}$, responsible for most of the particle number, much of the surface area, and a significant fraction of ultra fine mass, have high diffusion lengths and thus equivalent “settling velocities”, which in the case of very fine/ultra fine particles, can be either up, down or sideways, since gravity is not a factor in a Brownian motion dominated system.

ITEM 11.1.

Particle diameter microns	Theory DD	Deposition Diffusion	Settling v _{cp}	Removal Total	3&P pg 970 10 m veg	Velocity /
0.0021	2.28E-002	0.866	4965	10 sec		
0.0043	2.3E-003	0.435	1760			d
0.015	2.4E-004	0.175	4440	5000	5005.0	
0.021	3.0E-004	0.087	1570	1000	1001.0	
0.043	5.9E-005	0.046	55.50	0.220	0.220.2	
0.16	8.2E-006	0.020	140.0	150.0	150.2	
0.22	2.1E-006	0.011	4.960	0.100	0.100.1	
0.48	3.2E-007	0.007	1.760	0.150	0.150.2	
12.74	7.0E-007	0.004	0.444	0.018	0.040.0220.2	
21.27	7.0E-007	0.003	0.157	0.030	0.0150.0450.3	
46.1	8.0E-008	0.002	0.056	0.075	0.0750.75	
102.38	8.0E-008	0.001	0.014	0.500	0.5005.0	

Table 3 Deposition velocities for particles

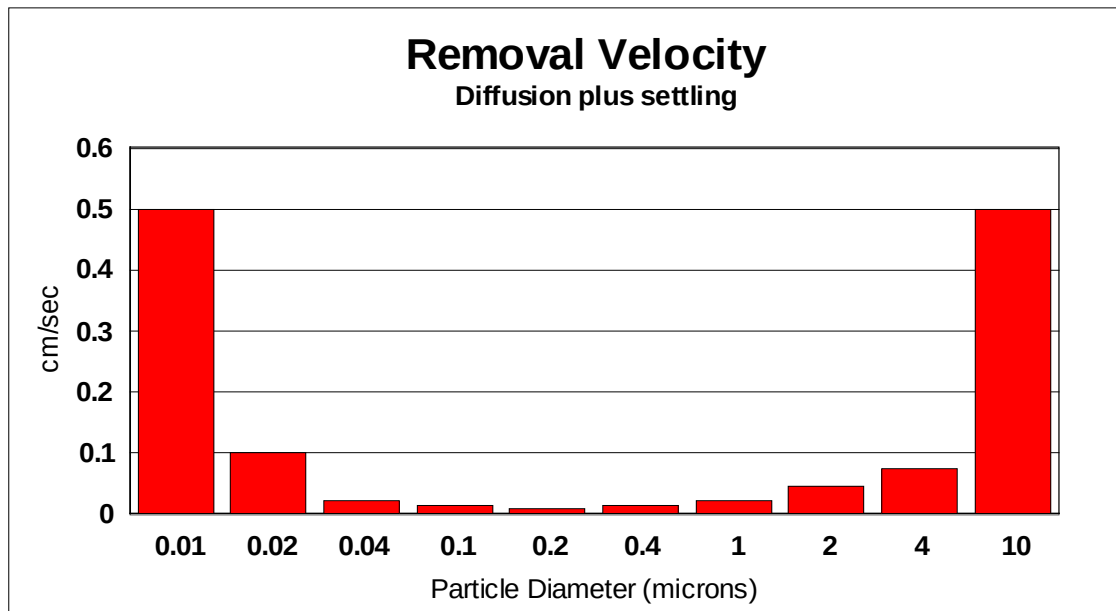


Figure 2 Plot of deposition velocities for particles. Note the rapid removal for ultra fine particles.

Using three values, one can calculate the removal of particles passing through finely divided needles or leaves in a tree, with the assumption that these ultra fine m[particles are generally sticky with oils, and once they contact a surface, they do not easily leave it until washed off.

d. Mitigation at the receptor

This area has a large and growing literature, via models, and other resources show that mitigation at the receptor has the proven potential to make the largest improvements

ITEM 11.1.

in air quality, to the point where the indoor air is much cleaner than even the regional outdoor air for very important pollutants, including very fine particles and ozone.

The state of the field was recently summarized (Morawska, 2006), based on her recent book. The basic science behind the indoor/outdoor (I/O) ratio of concentrations can be simplified when there are no internal sources (cooking, candles, smoking,...) to

$$I/O \equiv C_{\text{inside}}/C_{\text{outside}} = P a/(a + k),$$

where P is the penetration factor, a = the air exchange rate, usually expressed in 1/hours, and k = deposition (removal) of particles within the receptor, likewise expressed as 1/hours. Thus, there is a strong seasonal effect, with the air exchange rate minimizing in very cold conditions and, if air conditioning is available, in very hot conditions.

Morawska, while listing the myriad aspects that affect indoor air, summarized that “at times there is very little difference between the characteristics of indoor and outdoor particles. For example, for naturally ventilated buildings the penetration of particles of all sizes with significance to human health is almost 100 percent.” From roughly a score of studies, she found that the median Indoor/Outdoor ratio, I/O for naturally ventilated houses was

PM ₁₀	I/O = 0.64
PM _{2.5}	I/O = 0.85
Particle number	I/O = 0.56, which was also close the value for ozone.

However, I disagree with her statement in that recent studies and summaries of studies (EPA 2006) focus on the health impacts of the finest particles, which means the sharp reduction in particle numbers shown by and I/O ratio of 0.56 represents a significant health advantage.

Thus, buildings downwind of Watt Avenue would be closely coupled to the emissions from the highway, although with some mitigation occurring in naturally ventilated houses for the most worrisome very fine and ultra fine particles. To go beyond these generalities requires evaluation of each individual receptor site, its use patterns, construction, and other details

Mechanically ventilated buildings provide additional options, to the point that the indoor air can essentially be as clean as one wishes. An example is a recent study in Fairbanks, AK, (Reynolds and Cahill, 2004) during the heavy forest fires on 2004. The city of Fairbanks lived under a pall of smoke for months, with 24 hr PM_{2.5} levels in the region of 500 µg/m³. Studies were made during this period on indoor air cleaning. Two conditions were considered, treated outdoor air and internally circulated air, and two kinds of filters were used, HEPA and a more porous and standard electrostatic filter.

With internally circulated air, the Fantech 3000 HEPA filter lowered particle PM_{2.5} mass of smoke by 98%, which is much less than the 99.97% the manufacturer

ITEM 11.1.

claimed. A Matrix Air 450 cfm HEPA didn't do nearly as well, with decreases averaging 70%. The less efficient MERV 11 Filter plus pleated carbon, rated at 60 to 65% efficiency, actually achieved 75% reduction.

When the Fantech 3000 was used for outside air in a pressured mode, it reduced aerosols by 92 to 98%. The 90 to 95% MERV 14 reduced outside air, from $\text{PM}_{2.5}$ 492 $\mu\text{g}/\text{m}^3$ to 52 $\mu\text{g}/\text{m}^3$, or 72% (natural ventilation was 185 $\mu\text{g}/\text{m}^3$). However, when highly polluted outdoor air was brought into the building through an inefficient filter, it actually raised pollution levels. Thus, pressurization with clean air can be made to work.

In the winter, 2006 study at Arden Middle School, the heating system of the teacher ready room, a separate recirculation system, was supplied with these improved (but not HEPA) filters. They used MERV 11 filters, rated at 60 to 65% efficiency and rated at 1.0 to 3.0 microns. The result was a dramatic 75% reduction in very fine and ultra fine particles (Table 2). The key point is that the pressure drop across these filters, unlike HEPA filters, is low enough that standard air conditioning and heating systems can be used, with a major savings in cost.

With air brought in from outside, the HEPA filters have a high pressure drop and require more powerful fans than is normal in air handling systems. However, theoretical analysis indicates that a standard electrostatic filter should get more and more efficient as the particle size droops to 0.1 μm and below, offering the option a system like a standard attic fan blowing air into a house through such a filter, or more likely a standard furnace filter followed by an electrostatic filter to reduce dust clogging. This would result in a slightly positively pressurized house or school, blocking the input of polluted outdoor air.

This option has being studied under a grant from the Sacramento Metropolitan AQMD, with results released in June, 2008

ITEM 11.1.

Dear City Council folk, I continue to propose that Nishi be pulled off the June ballot to give time (2 years) for a full independent study of the air quality conditions at Nishi.

I have also assembled new information in the last 2 years on the air quality aspects of the proposed Nishi development in order to aid the city in its decision making process. These include 3 submissions: 1) impart of the new ARB/UCLA near freeway report on Nishi, 2) new information on downwind transport and mitigation by vegetation, and 3) new information on health impacts on near freeway residents. I shared this information with the developers, Tim Ruff and John and Sandy Whitcomb last Thursday and with the Planning Commission, but I will not overload you inboxes unless you ask me to send from tacahill2718@gmail.com.

In the course of this effort, I learned that Larry Green has forwarded to you comments contesting my opinions on Nishi. While I have great respect for Larry and all he has done for the area, I fear his opinions may be biased by the fact that as APCO he is required by law to operated based on federal and state standards that are now known by the US EPA and others to be inadequate to protect human health. I regret that Larry did not see fit to send me a copy, so my response must be based on a summary provide me by city staff (appended)



Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com

Transition metals in coarse, fine, very fine and ultra-fine particles from an interstate highway transect near Detroit

Thomas A. Cahill^{a,*}, David E. Barnes^a, Jonathan A. Lawton^a, Roger Miller^a, Nicholas Spada^b, Robert D. Willis^c, Sue Kimbrough^d

^a DELTA Group, University of California, Davis, CA 95616, USA

^b University of Houston, Houston, TX, USA

^c US Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC 27711, USA

^d US Environmental Protection Agency, National Risk Management Research Laboratory, Research Triangle Park, NC 27711, USA

ARTICLE INFO

Article history:

Received 17 June 2016

Received in revised form 5 September 2016

Accepted 12 September 2016

Available online xxx

Keywords:

Aerosols

Highway

Size profiles

Lateral transects

Ultra fine metals

ABSTRACT

As one component of a study investigating the impact of vehicle emissions on near-road air quality, human exposures, and potential health effects, particles were measured from September 21 to October 30, 2010 on both sides of a major roadway (Interstate-96) in Detroit. Traffic moved freely on this 12 lane freeway with a mean velocity of 69 mi/hr. with little braking and acceleration. The UC Davis DELTA Group rotating drum (DRUM) impactors were used to collect particles in 8 size ranges at sites nominally 100 m south, 10 m north, 100 m north, and 300 m north of the highway. Ultra-fine particles were continuously collected at the 10 m north and 100 m north sites. Samples were analyzed every 3 h for mass (soft beta ray transmission), 42 elements (synchrotron-induced x-ray fluorescence) and optical attenuation (350–800 nm spectroscopy). A three day period of steady southerly winds along the array allowed direct measurement of freeway emission rates for coarse ($10 > D_p > 1.0 \mu\text{m}$), $\text{PM}_{2.5}$, very fine ($0.26 > D_p > 0.09 \mu\text{m}$), and ultra-fine ($D_p < 0.09 \mu\text{m}$) particles. The $\text{PM}_{2.5}$ mass concentrations were modeled using literature emission rates during the south to north wind periods, and averaged $1.6 \pm 0.5 \mu\text{g}/\text{m}^3$, versus the measured value of $2.0 \pm 0.7 \mu\text{g}/\text{m}^3$. Using European freeway emission rates from 2010, and modeling them at the I-96 site, we would predict roughly $3.1 \mu\text{g}/\text{m}^3$ of $\text{PM}_{2.5}$ particles, corrected from the 4.9 PM_{10} value by their measured road dust contributions. Using California car and truck emission rates of 1973, this value would have been about $16 \mu\text{g}/\text{m}^3$, corrected down from the $19 \mu\text{g}/\text{m}^3$ $\text{PM}_{5.0}$ using measured roadway dust contributions. This would have included $2.7 \mu\text{g}/\text{m}^3$ of lead, versus the $0.0033 \mu\text{g}/\text{m}^3$ measured. Very fine particles were distributed across the array with a relatively weak falloff versus distance. For the ultra-fine particles, emissions of soot and metals seen in vehicular braking studies correlated with traffic at the 10 m site, but only the soot was statistically significant at the 100 m north site. Otherwise, the 10 m north and 100 m north sites were essentially identical in mean concentration and highly correlated in time for most of the 5 week study. This result supports earlier publications showing the ability of very fine and ultra-fine particles to transport to sites well removed from the freeway sources. The concentrations of very fine and ultra-fine metals from brake wear and zinc in motor oil observed in Detroit have the potential of being a significant component in statistically established $\text{PM}_{2.5}$ mortality rates.

© 2016 Published by Elsevier Ltd.

1. Introduction

Enormous advances have been made in the past 40 years in reducing particulate pollutants from highway vehicles, including the elimination of lead from gasoline. Additionally, important advances have been made in reducing emissions from diesel trucks by improved engine design, low-sulfur fuels, and especially diesel particulate filters. However, studies show that highways continue to be a source of both coarse and fine particulate matter (PM) including known toxics such as diesel exhaust (Zhu et al., 2002; Karner et al., 2010; Cahill and Cahill, 2013). In addition, particles associated from vehicular wear such as from brake pads and drums are currently roughly equal to tailpipe emissions and are on track to exceed tail pipe emissions in the near future (Denier Van der Gon et al., 2013). Only limited data

are available on wear particles by size and composition, but a major source is known to be ultra-fine metals from abrasion of brake pads and drums (Cahill et al., 2014).

In vitro laboratory studies of nanoparticles raise concerns about the health impacts of highway emissions, especially very fine and ultra-fine metals due to their propensity for penetrating to the deepest portions of the lung and diffusing into the circulatory system (Lewis et al., 2005; Chen and Lippmann, 2009; Lippmann, 2009; Oberdorster et al., 2007; Denier Van der Gon et al., 2013). Additionally, epidemiological health studies continue to show that highway emissions are damaging to both pulmonary and cardiovascular systems of people living near highways (Cahill et al., 2011), with reduced lung function in children (Peters et al., 1999a,b; Gauderman et al., 2000; HEI, 2009; Lin and Peng, 2010; Karner et al., 2010). These data have been combined with data on the health impacts of roadway pollutants, including potential cancer impacts largely from diesel exhaust, and used to generate estimated health impacts in models such as Emfac2007 (ARB, 2007).

* Corresponding author.

Email address: tomandginny12@gmail.com (T.A. Cahill)

ITEM 11.1.

2

Atmospheric Environment xxx (2016) xxx-xxx

A recent European survey noted that wear particles were approaching and would soon surpass exhaust particles near roadways, with uncertain health impacts. Their consensus statement concludes, "In light of the continuous increase of the relative contribution of non-exhaust emission to ambient PM, where it is becoming the dominant emission process for urban transport, it is more than timely to devote greater efforts to properly quantifying non-exhaust emissions and assessing health relevance." (Denier Van der Gon et al., 2013).

The U.S. Environmental Protection Agency (EPA) and the University of Michigan conducted the Near-road Exposures to Urban Air Pollutants Study (NEXUS) – a research project to study the impact of vehicle emissions on near-road air quality, human exposures, and potential health effects. Components of NEXUS include but are not limited to human exposures in near-road residences (Vette et al., 2013), studies of near roadway allergic impacts in mice (McGee et al., 2015). The NEXUS aerosol component reported in this publication was designed and conducted to update our information on highway emissions and their potential human impact with a component on vehicular wear emissions.

1.1. Experimental methodologies

1.1.1. Sampling array

Particles were measured from September 21 to October 30, 2010 on both sides of the Interstate 96 freeway 9 miles west of downtown Detroit. The I-96 monitoring location was established as part of a collaborative research study conducted by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Transportation Federal Highway Administration (FHWA) (US EPA, 2013). The test section was a 12-lane section of I-96 with an at-grade roadway configuration aligned east to west. Obstructions from vegetation between the test array of four sites, which extended from 100 m south of the highway to 300 m north of the highway, were negligible, as seen in

Fig. 1. As part of NEXUS, additional PM monitoring was conducted at these sites.

Particles were collected in 8 size ranges at sites 100 m south, 10 m north, 100 m north, and 300 m north of the highway, while ultra-fine particles were continuously collected at the 10 m north and 100 m north sites. (Table 1) All sampling sites were on the top of trailers or one-story buildings with minimal obstructions (approximately 4 m from ground to inlets). The exception was the 100 m south site that had heavy trees south of the site, which did not obstruct the air flow from the highway.

1.1.2. Weather

Wind direction and wind speed were measured continuously at the 100 m north site (Fig. 2). During most of the study winds were weak, and extensive periods of calms occurred, especially at night. Wind directions were most frequent from the northwest (315°) through north northeast (35°). Given the southeast to northwest orientation of the sampling array, an upwind/downwind analysis of I-96 traffic emissions is best conducted when winds are from the southeast to southwest sector.

Thus, in order to address the prime goal of the study, a small fraction of the entire five-week period was chosen for which there was a clean upwind-downwind profile along the array. Since the goal was to quantify aerosol transport downwind of the freeway, results were limited to periods when the upwind-downwind trajectory was within $\pm 67^\circ$ of the north-south axis across the east-west freeway with wind speeds > 1 km/hr. Periods of extreme wind or rain events were excluded as well as wind trajectories pointing back to strong upwind sources such as the Monroe coal-fired power plant.

In terms of duration, while any 3 h period provides a valid signature in time, the ideal is several days in a row. The reasons include reducing the inherent $1\frac{1}{2}$ hr uncertainty in the elemental data set by the width of the x-ray analysis microprobe to roughly 30 min, which al-

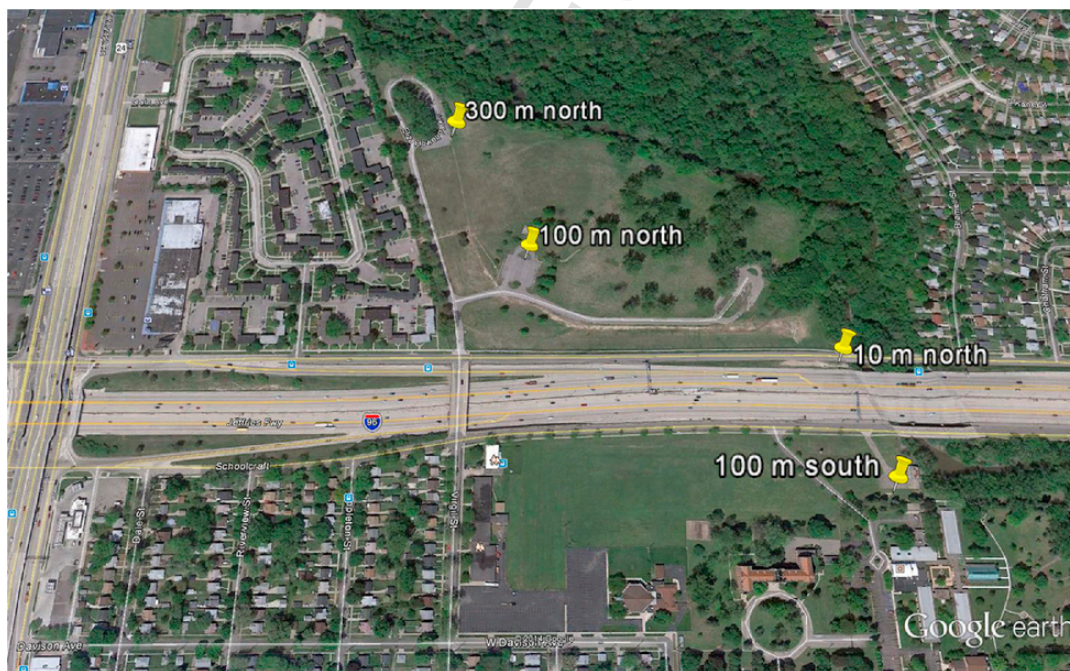


Fig. 1. Monitoring site transect array across I-96 west of Detroit established for the EPA/FHWA National Near Road Study and used as a component of the NEXUS study. I-96 runs east-west and Telegraph Road is the multi lane road running north-south to the west of the sampling sites.

ITEM 11.1.

Atmospheric Environment xxx (2016) xxx-xxx

3

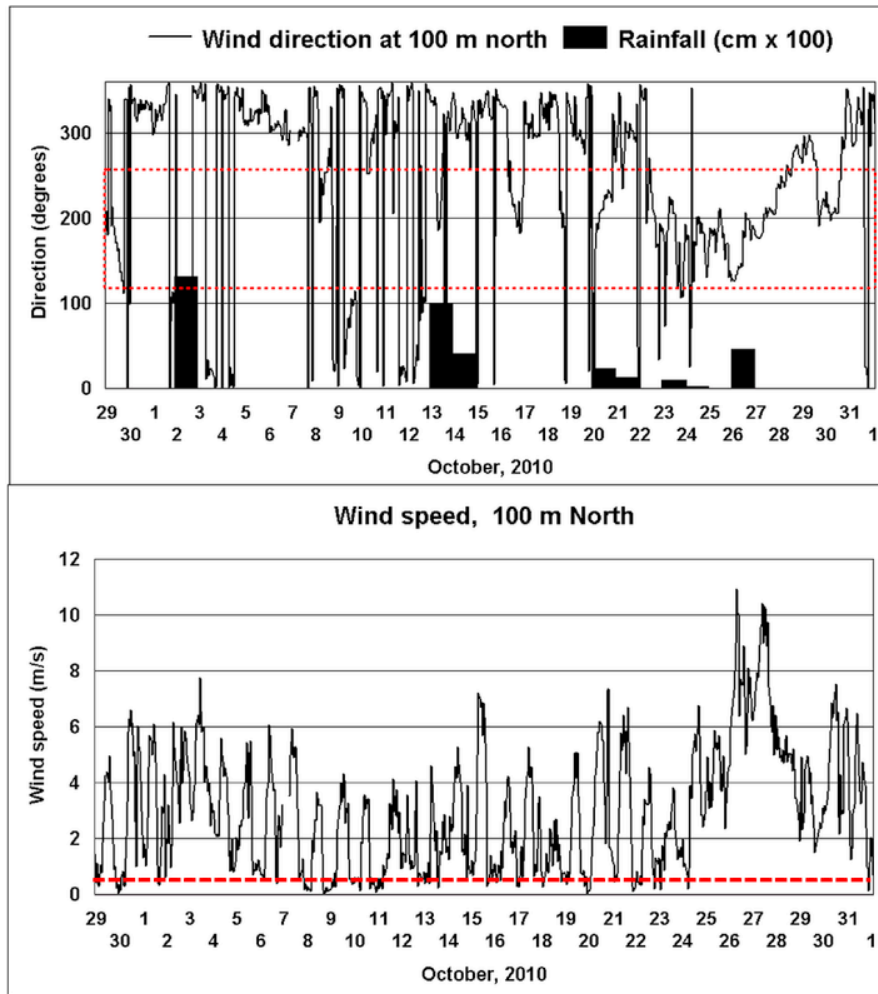


Fig. 2. a) Wind direction and rainfall, and b) wind speed, with the dotted box showing the periods with the wind from the south, $180^\circ \pm 67^\circ$, measured at the 100 m north site. Data below the dashed line are calm periods with wind speed < 1.0 km/hr.

lows better accord with meteorology and traffic patterns. It also allows better sensitivity by summing the periods for averaging actions such as size profiles. Limiting the intensive to week days avoided the complexity of highly variable weekend conditions, especially in terms of the truck traffic.

1.2. Experimental techniques

1.2.1. Sample collection

The primary aerosol collection instrument was the UC Davis DELTA Group rotating drum (DRUM) impactor (Cahill et al., 1985; Raabe et al., 1988;) delivering aerosol samples in 8 size ranges: 10 to 5.0, 5.0 to 2.5, 2.5 to 1.15, 1.15 to 0.75, 0.75 to 0.56, 0.56 to 0.34, 0.34 to 0.26 and 0.29 to 0.09 μm aerodynamic diameter. Samples were impacted at the rate of 4 mm/day onto 168 mm long, lightly greased Mylar foils, which were then transferred to plastic frames for analyses. Excellent agreement ($r^2 = 0.99$, slope = 0.99 ± 0.011 , and intercept = 14 ng/m^3) was seen in a side by side comparison of the DRUM mass (summed over all stages including ultra-fines) versus a California Air Resources Board $\text{PM}_{2.5}$ Federal Reference Monitor (Cahill et al., 2014; Nichols, 2009, Supplemental Materials A).

For this study, a newly developed continuous ultra-fine stage was added at the 10 m north and 100 m north sites. These allow continuous collection of ultra-fine ($< 0.09 \mu\text{m}$) particles directly after the last stage of the DRUM and keyed to deliver a stretched Teflon filter strip exactly matching in time the rotating drum stages (Cahill and Barnes, 2009).

1.2.2. Sample analysis

Details of the accuracy and precision of the mass, optical, and elemental analyses of the DRUM are included in Supplemental Materials. The measurements were made in 3 h increments using 500 μm wide excitation sources, and included:

- Mass (soft beta ray transmission, Ni^{63} source, MDL = $0.7 \mu\text{g/m}^3$).
- Elements sodium through molybdenum, plus lead (Synchrotron-induced X-Ray Fluorescence (S-XRF), MDLs typically $\sim 0.1 \text{ ng/m}^3$).
- Diesel soot (optical attenuation, 380–820 nm, 50 nm bites, Ocean Optics spectrophotometer).

ITEM 11.1.

4

Atmospheric Environment xxx (2016) xxx-xxx

1.3. Black carbon data

Measurements of black carbon were also collected at the I-96 sites based on optical absorption (880 nm) using a Magee Scientific rack mount aethalometer (US EPA, 2013) and were compared to the DRUM optical attenuation.

1.4. Traffic data

Traffic volume during the study period showed a highly reproducible weekly pattern (Fig. 3). Weekday traffic averaged 175,000 cars and light trucks/day along with 12,000 heavy-duty trucks/day, or 6.6% trucks. Weekend traffic averaged 110,000 cars and light trucks/day, and about 3% trucks. Traffic data were collected as part of the EPA/FHWA study in 5 min increments individually for each of the 12 traffic lanes and for 6 classes of vehicle by length: 10 ft. (3 m), 30 ft. (9 m), 40 ft. (12 m), 50 ft. (15 m), 60 ft. (18 m), and 70 ft. (21 m) to 80 ft. (24.2 m), the maximum length allowed (US EPA, 2013). Traffic moved freely on the test section during the study, with

a mean speed of 69 ± 3 miles/hr (110 ± 5 km/hr), with little braking activity. Below we plot the data reduced to one hour averages over all 12 lanes, using the 10 ft. (3 m) and 30 ft. (9 m) categories for cars and pickup trucks (light-duty vehicles or LDVs, mostly gasoline powered) and 40 ft. (12 m) to 70 ft. (24.2 m) for heavy trucks (mostly diesel). The very strong morning and afternoon peaks seen in the light duty vehicle (LDV) data is much less pronounced in the truck data, which tends to be more uniform all day. Traffic data were not available before Sep. 29.

1.5. Results of the 5-week study

The meteorology encountered during most of the study resulted in aerosol concentrations that, even at the close-in 10 m north site, displayed little or no correlation with the local traffic volume (Fig. 3). In Figs. 4–10 below we show four examples of typically regional particles and three examples of particles likely to have local roadway influence. Regional particles include PM_{10} and $PM_{2.5}$ mass, silicon (soil), sulfur (sulfates) and fine potassium (wood smoke). Particles with known roadway sources include zinc in coarse mode

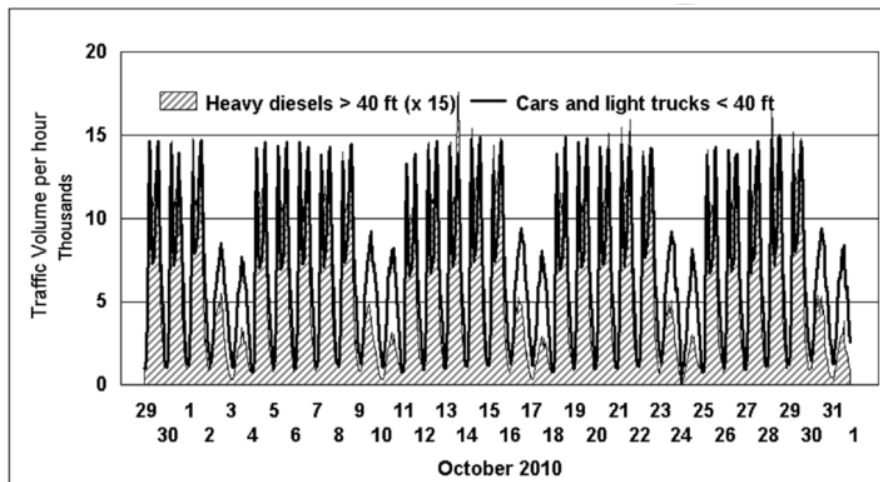


Fig. 3. Traffic measured on I-96 west of Detroit on the EPA/FHWA National Near Road Study site. Heavy diesel truck numbers are scaled by a factor of 15 to facilitate comparison. Weekends occurred on Sept. 25–26, Oct. 2–3, Oct. 9–10, Oct. 16–17, Oct. 23–24, and Oct. 30–31.

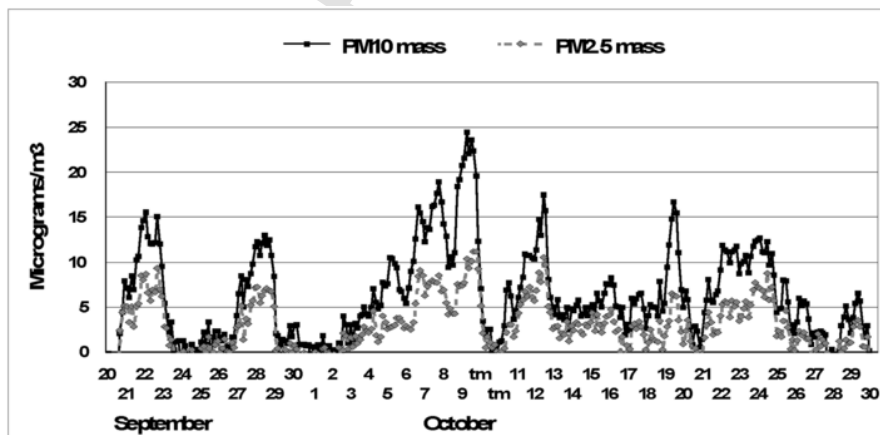


Fig. 4. PM_{10} and $PM_{2.5}$ mass (without ultra-fines $< 0.09 \mu m$), at the 10 m north site. Each data point represents a 3 h measurement. The notation "tm" denotes a 6 mm long integral blank for timing and background subtraction validation.

ITEM 11.1.

Atmospheric Environment xxx (2016) xxx-xxx

5

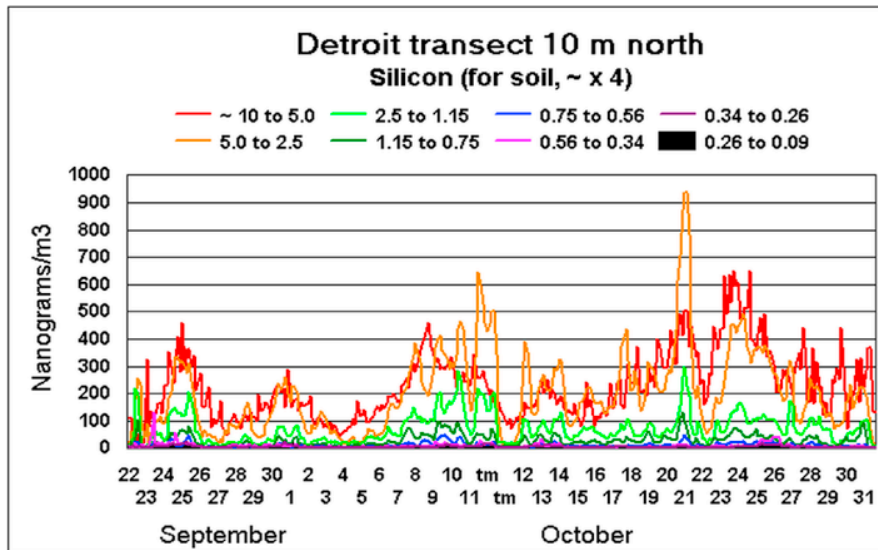


Fig. 5. Silicon from 10 to 0.09 μm derived from soil. The notation “tm” denotes a 6 mm long integral blank for timing and background.

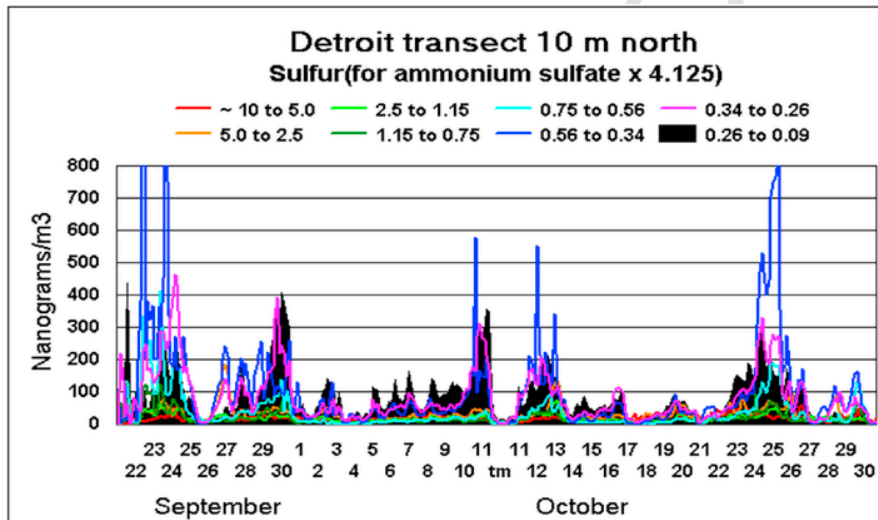


Fig. 6. Sulfur (for sulfate, x 3.0) at 10 m north.

(5.0–1.15 μm) from tire wear, zinc in the very fine mode ($0.26 > D_p > 0.09 \mu\text{m}$) from motor oil combustion, and black carbon (diesel soot) (Malm et al., 1994; Supplemental Materials 1).

Zinc is seen routinely both in transects from the roadway and in the ambient atmosphere. Zinc at the 10 m north site was highly variable in concentration, with highest concentrations typically occurring when the site was upwind of I-96. Note that unlike the potassium in Fig. 7, there are strong sources of coarse zinc not associated with the very fine zinc. Since there were no known sources close to the NEXUS site, the calculated rate of settling favors regional industrial processes with stack emissions.

Optical absorption was measured by two very different techniques, namely light transmission through the DRUM Mylar foils using a multi-wavelength optical spectrometer (Fig. 9), and direct measurement of optical absorption (b_{abs}) from an aethalometer (Fig. 10; data provided by the EPA). The average b_{abs} in units of ng/m^3 of Black Carbon (BC $\cong$ soot) for the entire period was 648 ng/m^3 at

100 m south, 1014 ng/m^3 at 10 m north, 638 ng/m^3 at 100 m north, 438 ng/m^3 at 300 m north, showing the impact of soot from the freeway.

1.6. Results of the 3-day intensive

The conclusion from the aethalometer data is that even close to the freeway, regional sources are a major factor compared to roadway particles for much of the five week study. Thus, for the remainder of this report, we will focus on those periods during which the criteria for a clean upwind-downwind profile were achieved. The results of the transects can then be compared to the regional particles seen during the entire study, isolating roadway impacts.

In order to identify those periods that met these criteria, nonparametric trajectory analysis (NTA) was performed using the meteorological data collected at the 100 m north site (Henry et al., 2011).

ITEM 11.1.

6

Atmospheric Environment xxx (2016) xxx-xxx

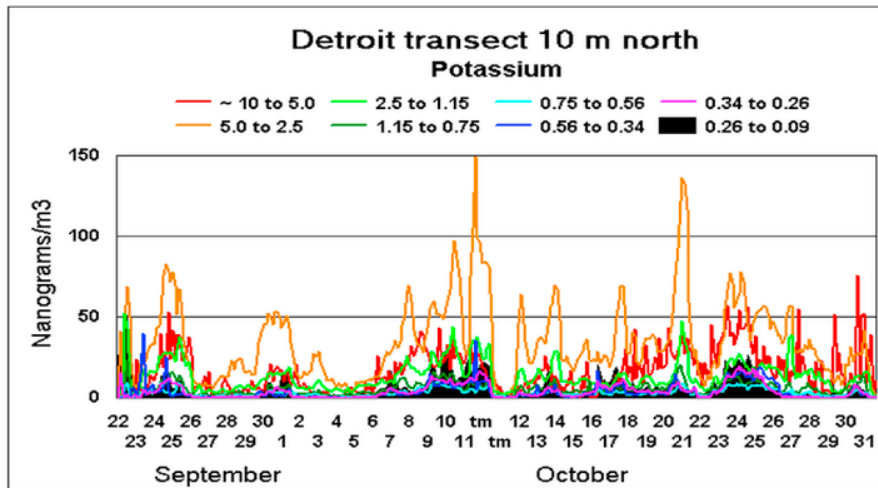


Fig. 7. Potassium at 10 m north, with coarse modes derived from soil and fine modes largely from wood smoke and industrial combustion processes.

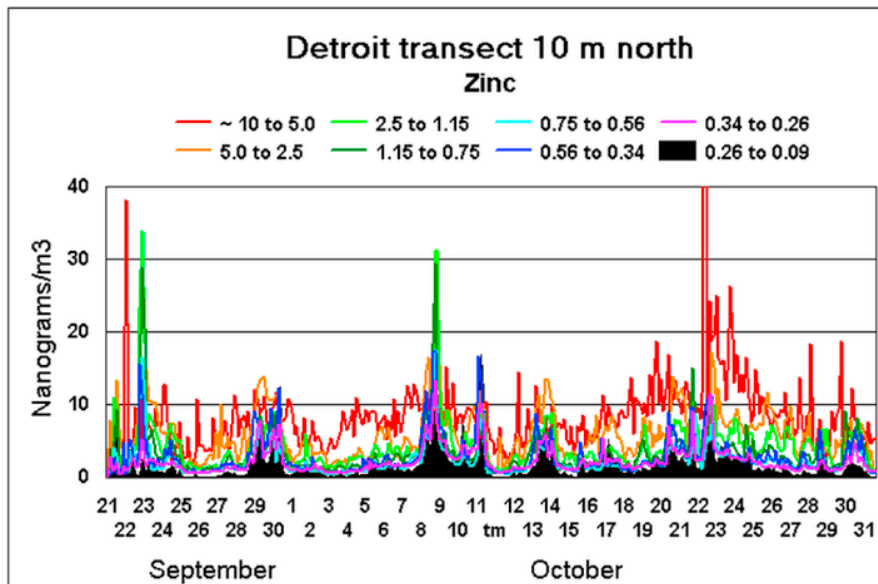


Fig. 8. Zinc from 10 μm to 0.09 μm at 10 m north.

Hourly averaged met data were aggregated into 3 h averages to better match the 3 h aerosol data. Fig. 11 shows the fraction of time in each 3 h period when the wind was blowing across I-96 from the south to the north. Upon early analysis of the data, an additional criterion was added, namely avoidance of sulfur ($\text{MDL} = 5 \text{ ng/m}^3$) and selenium-rich (Se and As, $\text{MDL} = 0.1 \text{ ng/m}^3$) particles transported by SSE winds that passed over the Ford Rouge River complex, other industrial sources, and the large Monroe coal fired power plant 34 miles (54 km) south (185°) of the array (Fig. 6). This eliminated the potential October 25 day, while October 23 and 24 were both weekend days and impacted by upwind aerosol sources. October 30 was also eliminated as a weekend day. Although October 8 and 20 met the trajectory criteria, both had extended periods of calm winds making clean upwind-downwind analysis uncertain. A final criterion for the upwind-downwind study was that the 10 m north site should be minimally impacted by Telegraph Road, a multi lane road west of the I-96

sites (Fig. 1). Fig. 12 shows the subset of trajectories for which the 10 m north site was downwind of I-96 and without significant influence from Telegraph Road.

Although there was some influence of Telegraph Road traffic on Oct. 27 and 28 at the 10 m north site, the distance to Telegraph road was much farther than at the 100 m north site and a belt of trees in a residential neighborhood interfered with wind and aerosol transport. (Fig. 1). Also, Telegraph Road traffic volume was a tiny fraction of I-96 traffic volume. For these reasons, the impact should be small, confirmed by the low aethalometer soot readings (Fig. 13 below). The 300 m north site, on the other hand, is much closer to Telegraph Road and was probably significantly impacted by Telegraph Road traffic for much of the study period. The longest period during the NEXUS campaign that met all criteria for a north-south transect occurred from Oct 26 through Oct. 28, 24–3 h periods, shown in the dashed box in Fig. 11.

ITEM 11.1.

Atmospheric Environment xxx (2016) xxx-xxx

7

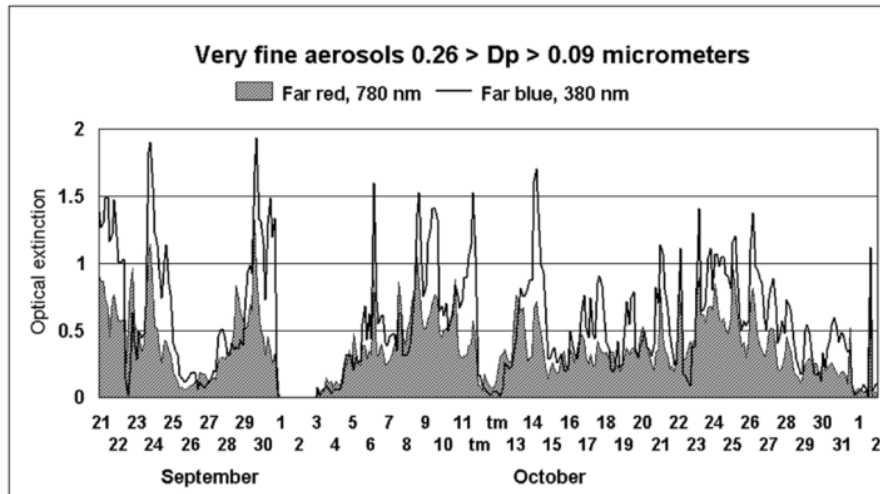
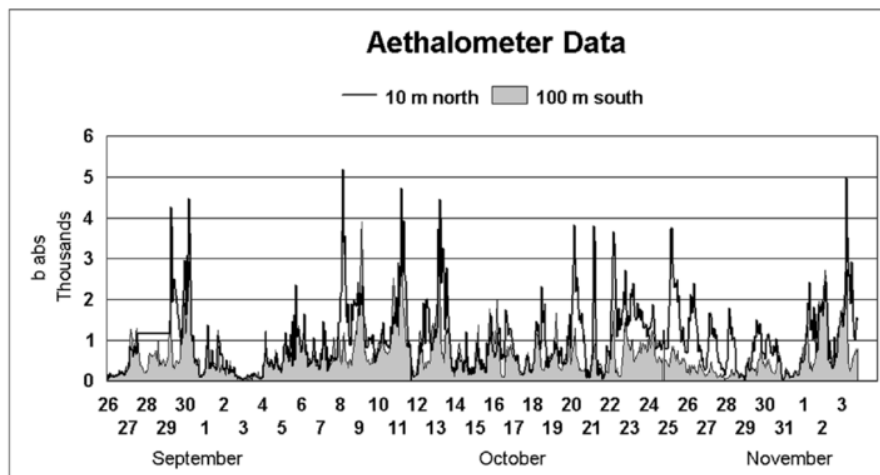


Fig. 9. Optical extinction at two wavelengths for very fine particles at the 10 m north site.

Fig. 10. Optical absorption (b_{abs}) from an aethalometer at both 10 m north and 100 m south.

The wind speed for the 3-day intensive averaged 10.7 ± 3.0 km/hr, and the average direction was SSW, $208 \pm 43^\circ$. However, the 10 m north site was in the turbulent mixed zone of the northernmost lane of the freeway, as evidenced by the winds from passing trucks. Thus, this site was impacted by one lane of the freeway under most wind conditions, representing only a small fraction of all traffic volume on the 12 lane freeway.

1. Validation of the meteorological analysis

Validation of the Oct. 26–28 choice for the upwind-downwind study was obtained by correlation of soot and typical roadway particles with the daily daytime traffic maxima as shown in Figs. 13 and 14.

The days chosen for the intensive are in the dotted box area. Data are from the 10 m north site.

During the intensive period, the calcium (roadbed abrasion) and iron (vehicle “wear”) particles (Fig. 14a and b) are correlated with traffic volume (Fig. 14d), with daytime peaks and nighttime low values, unlike during most of the prior sampling period. Both elements are strongly enhanced over Earth crustal average, calcium by a factor

of 5, and iron by a factor of 10, suggesting resuspension of roadbed concrete erosion and vehicle “wear” particles by wind and vehicular turbulence. There was almost no braking of vehicles during the study, so concentrations of the very fine Fe, Ni, Cu and Zn particles characteristic of braking (Cahill et al., 2014) are limited.

Highway zinc coarse particles (Fig. 14c) are enhanced by the zinc in tires and brake wear, while fine and ultra-fine zinc are observed in both brake wear and the burning of the zinc thiophosphate stabilizer used in many motor and lubricating oils, including diesels (Zielinska et al., 2003).

2. Size profiles of the elements

Fig. 15a, b and c plot particle size distributions during the intensive for crustal species (a), transition metals and lead (b) and sulfur (c). The mean size distributions for crustal elements peak in the supra-micron particles, indicating a mechanical source, such as mechanical wear and resuspension of contaminated soils. Iron is very interesting, as it peaks in the $2.5\text{--}5.0\ \mu\text{m}$ mode but in concentrations far in excess of what would be expected in soil.

ITEM 11.1.

8

Atmospheric Environment xxx (2016) xxx-xxx

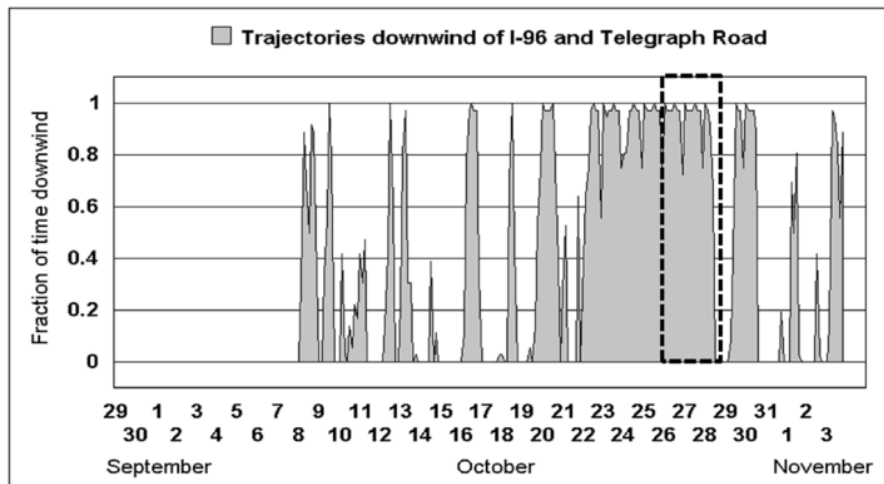


Fig. 11. Trajectory analysis for the 100 m north site isolating those periods when the northern sites were approximately downwind of I-96 and the 100 m south site was a clean upwind background site. The period chosen for the intensive is shown in the dashed box, October 26 through October 28.

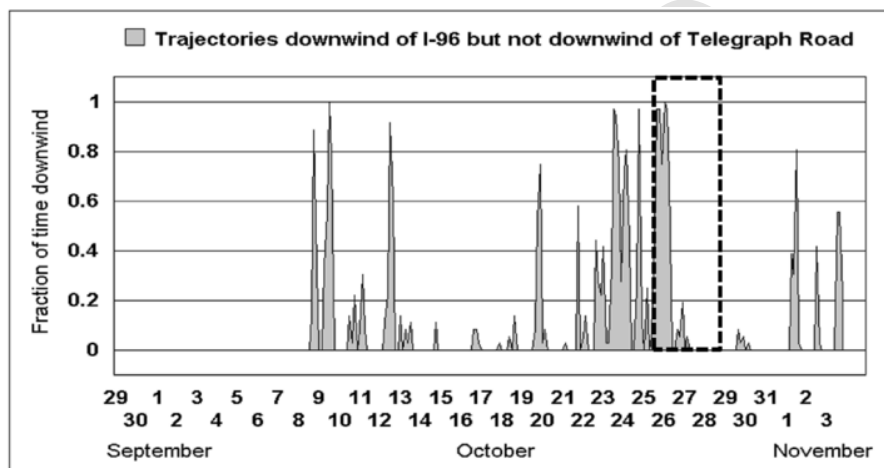


Fig. 12. Trajectory analysis isolating those periods when the 100 m south site was a clean upwind background for 100 m north. The 10 m north site had less Telegraph Road interference.

Size distributions for transition metals (Fig. 15b) also peak in the supra-micron range. Iron (brake drums and rust), copper (brake pads), zinc (stabilizing agent in lube oil, tire wear), and lead ("legacy lead" from past emissions) are known to be associated with traffic (Cahill et al., 2011). Note that in addition to a coarse mode (re-suspended road dust), zinc, lead and copper also exhibit an ultra-fine mode. Very fine and ultra-fine zinc is most likely associated with lubricating oil.

A very different profile is shown for sulfur (Fig. 15c). Typically the accumulation mode around $0.5 \mu\text{m}$ represents regional ammonium sulfate, while very fine and ultra-fine sulfate has local combustion origins, including from diesel combustion in trucks and cars.

3. Transects in the three day intensive: Coarse ($5.0 > D_p > 2.5$) particles – experimental

For the time-resolved coarse particles, we used only part of the distribution since the time resolution of the coarsest DRUM stage, 10 to $5.0 \mu\text{m}$, was large enough to blur the day/night differences. (Supplemental Materials B).

Results of the highway transect (Fig. 16) show highest concentrations at the near freeway site at 10 m north, supporting traffic-derived sources. Concentrations fall off from the roadway to 100 m north, but concentrations of the coarsest particles increase again at 300 m north, especially for crustal species. The presence of the heavily traveled Telegraph Road approximately 380 m west of the 300 m site (Fig. 1) as well as local exposed soils near the site might be contributory factors. In addition, the sampler inlet cut point may have been raised by an estimated 10% due to a non-standard, slightly wider inlet slot. This effect disappeared for the $\text{PM}_{2.5}$ particles which are not influenced by coarse local soils.

4. Transects in the three day intensive: Coarse ($10 \mu\text{m} > D_p > 1.15 \mu\text{m}$) particles – theoretical

I-96 traffic during the intensive was typical of the entire 5 week period (Fig. 2). For modeling purposes, traffic data for the intensive was broken into two periods: daytime (6 a.m. through 9 p.m.), and nighttime (9 p.m. through 6 a.m.). Daytime traffic averaged 10,479

ITEM 11.1.

Atmospheric Environment xxx (2016) xxx-xxx

9

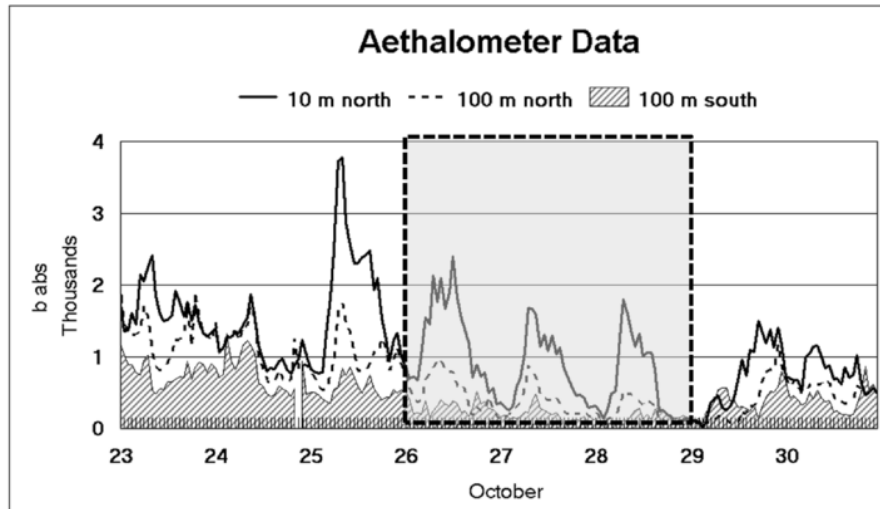


Fig. 13. Aethalometer data on optical absorption ($\sim$ soot) from the EPA/FHWA National Near Road Study. The days chosen for the intensive are in the shaded area. October 25 and earlier days were rejected because of substantial upwind aerosol pollution seen in Figs. 5–7.

cars and light trucks/hr, and 824 heavy trucks/hr, while the numbers at night were 3874 and 187 vehicles/hr respectively.

For the theoretical analysis of the data, all coarse particles from 10 to $1.15\ \mu\text{m}$ were used so as to allow comparisons to other work. We used a Sliding Box Model Estimate of the I-96 10 to $1.15\ \mu\text{m}$ mass emission rate for the 3-day intensive. The “sliding box model” (Cahill and Feeney, 1973; Feeney et al., 1975; Courtney et al., 1978) is a well-tested way to measure roadway emissions when one has access to both upwind and downwind information on pollutants, a flat terrain, and a lateral wind across the roadway. The dimensions of the box are set by the roadway width, including lateral turbulence, and the top of the mixed zone, set by vehicle height and velocity. The latter is the greatest uncertainty, but extensive data on the height of the mixed zone were taken in Los Angeles in 1973 and used in several studies. The length of the box is arbitrary, and we use 1.6 km, which was needed since the project accepted winds at $\pm 45^\circ$ from normal and still had to meet the line source assumption even 300 m downwind. The box so defined represents a volume into which pollutants are uniformly mixed by vehicular turbulence. The box then slides laterally across the freeway while vehicles are emitting into the box. A new box takes its place upwind in a smooth transition and the process repeats.

The model was validated with data taken in 80 two-hr upwind-downwind periods of lead transport from five freeway sites in 1972 (Cahill and Feeney, 1973; Feeney et al., 1975). Since accurate traffic data and meteorology were available and emissions of automotive lead were precisely known from the literature (Habibi, 1973), the sliding box model gave a roadway edge prediction at the at-grade freeway section of $4.0 \pm 0.4\ \mu\text{g}/\text{m}^3$ for 5000 vehicles/hr. The three day average measured at the at-grade site was in excellent agreement, $4.0 \pm 0.15\ \mu\text{g}/\text{m}^3$. The sliding box model was also successfully applied in General Motors test facility studies of sulfur from catalytic converters (Courtney et al., 1978).

Sliding box model calculations were run separately for daytime, 6 a.m. to 9 p.m., and nighttime, 9 p.m. to 6 a.m., keyed to the traffic flow. Traffic flow, wind velocities were also separated in the analysis. It was assumed that trucks had 10 times the emission rates as cars (Gertler et al., 2003). Table 2 below shows the analysis for cars and trucks for calcium, and then the net result for calcium, iron, and zinc.

Coarse calcium and iron are enhanced by enrichment factors 5 and 10 times Earth crustal averages respectively (Fig. 14a and b), likely a consequence of the erosion of the concrete highway and iron-rich debris from vehicles. The transition and heavy metals, vanadium, copper, zinc, and lead, are enormously enhanced compared to Earth crustal averages and represent vehicular debris, including brake pads, brake drums and tire wear.

In this analysis, the unknown emission rates were calculated by matching the predicted concentrations to the measured concentrations at the 10 m north site after correcting for concentrations at the 100 m south site.

In Table 2, the emission rates in mg/km were fit to the NEXUS background corrected concentrations ($\mu\text{g}/\text{m}^3$) at 10 m north (Fig. 14a–c). Matching the upwind-corrected data at the 10 m north site for freeway impact to the predicted concentrations, emission rates of 1.5 mg/km for calcium, 2.8 mg/km for iron, and 0.09 mg/km for zinc are calculated, with truck emission rates 10 times these values.

Direct comparisons are possible to similar analyses in Los Angeles in 1972 from an at-grade concrete freeway. The NEXUS freeway-sourced calcium level in the mixed zone, $0.24\ \mu\text{g}/\text{m}^3$, is about 1/5 of that seen in 1973, $1.13\ \mu\text{g}/\text{m}^3$. Note that the Los Angeles freeway had not seen rain in over 2 months, while rain fell about once/week in the NEXUS study. For iron, which has both a concrete component and one associated with vehicle wear, the NEXUS values are $0.52\ \mu\text{g}/\text{m}^3$, versus $1.43\ \mu\text{g}/\text{m}^3$ in Los Angeles. For zinc, the NEXUS level of $0.017\ \mu\text{g}/\text{m}^3$ is far less than the $0.22\ \mu\text{g}/\text{m}^3$ seen in Los Angeles in 1973. The California data (Cahill et al., 2003) for $15 > D_p > 5.0\ \mu\text{m}$ particles from tire wear were run through the sliding box model of Table 2 and yielded $120\ \text{ng}/\text{m}^3$ of zinc, about 10 times what was observed in NEXUS for $< 5.0\ \mu\text{m}$ particles (Fig. 14c). However, the upper cut point for the Los Angeles particles was $\sim 15\ \mu\text{m}$, which increased the numbers, while better high mileage tires and aerosol size differences reduce the NEXUS value.

A very similar protocol (upwind-downwind samplers, rotating drum impactors, x-ray analysis) was utilized in Switzerland (Bukowiecki et al., 2010) for an extensive series of measurements to separate vehicular wear from exhaust emissions. The Swiss results showed most vehicular wear particles in the 10 to $1\ \mu\text{m}$ range. The vehicular wear results were $50 \pm 13\ \text{mg}/\text{km}$ per vehicle for light duty

ITEM 11.1.

10

Atmospheric Environment xxx (2016) xxx-xxx

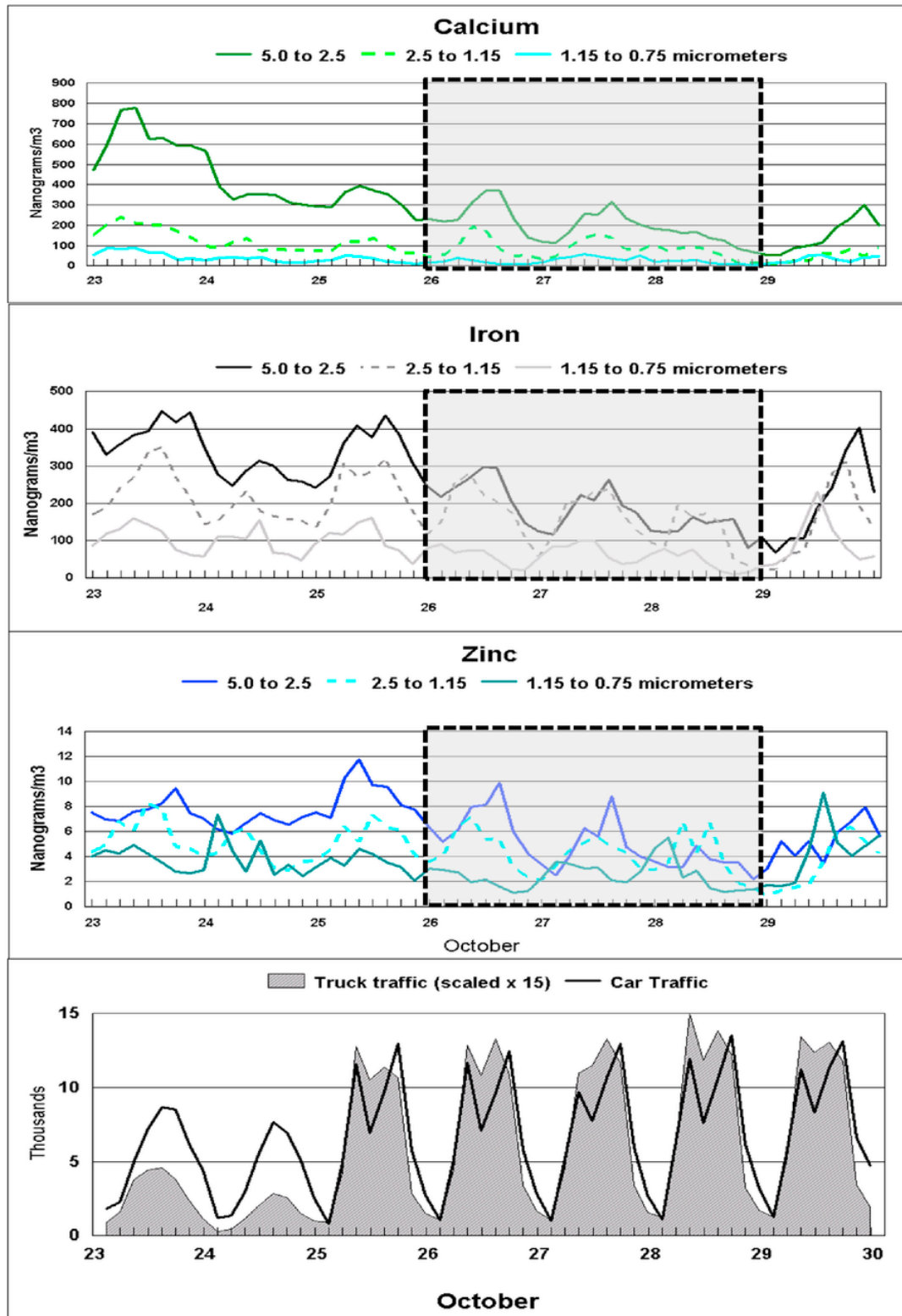


Fig. 14. a, b, and c. Typical roadway particles during the Oct. 26 through Oct 28 intensive (in shaded box). d. Traffic from Fig. 3 on the same time scales (trucks x 15).

vehicles, 288 ± 72 mg/km for heavy duty vehicles, with 3% brake wear, 56% suspended/abraded road dust, and no evident tire wear. This gives roughly 3.2 mg/km brake wear, assuming 6% trucks in

their mix. If the NEXUS iron and zinc were all from brake wear, it would amount to roughly 5.2 mg/km, similar to the Swiss results. This is an overestimate, since the NEXUS iron value should be re-

ITEM 11.1.

Atmospheric Environment xxx (2016) xxx-xxx

11

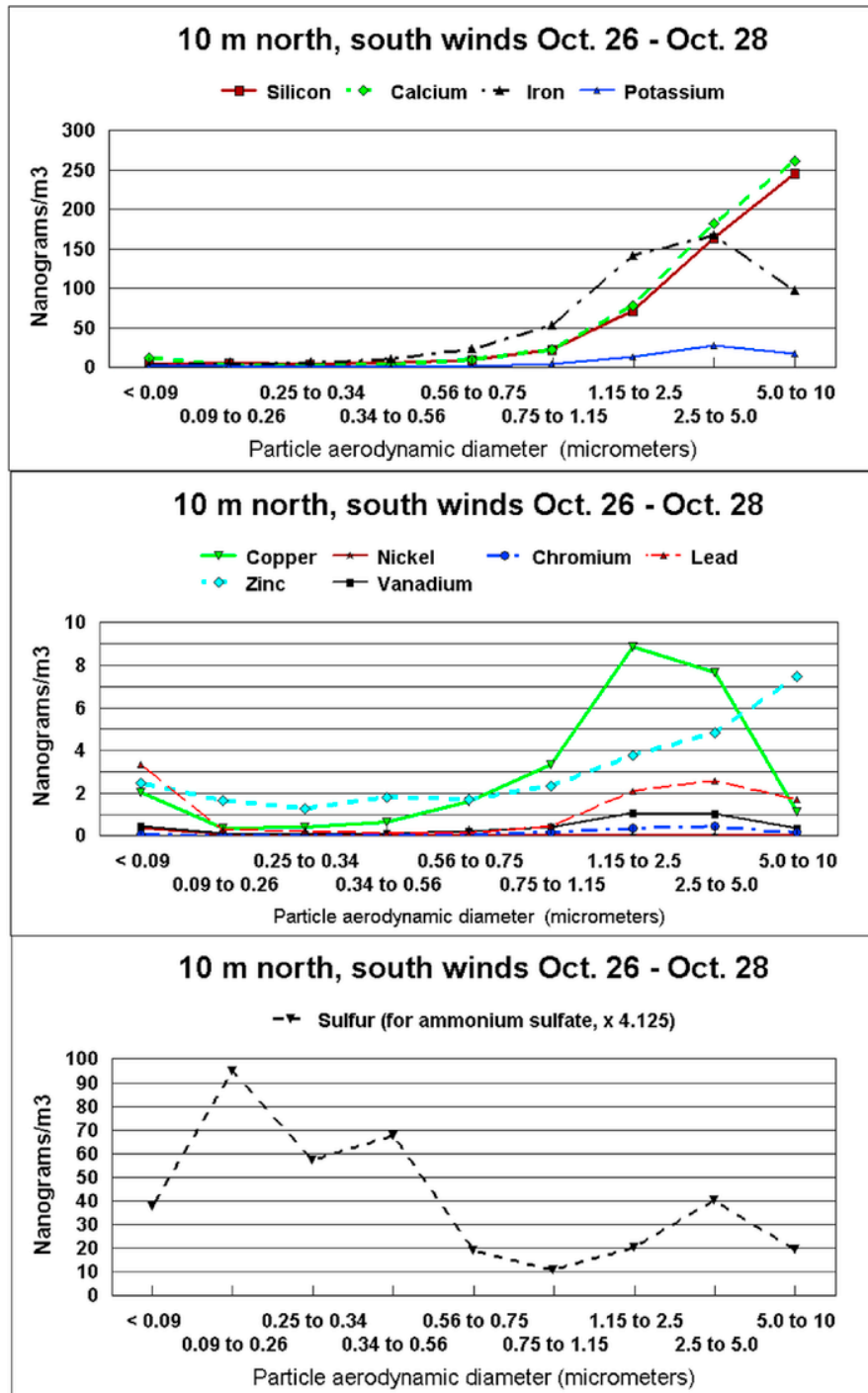


Fig. 15. Size distributions of a) crustal species; b) transition metals and lead; and c) sulfur at the 10 m north site during the NEXUS intensive.

duced due to iron from vehicle debris and roadbed wear.

5. Transects in the three day intensive: Fine $PM_{2.5}$ particles – experimental

Fig. 17a and b shows transects for fine crustal species and fine transition metals and lead, respectively, during the Oct. 26–28 intensive. Fine crustal species, like coarse, show a near-freeway enhancement, especially for iron, enhanced by a factor of 20 over typical

soils. The fall-off versus distance is slower than with coarse species, with aluminum and silicon being essentially the same at the 10 m north and 100 m north sites. The 300 m north site is almost identical to the 100 m south site, consistent with a regional background.

The data clearly show the impact of highway derived particles. First, the aluminum and silicon have about the correct ratio for Earth's crustal averages, and therefore represent crustal materials either in the roadway aggregate or the surrounding soils. The parking

ITEM 11.1.

12

Atmospheric Environment xxx (2016) xxx-xxx

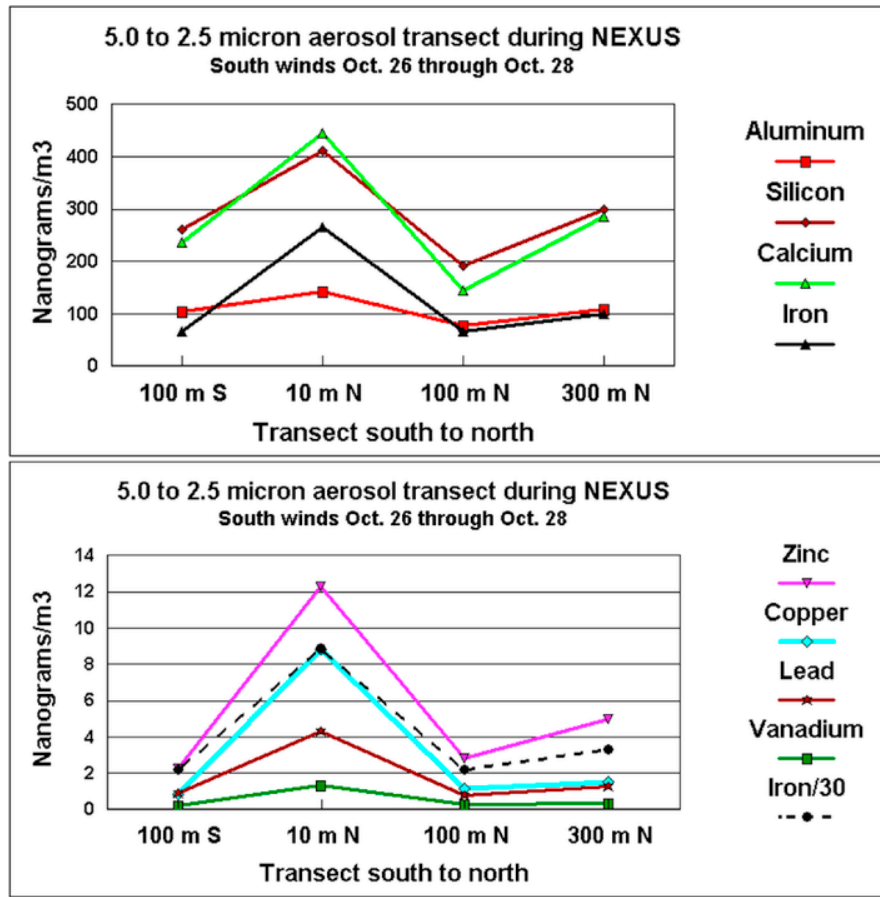


Fig. 16. Coarse aerosol transect during the Oct. 26–28 intensive: a) crustal species; b) transition metals and lead.

Table 1

Distance of samplers from roadway median and nearest active traffic lane of the 10 lane freeway. We also include the relative roadway impacts on cancer from the widely used model Emfac2007 (ARB, 2007).

Site	Distance from median	Distance from closest traffic lane	Relative cancer impact
100 m south	92 m south	71 m south	0.13 upwind
10 m north	26 m north	10 m north	1.00 downwind
100 m north	142 m north	100 m north	0.25 downwind
300 m north	332 m north	270 m north	0.10 downwind

area just upwind of the 100 m north site may also be a source of such materials. Calcium, however, is enhanced by a factor of about 3 over Earth's crustal average, and is consistent with roadway abrasion from the concrete highway. Iron is enhanced by a factor of about 10, which is consistent with brake wear and resuspended rust in a region where road salting is a common source of vehicle degradation. Fine copper (Fig. 17b) also shows enhancement, possibly from brake pads. In summary, fine concentrations of these resuspended soil and vehicular wear particles are about 1/2 of the observed mass, similar to European estimates that “wear” particles are about equal to tailpipe emissions (Denier Van der Gon et al., 2013).

All the non-crustal elements as well as zinc show a near freeway enhancement during the Oct. 26–28 intensive. All are strongly enhanced over what would be expected from soil, suggesting roadway pollution. The iron is about 16× the copper, while the iron/copper ratio from braking is only about 3. Thus, most of the iron is not from brake drums and pads, but probably represents re-suspended rust particles from degraded cars and trucks. Recall that little vehicular braking occurred in this freeway section. The 300 m north site is almost identical to the 100 m south site, establishing a small regional background. The fall-off versus distance for zinc is much slower, and the upwind value elevated, showing regional fine zinc aerosol sources. The enhanced zinc at 10 m north may be due to the zinc thiophosphate oil additive.

6. Transects in the three day intensive: Fine $PM_{2.5}$ particles – theoretical

In the sliding box model, we assumed an I-96 $PM_{2.5}$ mass emission rate (row labeled “Source $PM_{2.5}$ mass” in Table 3) based on recently measured car and truck emission rates for $PM_{2.5}$ in the eastern US (Gertler et al., 2003). The sliding box model was then used to calculate $PM_{2.5}$ values downwind of the freeway which were compared to measured $PM_{2.5}$ concentrations.

The results shown in Table 3 can be compared to the PM concentrations measured at the 10 m north site which was just on the edge of the lateral turbulence zone. The 24 h average $PM_{2.5}$ estimated for the 3 day intensive was $1.6 \pm 0.5 \mu g/m^3$, versus the measured 2.0 ± 0.7

ITEM 11.1.

Atmospheric Environment xxx (2016) xxx-xxx

13

Table 2

Sliding box model of coarse ($10 > D_p > 1.15 \mu\text{m}$) particles for daytime periods during the NEXUS 3 day intensive. LDV = Light duty vehicles, cars and light trucks (Class 1, 2); HDV = Heavy duty vehicles, trucks (Class 3–6).

Site		I-96 Detroit	I-96 Detroit	I-96 Detroit	I-96 Detroit	I-96 Detroit
Date	October 26–28, 2010	Calcium	Calcium	Calcium	Iron	Zinc
Time	15 h blocks	Days 6–21	Days 6–21	Days 6–21	Days 6–31	Days 6–21
Vehicle type	Classes	LDV	HDV	Total cars and trucks	Total cars and trucks	Total cars and trucks
Fit to data	mg/km	1.5	15.0	1.5, 15	2.8, 28.3	0.09, 0.90
Box dimensions	height m	5	5	5	5	5
	width m	54	54	54	54	54
	length m	1000	1000	1000	1000	1000
Box volume	x 1000 m ³	270	270	270	270	270
Traffic	vehicles/hr	10,479	824	11,303	11,303	11,303
Speed	mi/hr	69	69	69	69	69
Speed	km/hr	110.4	110.4	110.4	110.4	110.4
vehicles in box	# vehicles	95	7	102	102	102
Emissions	mg/min	142	112	254	480	15.3
Concentration in box per minute	$\mu\text{g}/\text{m}^3$	0.53	0.41	0.94	1.78	0.057
Wind velocity	m/second	3.1	3.1	3.1	3.1	3.1
Sliding box translation	Seconds	17.4	17.4	17.4	17.42	17.4
Sliding box translation	Fraction of minute	0.29	0.29	0.29	0.29	0.29
Calculated concentration at 10 m north	$\mu\text{g}/\text{m}^3$	0.153	0.120	0.273	0.517	0.0164
Measured concentrations 10 m north	$\mu\text{g}/\text{m}^3$			0.242 $\pm$ 0.050	0.516 $\pm$ 0.05	0.0169 $\pm$ 0.008
Los Angeles 1972						
5.0–15 μm	mg/mi			6.2, 62	8, 80	1.2, 12
Concentration in mixed zone	$\mu\text{g}/\text{m}^3$			1.13	1.43	0.22

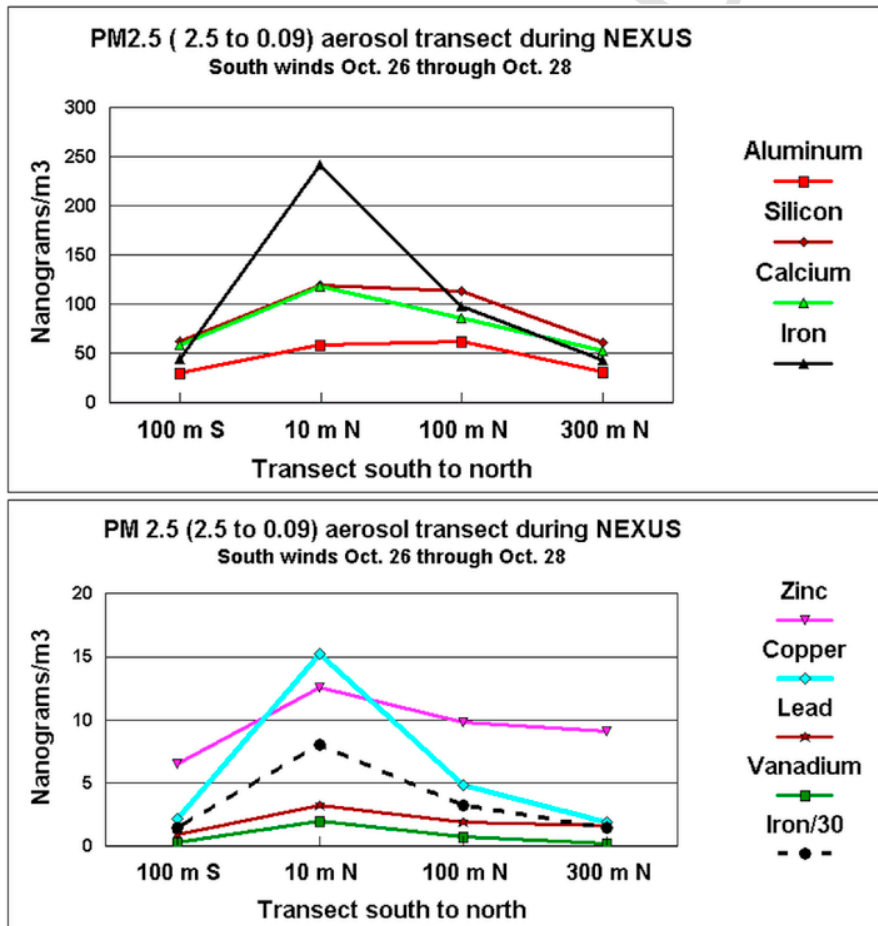


Fig. 17. Fine aerosol transect during the Oct. 26–28 intensive: a) crustal species; b) transition metals and lead.

ITEM 11.1.

14

Atmospheric Environment xxx (2016) xxx-xxx

Table 3

Sliding box model of the three day intensive, when meteorological and traffic conditions were suitable. Also shown are the Swiss data (2010) and Los Angeles data (1973) estimated from measured values.

Emission rate estimates		Gertler et al., 2003 eastern US Daytime 6 to 21	Gertler et al., 2003, eastern US Daytime 6 to 21	Gertler et al., 2003, eastern US 24 h average	Bukowiecki et al., 2010, Swiss freeways 24 h average	Cahill and Feeney, 1973, LA freeways 24 h average
Time	15 h increment					
Vehicle type	Classes	LDV	HDV	All vehicles	All vehicles	All vehicles
Source PM _{2.5} mass	mg/km	14	135	14/135	50/288	1056
Box dimensions	height m	5	5	5	5	5
	width m	54	54	54	54	54
	length m	1000	1000	1000	1000	1000
Box volume	x 1000 m ³	270	270	270	270	270
Traffic	vehicles/hr	10,479	824	7682	7682	7682
Speed	km/hr	110	110	110	110	110
vehicles in box	# vehicles	95	7	70	70	70
Emissions	mg/min	1329	1008	1528	4538	17,636
Concentration in box per minute	µg/m ³	4.9	3.7	5.7	16.9	65.3
Wind velocity	m/second	3.1	3.1	3.1	3.1	3.1
Sliding box translation	Seconds	17.4	17.4	17.4	17.4	17.4
Sliding box translation	Fraction of minute	0.29	0.29	0.29	0.29	0.29
Calculated PM _{2.5} Concentration	µg/m ³	1.43, 1.08	0.53, 0.25	1.6 ± 0.5	4.9 ± 1.2	19.0 ± 3
Size ranges	µg/m ³	PM _{2.5}	PM _{2.5}	PM _{2.5}	PM ₁₀	PM _{5.0}
Measured PM _{2.5} Concentrations (some estimated)	µg/m ³			2.0 ± 0.7	3.1 ± 1(est)	16 ± 2 (est)

µg/m³. Note that the Gertler et al., 2003 emission values were for California cars and fuels.

Table 3 also includes estimates of the 10 m north concentrations based on the Swiss (Bukowiecki et al., 2010) and Los Angeles (Habibi, 1973; Cahill and Feeney, 1973) freeway emission rates. The Swiss study gave PM₁₀ emission rates of 50 ± 13 mg/km for light duty vehicles, and 288 ± 72 mg/km for heavy duty vehicles. Applying these emission rates to the NEXUS configuration, one would predict about 4.9 µg/m³ PM₁₀ mass at the freeway edge, slightly less than the 10 µg/m³ to 19 µg/m³ PM_{2.5} values reported as the traffic-impacted Central European average (Denier Van der Gon et al., 2013). The Swiss data included about ½ roadway crustal particles, which would likely reduce their 4.9 µg/m³ PM₁₀ values to around 3.1 µg/m³ of PM_{2.5}.

The right hand column of Table 3 is the predicted 24 h PM_{5.0} mass at the 10 m north site using the emission rates from the 1973 Los Angeles study (Habibi, 1973). The mean estimated PM_{2.5} mass concentration of 19 µg/m³, would also have included 2.7 µg/m³ of lead. Making the correction for presumed coarse roadway wear particles, the 1973 PM_{5.0} data would be reduced to roughly 16 µg/m³ equivalent PM_{2.5} in the NEXUS configuration.

7. Transects in the three day intensive: Very fine (0.26 µm > D_p > 0.09 µm) particles

Very fine particles (Fig. 18) were less impacted by distance from the freeway compared to fine and coarse particles. These results reinforce the behavior seen in the Los Angeles I-710 studies (Fig. 19, Zhu et al., 2002) in which very fine and ultra-fine components extended both upwind and downwind from the array with little change in concentration with distance from the freeway once one was farther away than about 150 m (see Fig. 19).

1.7. Ultra-fine particles

The development of a means to measure ultra-fine particles as a function of time allows for the first time the ability to match compositionally-resolved ultra-fine particles to potential sources and meteorology. Two such units were built and tested to run behind the

DELTA 8 DRUM, which has a validated lower cut point of 0.09 µm. Thus, for this study, ultra-fine particles are particles having aerodynamic diameters <0.09 µm. These two units were placed at the 10 m north site and the main site at 100 m north, and ran for 5 weeks to match the 8 DRUMs.

The ultra-fine data did not have an upwind site, but the agreement between the 10 m north and 100 m north sites is confirmation of a regional distribution. The major exception to this pattern was optical attenuation (Fig. 13), which in the 0.26 > D_p > 0.09 µm size mode is almost entirely soot, largely from diesel trucks. We did not measure soot in the DRUM ultra-fine mode.

An examination of the 3 day intensive period at 10 m north showed that, of the four elements known to be present in the ultra-fine size ranges from traffic, zinc and iron show some modest correlation with daytime traffic peaks (Fig. 21). Recall, however, that relatively little braking occurs on this stretch of I-96.

Ultra-fine particles at the 100 m north site showed essentially no correlation with daytime traffic, in accord with the factor of ~10 reduction seen in previous studies (Cahill and Feeney, 1973; Zhu et al., 2002; Emfac2007). For diesel-generated ultra-fine sulfur, (Zielinska et al., 2004), the freeway contribution is largely lost in high levels of ultra-fine sulfur associated with upwind sources possibly including the Monroe coal-fired power plant.

2. Discussion

The particles in the NEXUS study ranged from coarse concrete erosion and resuspended roadway particles contaminated with tire and brake drum debris, to very fine and ultra-fine particles generated by traffic and diverse regional sources.

The behavior of the particles during the three day transect intensive was roughly as expected, with coarser particle concentrations declining rapidly downwind while fine and especially very fine particle concentrations dropped more slowly, as shown in Figs. 16–18.

The agreement between the predictions of the sliding box model and the observed near-roadway PM_{2.5} concentrations (Table 3) gives confidence that literature emission rates used in the model must be close to reality. The results also highlight the enormous improvement in vehicle tailpipe emissions in the past 40 years.

ITEM 11.1.

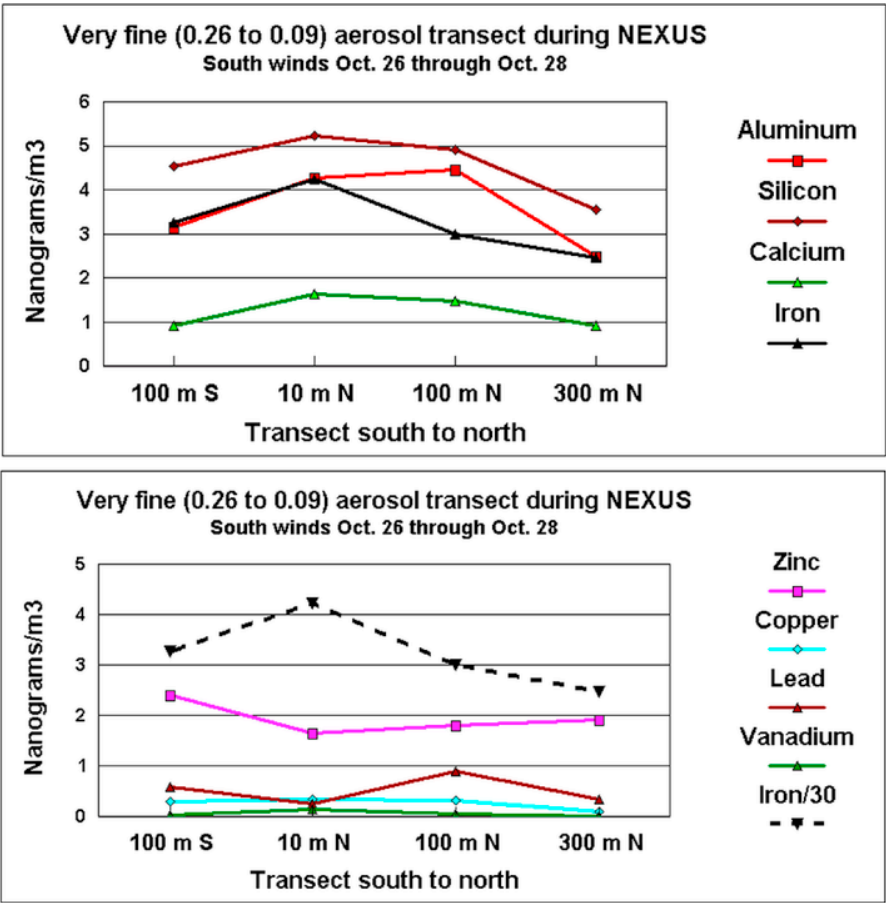


Fig. 18. Very fine aerosol transect during the Oct. 26–28 intensive. a) crustal species; b) transition metals and lead.

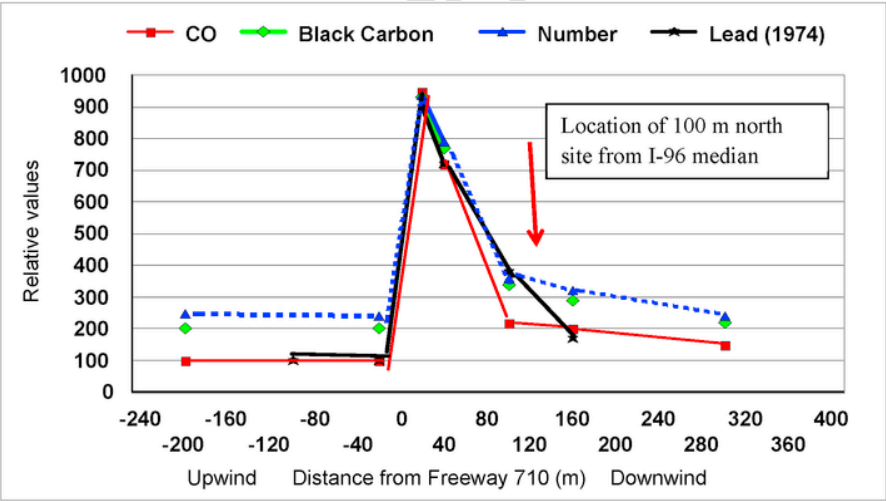


Fig. 19. Transect of Interstate 710 in Los Angeles from Zhu et al. (2002). Superimposed are lead data from 1973 (Cahill and Feeney, 1973; Feeney et al., 1975). The arrow marks the distance of the 100 m north site from the I-96 median in the present study.

The situation with the ultra-fine particles, on the other hand, indicates a dominance of regional concentrations little affected by the nearby freeway traffic with the striking exception of optical absorption (diesel soot) as seen in both optical spectroscopy from the

DRUM finest stages and the aethalometer data (Fig. 13). The ultra-fine particles have elemental signatures consistent with brake wear and zinc in motor oil, but the concentrations are small, consistent with little braking on that section of I-96 during the 3 day intensive.

ITEM 11.1.

16

Atmospheric Environment xxx (2016) xxx-xxx

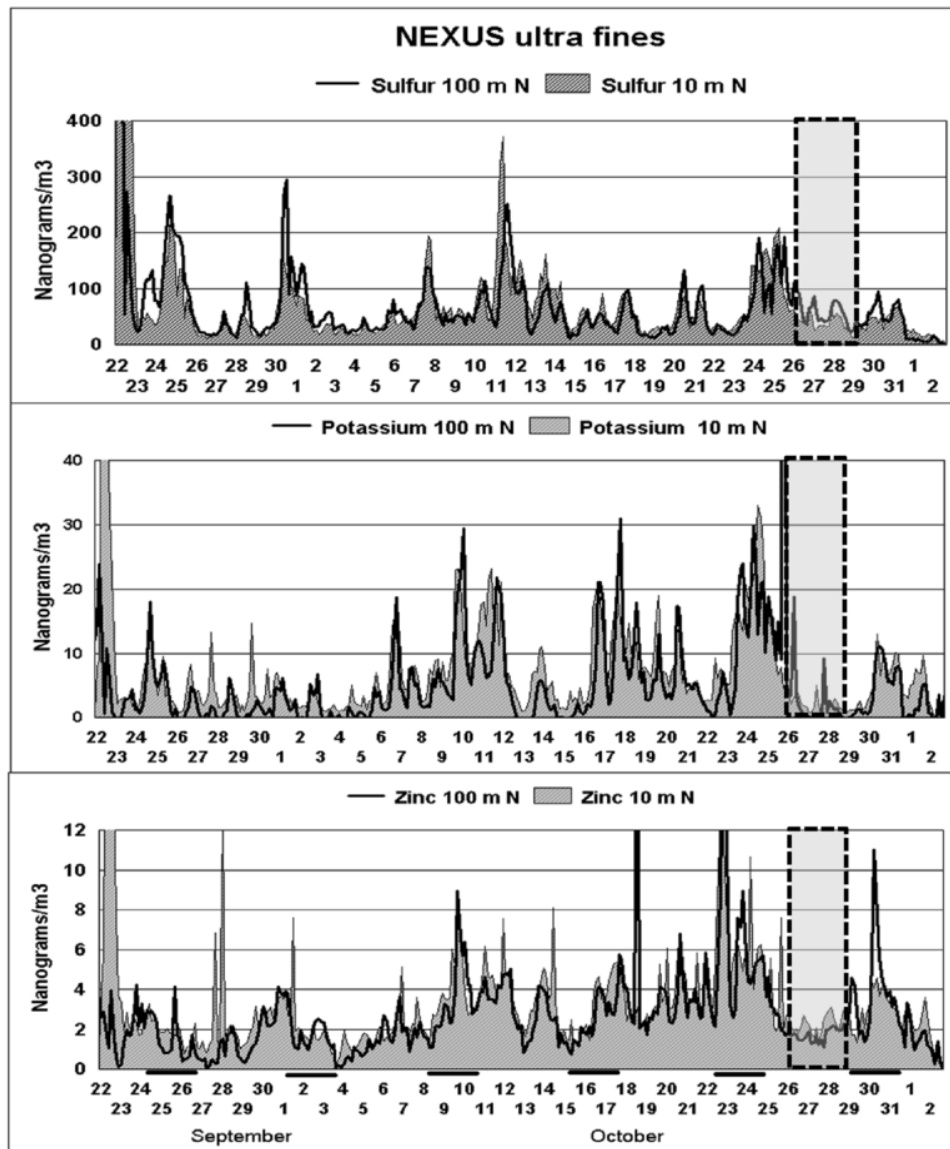


Fig. 20. Ultra-fine sulfur, potassium, and zinc at the 10 m N and 100 m N sites. The large ultra-fine sulfur peaks on October 24 through 25 were likely from the Monroe coal fired power plant. The Sept. 30 and Oct. 12 plumes were from a source to the north. Black lines above the dates in the zinc plot are weekends.

These three days were selected when there was minimal impact from Telegraph Avenue which had extensive stop and go periods. The ultra-fine data are a more extreme case of the behavior seen in the very fine particles, which had large regional sources and fell off slowly downwind.

The potential exposure and human health implications of these particles can be estimated by comparison with recent work tying roadway-derived ultra-fine particles to ischemic heart disease in the California Central Valley (Cahill et al., 2011). An increase in IHD mortality of ~30% at Bakersfield, CA, was associated with elevated levels of very fine and ultra-fine roadway-derived transition metal particles, mostly from brake drums and pads (Table 4 below). However, the concentrations in Detroit were generally far lower than those measured in Bakersfield.

As shown in Table 4, ultra-fine concentrations measured at the 10 m north and 100 m north sites are similar to those at Watt Avenue

(Spring) in Sacramento, CA measured 20 m downwind of a 65,000 vehicles/day secondary street, at a stop light, during non-inversion conditions (Cahill et al., 2014). In both cases, little influence was seen from the nearby roadway, and the ultra-fine particles were regionally distributed. However, there was only very limited braking and acceleration during the NEXUS intensive, thus limiting concentrations of brake wear particles. Nevertheless, if the observed ultra-fine metallic particles seen in the NEXUS experiment extend over large numbers of people, it could potentially enhance the ischemic heart disease death rate in the same manner seen in Bakersfield, CA (Cahill et al., 2011).

3. Conclusions

Important differences in the behavior of particles of different sizes were observed during this study. For coarse species, the fall-off in concentration versus distance was rapid, roughly in accord with cur-

ITEM 11.1.

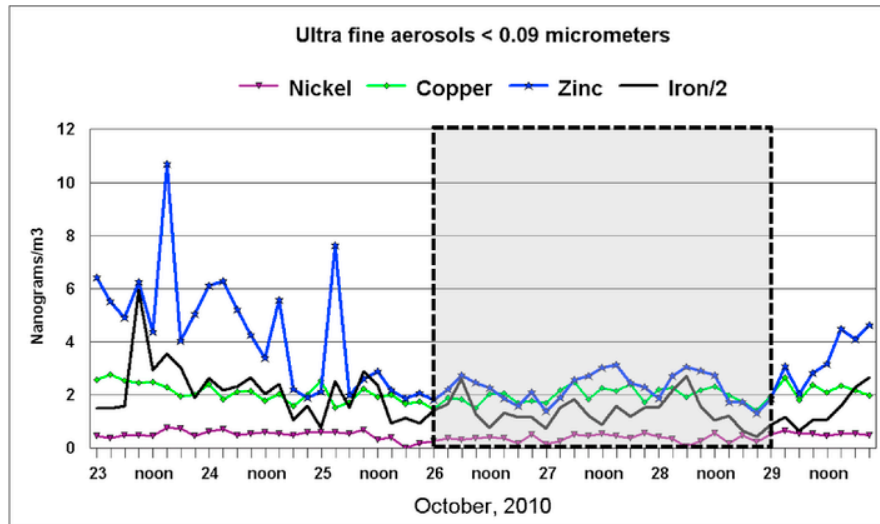


Fig. 21. Ultra-fine nickel, copper, iron and zinc at 10 m north during the 3 day intensive.

Table 4

Comparison of ultra-fine ($D_p < 0.09 \mu\text{m}$) traffic-derived particles measured in NEXUS versus Watt Ave. in suburban Sacramento, CA during spring non-inversion conditions (Cahill et al., 2014). NEXUS concentrations are 5-week averages. na = not available. For comparison, winter values which are impacted by strong surfaced-based inversions in the California Central Valley are included. The sources of the high nickel values seen at Watt Avenue in winter were totally absent 500 m upwind, so they must be associated with Watt Avenue traffic. Such levels, however, have never been seen in our other studies.

Ultra-fine elements (ng/m^3)	S	P	Fe (non-soil)	Ni	Cu	Zn	Pb
Non-inversion conditions							
Detroit							
10 m n	68.1	10.5	3.4	0.5	1.9	3.2	2.9
100 m n	61.4	9.5	3.4	0.5	1.8	2.6	3.3
Watt Ave (Spring)	129	na	4.8	0.3	0.4	2.0	1.4
Strong inversions conditions							
Watt Ave (Winter)	42.8	na	29.3	12.1	9.3	13.7	1.6
Sacramento (Winter)	52	4.0	14.3	0.6	na	14.3	2.5
Bakersfield (Winter)	242	10.5	27.7	1.6	na	12.3	2.6

rent models such as Emfac2007. Concentrations were strongly affected by meteorology such as wind velocity and rain fall. For the $\text{PM}_{2.5}$ particles, the fall off versus distance was still close to the models, reaching a 90% reduction in freeway-derived particles in the 200–250 m range. Very fine particles, $0.26 > D_p > 0.09 \mu\text{m}$ diameter, persisted all the way to the 300 m downwind site, with only a modest reduction in concentrations. Ultra-fine particles were only measured at two sites, 10 m north and 100 m north, and the concentrations at both sites were almost identical indicating a very slow fall off and/or strong upwind sources. The persistence of ultra-fine particles in urban areas away from freeways was also observed in the Los Angeles data (Zhu et al., 2002).

A 3-day period of southerly winds provided an opportunity to conduct an upwind-downwind highway transect to assess the impact of roadway emissions. For $\text{PM}_{2.5}$, the transect yielded a measured near-roadway $\text{PM}_{2.5}$ concentration of $2.0 \pm 0.7 \mu\text{g}/\text{m}^3$ versus a value of $1.6 \pm 0.5 \mu\text{g}/\text{m}^3$ predicted from recent California vehicle emission rates and $\sim 3 \mu\text{g}/\text{m}^3$ using current European freeway data. Thus, measured $\text{PM}_{2.5}$ concentrations at the near-road site showed excellent agreement with predicted $\text{PM}_{2.5}$ concentrations assuming recent published emission rates. By contrast, using 1973 emission rates one would predict roughly $16 \mu\text{g}/\text{m}^3$ of $\text{PM}_{2.5}$, thus illustrating the dra-

matic progress that has been made in reducing roadway emissions in the US during the past four decades.

The NEXUS and European estimates of the contribution of brake drums were also similar, although numerous assumptions are needed to make the comparison. The European value is roughly $3.2 \text{ mg}/\text{km}$ brake wear, assuming 6% trucks in their mix. The NEXUS iron values were strongly enhanced over soil concentrations, indicating roadway sources including brake wear. The fine and very fine zinc particles were too fine in size to be from tire erosion. With these assumptions, the expected emission rate from brake wear is roughly $5.2 \text{ mg}/\text{km}$, similar to the European values especially after some iron reduction from vehicle debris and roadbed wear.

For ultra-fine particles, there was a dramatic increase in diesel soot, closely tied to traffic volumes, but only a modest increase in traffic-correlated zinc and other transition metals during the 3 day intensive. For the rest of the 5 week study, mean elemental concentrations were essentially identical at the 10 m and 100 m north sites and highly correlated in time. Further, this correlation existed independent of wind direction, including having both the 10 m north and 100 m north sites upwind of the freeway. From these results, we conclude that most of the time the freeway was a negligible enhancement of a regional ultra-fine background of transition metals.

The regional ultra-fine species closely resembled those seen in a recent study of stop-and-go traffic on a heavily traveled secondary road with heavy braking (Cahill et al., 2014). These particles are similar in composition to debris from brake pads, drums, and the zinc additive in motor oil (Cahill et al., 2011). These results reinforce the behavior seen in the Los Angeles I-710 studies (Zhu et al., 2002) for ultra-fine particle number and black carbon, e.g., these components extended well upwind of the freeway and were soon reestablished at the same concentrations downwind beyond 150 m, thus showing a regional distribution of ultra-fines well away from the local freeway.

The NEXUS data also support the conclusions of Zhu et al. (2002) that little coagulation or particle size growth was seen in ultra-fines from freeways, as both Zhu's ultra-fine soot and particle number data were essentially identical versus distance with non-reactive CO.

The conclusion from this study is that for traffic on a freely flowing, high speed freeway with little braking and acceleration, almost all ultra-fine particles except for diesel soot, and most of the very fine particles, are generated from diverse vehicular and industrial sources

ITEM 11.1.

18

Atmospheric Environment xxx (2016) xxx-xxx

in the region and are not directly associated with local freeway traffic.

Uncited reference

Acknowledgements

The authors gratefully acknowledge the assistance in meteorological models of Ron Henry, as well as the detailed aethalometer, meteorological and traffic data of the US EPA/FHWA study (US EPA, 2013). The United States Environmental Protection Agency through its Office of Research and Development funded and collaborated in the research described here under contract EP-12-D-000219 to the University of California, Davis. It has been subjected to Agency review and approved for publication.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.atmosenv.2016.09.023>.

References

- ARB, 2007. Emfac2007. California Air Resources Board. http://www.arb.ca.gov/msei/onroad/downloads/docs/user_guide_emfac2007.pdf.
- Bukowiecki, N., Lienemann, P., Hill, M., Furger, M., Richard, A., Amato, F., Prévôt, A.S.H., Baltensperger, U., Buchmann, B., Gehrig, R., 2010. PM10 emission factors for non-exhaust particles generated by road traffic in an urban street canyon and along a freeway in Switzerland. *Atmos. Environ.* 44, 2330–2340.
- Cahill, T.A., Feeney, P.J., 1973. Contribution of Freeway Traffic to Airborne Particulate Matter. Final Report of the California Air Resources Board, Contract ARB-502.
- Cahill, T.A., Goodart, C., Nelson, J.W., Eldred, R.A., Nasstrom, J.S., Feeney, P.J., 1985. In: In: Ariman, Teoman, Nejat Veziroglu, T. (Eds.), *Design and Evaluation of the Drum Impactor. Proceedings of International Symposium on Particulate and Multi-phase Processes*. vol. 2. Hemisphere Publishing Corporation, Washington, D.C., pp. 319–325.
- Cahill, T.A., Barnes, D.E., 2009. Comparison of Fine Mass, UC Davis DRUM versus FRM, at the ARB 13th and T Street Site. Final Report to the California ARB (2009).
- Cahill, Thomas A., Barnes, David E., Spada, Nicholas J., Lawton, Jonathan A., Cahill, Thomas M., 2011. Very fine and ultra-fine metals and ischemic heart disease in the California Central Valley I: 2003 – 2007. *Aerosol Sci. Technol.* 45, 1125–1134.
- Cahill, T.A., Barnes, D.E., Lawton, J.A., Miller, R., Spada, N.J., Cliff, S.S., Zhou, Y.J., Perry, K.D., Cahill, C.F., 2010. Continuous Aerosol Sampling and Analysis in Support of Health Based Studies. Final Report to W. Wilson, US EPA RFQ-RT-09-00122.
- Cahill, T.A., 2010. How does Vegetation affect pollution removal. In: *The Workshop on the Role of Vegetation in Mitigation Air Quality Impacts from Traffic Emissions EPA RTP North Carolina April 27, 28*.
- Cahill, Thomas M., Cahill, Thomas A., 2013. Seasonal variability of particle-associated organic compounds near a heavily traveled secondary road. *Aerosol Sci. Technol.* <http://dx.doi.org/10.1080/02786826.2013.857757>.
- Cahill, T.A., Barnes, D.E., Spada, N.J., 2014. Seasonal variability of ultra-fine metals downwind of a heavily traveled secondary road. *Atmos. Environ.* 94, 173–179.
- Chen, L.C., Lippmann, M., 2009. Effects of metals within ambient air particulate matter (PM) on human health. *Inhal. Toxicol. Int. Forum Resp. Res.* 21, 1–31.
- Courtney, W.J., Rheingrover, S., Pilotte, J., Kaufmann, H.C., Cahill, T.A., Nelson, J.W., 1978. Continuous observation of particulates during the general motors sulfate dispersion experiment. *J. Air Pollut. Control Assoc.* 28, 225–228.
- Denier Van der Gon, H., Gerlofs Nijland, M., Gehrig, R., Gustafsson, M., Janssen, N., Harrison, R., Hulskotte, J., Johansson, C., Jozwicka, M., Keuken, M., Krijgheld, K., Ntziachristos, L., Riediker, M., Cassee, F., 2013. The policy relevance of wear emissions from road transport, now and in the future – an international workshop report and consensus statement. *J. Air Waste Manag. Assoc.* 63, 136–149.
- Feeney, P.J., Cahill, T.A., Flocchini, R.G., Eldred, R.A., Shadoan, D.J., Dunn, T., 1975. Effect of roadbed configuration on traffic derived aerosols. *J. Air Pollut. Control Assoc.* 25, 1145–1147.
- Gauderman, W.J., McConnell, R., Gilliland, F., London, S., Thomas, D., Avol, E., Vora, H., Berhane, K., Rappaport, E.B., Lurmann, F., Margolis, H.G., Peters, J., 2000. Association between air pollution and lung function growth in southern California children. *Am. J. Respir. Crit. Care Med.* 162, 1383–1390.
- Gertler, Alan, Abu-Allaban, Mahmoud, Coulombe, William, Gillies, John A., Pierson, William R., Rogers Rogers Fred, C., Sagebiel, John C., Tarnay, Leland, Cahill, Thomas A., 2003. Measurements of mobile source particulate emissions in a highway tunnel. *Int. J. Veh. Des.* 27, 86–93.
- Habibi, Kamran, 1973. Characterization of particulate matter in vehicle exhaust. *Environ. Sci. Technol.* 7 (3), 223–234. <http://dx.doi.org/10.1021/es60075a001>.
- Health Effects Institute, 2009. Traffic Related Air Pollution: a Critical Review of the Literature on Emissions, Exposure, and Health Effects. HEI 17, Boston, MA.
- Henry, Ronald C., Vette, Alan, Norris, Gary, Vedantham, Ram, Kimbrough, Sue, Shores, Richard C., 2011. Separating the air quality impact of a major highway and nearby sources by nonparametric trajectory analysis. *Environ. Sci. Technol.* 45, 10471–10476. <http://dx.doi.org/10.1021/es202070k>.
- Karner, A.A., Eisinger, D.S., Neimeier, D.A., 2010. Near roadway air quality: synthesizing the findings from real world data. *Environ. Sci. Technol.* 44, 5334–5344.
- Lewis, T.C., Robins, T.G., Dvonch, J.T., Keeler, G.J., Yip, F.Y., Mentz, G.B., Lin, X.H., Parker, E.A., Israel, B.A., Gonzalez, L., Hill, Y., 2005. Air pollution-associated changes in lung function among asthmatic children in Detroit. *Environ. Health Perspect.* 113, 1068–1075.
- Lin, C.C., Peng, C.K., 2010. Characterization of indoor PM10, PM2.5, and ultra-fine particles in elementary school classrooms: a review. *Environ. Eng. Sci.* 27, 915–922.
- Lippmann, Morton, 2009. Semi-continuous speciation analyses for ambient air particulate matter: an urgent need for health effects studies. *J. Expo. Sci. Epidemiol. Stud.* 19, 235–247.
- Malm, W.C., Sisler, J.F., Huffman, D., Eldred, R.A., Cahill, T.A., 1994. Spatial and seasonal trends in particle concentration and optical extinction in the United States. *J. Geophys. Res.* 99 (1), 1347–1370.
- McGee, M.A., Kamal, A.S., McGee, J.K., Wood, C.E., Dye, J.A., Krantz, Q.T., Landis, M.S., Gilmour, M.I., Gavett, S.H., 2015. Differential effects of particulate matter upwind and downwind of an urban freeway in an allergic mouse model. *Environ. Sci. Technol.* 49 (6), 3930–3939.
- Nichols, M., 2009. Letter and Appended Report from the Staff of the California Air Resources Board.
- Oberdorster, Gunter, Stone, Vicki, Donaldson, Ken, 2007. Toxicology of nanoparticles: a historical perspective. *Nanotoxicology* 1 (1), 2–25.
- Peters, John M., Avol, Edward, Navidi, William, London, Stephanie J., James Gauderman, W., Lurman, Fred, Linn, William S., Margolis, Helene, Rappaport, Edward, Gong Jr., Henry, Thomas, Duncan C., 1999a. A study of Twelve southern California communities with differing levels and types of air pollution I. Prevalence of respiratory morbidity. *Am. J. Respir. Crit. Care Med.* 159 (3), 760–767.
- Peters, John M., Avol, Edward, Navidi, William, London, Stephanie J., James Gauderman, W., Lurman, Fred, Linn, William S., Margolis, Helene, Rappaport, Edward, Gong Jr., Henry, Thomas, Duncan C., 1999b. A study of Twelve southern California communities with differing levels and types of air pollution; II. Effects on pulmonary function. *Am. J. Respir. Crit. Care Med.* 159 (3), 768–775.
- Raabe, Otto G., Braaten, David A., Axelbaum, Richard L., Teague, Stephen V., Cahill, Thomas A., 1988. Calibration studies of the DRUM impactor. *J. Aerosol Sci.* 19 (2), 183–195. Personal communication 1995.
- US EPA, 2013. FHWA and EPA National Near-road Study. Detroit, MI. Report No. DTFH61-07-X-30015 http://www.fhwa.dot.gov/environment/air_quality/airtoxics/research_and_analysis/near_road_study/detroit_michigan/index.cfm.
- Vette, A., Burke, J., Norris, G., Landis, M., Batterman, S., Breen, M., Isakov, V., Lewis, T., Gilmour, M.I., Kamal, A., Hammond, D., Vedantham, R., Bereznicki, S., Tian, N., Croghan, C., 2013. The near-road exposures and effects of urban air pollutants study (NEXUS): study design and methods. *Sci. Total Environ.* 448, 38–47.
- Zielinska, B., Goliff, W., McDaniel, M., Cahill, T., Kittelson, D., Watts, W., 2003. Chemical Analyses of Collected Diesel Particulate Matter Samples in the E-43 Project. National Renewable Energy Laboratory.
- Zielinska, B., Sagebiel, J., McDonald, J.D., Whitney, K., Lawson, D.R., 2004. Emission rates and comparative chemical composition from selected in-use diesel and gasoline fueled vehicles. *J. Air Waste Manag. Assoc.* 54, 1138–1150.
- Zhu, Y., Hinds, W.C., Kim, S., Shen, S., Sioutas, C., 2002. Study of ultra-fine particles near a major highway with heavy duty diesel traffic. *Atmos. Environ.* 36, 4323–4335.

Freeway Pollution

L.A. keeps building near freeways, even though living there makes people sick

Are you one of the 2.5 million Southern

Californians already living in the pollution zone?

By **TONY BARBOZA AND JON SCHLEUSS**

MARCH 2, 2017, 3 A.M.

1 dot = 1 person living within 1,000 feet of a freeway in 2010

For more than a decade, California air quality officials have warned against building homes within 500 feet of freeways.

And with good reason: People there suffer higher rates of asthma, heart attacks, strokes, lung cancer and pre-term births. [Recent research](#) has added more health risks to the list, including childhood obesity, autism and dementia.

Yet Southern California civic officials have flouted those warnings, allowing a surge in home building near traffic pollution, according to a Los Angeles Times analysis of U.S. Census data, building permits and other government records.

ITEM 11.1.

In Los Angeles alone officials have approved thousands of new homes within 1,000 feet of a freeway — even as they [advised developers](#) that this distance poses health concerns.

Play Video

The city issued building permits for 4,300 homes near freeways in 2015 — more than in any year over the last decade — and signed off on an additional 3,000 units last year.

Public funds, including millions of dollars from California's cap-and-trade program to cut greenhouse gas emissions, are going to developers to build new homes in freeway pollution hot spots.

The population near Los Angeles freeways is growing faster than elsewhere in the city as planners push developers to concentrate new housing near transportation hubs, convinced that increasing urban density will help meet state targets for greenhouse gas reductions.

More than 1.2 million people already live in high-pollution zones within 500 feet of a Southern California freeway, with more moving in every day. Between 2000 and 2010 — the most recent period available — the population within 500 feet of a Los Angeles freeway grew 3.9%, compared with a rate of 2.6% citywide.

Orsini

- 1,072-unit apartment complex
- Opened in three phases between 2004 and 2010
- 1-bedroom apartment rents for \$2,000 to \$2,500 a month
- Developer Geoffrey H. Palmer has built thousands of units near downtown L.A. freeways and plans more

Have you ever lived near a freeway?

ITEM 11.1.

Tell us your story



Los Angeles City Councilman José Huizar, who lives several hundred feet from Interstate 5, said freeway pollution is such an urgent and complex problem that he wants the city to establish buffer zones. He called for a “comprehensive, citywide study of development near freeways that would analyze all impacts of limiting development around freeways.”

ITEM 11.1.

Other elected officials and business groups argue that Los Angeles is so thoroughly crisscrossed by freeways that restricting growth near them is impractical and would hamper efforts to ease a severe housing shortage. In some cases, city officials are paving the way by re-zoning industrial land along freeways and other transportation corridors.

In an interview at a recent groundbreaking for a freeway-adjacent apartment project, Los Angeles Mayor Eric Garcetti said that he grew up near the 101 and 405 freeways and that many in his family had cancer.

But he said he opposes any restrictions on how many homes can be built near freeways and thinks that improving air-filtration, building design and tailpipe emissions are a better way to reduce risks to residents.

“I take this stuff very seriously, but I also know that in looking for housing we have a very constricted city,” he said.

Garcetti spokesman Carl Marziali noted that a prohibition on building within 1,000 feet of freeways, for example, would cover more than 10% of land currently zoned for residential construction in the city, from Westwood to Boyle Heights and San Pedro to Sherman Oaks. But proponents of stricter planning, including supporters of Measure S, a proposal on the March 7 ballot that would place new restrictions on development, have criticized city officials for approving what they term “black lung lofts.”

How close to the freeway are you?

ITEM 11.1.

Low rent and a location near shops and restaurants are what brought Jeremiah Caleb to an apartment on Beloit Avenue, where a sound wall is all that separates the 405 freeway from sleek new apartments and lofts advertising “good living.”

But life got worse for Jeremiah and his wife Angel soon after moving into that one-bedroom on the Westside of Los Angeles.

The couple began to struggle with bouts of coughing, sneezing and headaches. They kept the windows shut, yet a grimy, black film settled regularly over the furniture, counters and even their skin — a never-ending reminder of the vehicle exhaust and soot they were breathing just 100 feet from 14 lanes of traffic.

“We were constantly sick,” said Caleb, an actor in his 30s. The couple worried enough about dirty air that they put off having children. “We were desperate to leave, but we felt stuck. We just couldn't afford it.”

Business groups have consistently opposed any suggestion of restricting development near heavy traffic.

“Freeways are part of Los Angeles' fabric and prohibiting housing by them is unrealistic,” said Carol Schatz, president of the Downtown Center Business Improvement District. She argues that such restrictions would worsen the housing crisis and severely limit the ability to build housing near mass transit.

The Southern California Assn. of Governments, the regional planning agency for Los Angeles, Ventura, Orange, Riverside, San Bernardino and Imperial counties, has projected that the population within 500 feet of a freeway will increase by a quarter million people by 2035.

ITEM 11.1.

Rob McConnell, a professor of preventive medicine at USC who studies roadway pollution, is one of a number of health researchers who has advised city officials not to allow new housing that close to freeways.

“I tell them you’re going to make a lot of people sick,” McConnell said.

Play Video

Scientists have long known that polluted air cuts lives short.

But pinpointing the harmful agents in traffic pollution is difficult because it’s a stew of ingredients including toxic combustion gases, microscopic soot particles, compounds from worn tires and dust from vehicle brake pads. Recent research has narrowed in on one component of special concern: ultra-fine particles, pollutants in freshly emitted vehicle exhaust that can be five to 10 times higher near traffic.

The invisible, chemical-laden specks are less than one-thousandth the width of a human hair — so tiny they are hard to capture with pollution controls or filters. Scientists suspect ultra-fine particles are able to pass through the lungs and into the bloodstream, where they may harm the heart, brain and other organs. Yet they remain unregulated by state and federal authorities.

That emerging science has raised concerns that decades of government regulations, aimed at curbing smog that builds up across vast urban areas, are not sufficiently tailored to the more localized problem of roadway pollution.

ADVERTISEMENT

Two years ago, state environmental officials concluded that diesel soot and other carcinogens in vehicle exhaust pose nearly three times the cancer risk previously thought.

ITEM 11.1.

In a [long-term study](#), USC researchers have for more than two decades measured the lung capacity of thousands of school children across Southern California. They found that children growing up near major roadways have higher rates of asthma and other respiratory illnesses, including deficits in lung function that can be permanent and lead to a lifetime of health problems.

Even in communities with cleaner air, such as Santa Maria near the Santa Barbara County coast, children living near traffic had the same lung function loss as those in Riverside and other smoggy inland areas, the scientists found.

Anthony Moretti, chairman of pediatrics at White Memorial Medical Center in Boyle Heights, said children who live close to freeways are among those who most frequently land in the emergency room struggling to breathe and in need of treatment for asthma and other respiratory diseases.

“These kids will come in four, five, six times over a six-month period, and clearly their environment is a factor,” he said. “I feel for these families because they suffer an undue burden of illness simply because of where they live.”

Public health officials have long warned that traffic pollution can drift well over 1,000 feet from traffic — and more recent research suggests that it may waft more than a mile.

Yet it took lawsuits and a nationwide mandate from the U.S. Environmental Protection Agency to force Southern California air quality officials to begin regularly measuring pollution near Southern California freeways in 2014.

ITEM 11.1.

The first readings confirmed that people near freeways breathe higher levels of the exhaust gases nitrogen dioxide and carbon monoxide. Then, in 2015, the South Coast Air Quality Management District detected the region's highest concentrations of fine particulate matter at a new monitoring station 30 feet from the 60 Freeway in Ontario. The findings added compelling evidence that traffic emissions are piling on top of regional smog, hitting people near freeways with a double dose of pollution.

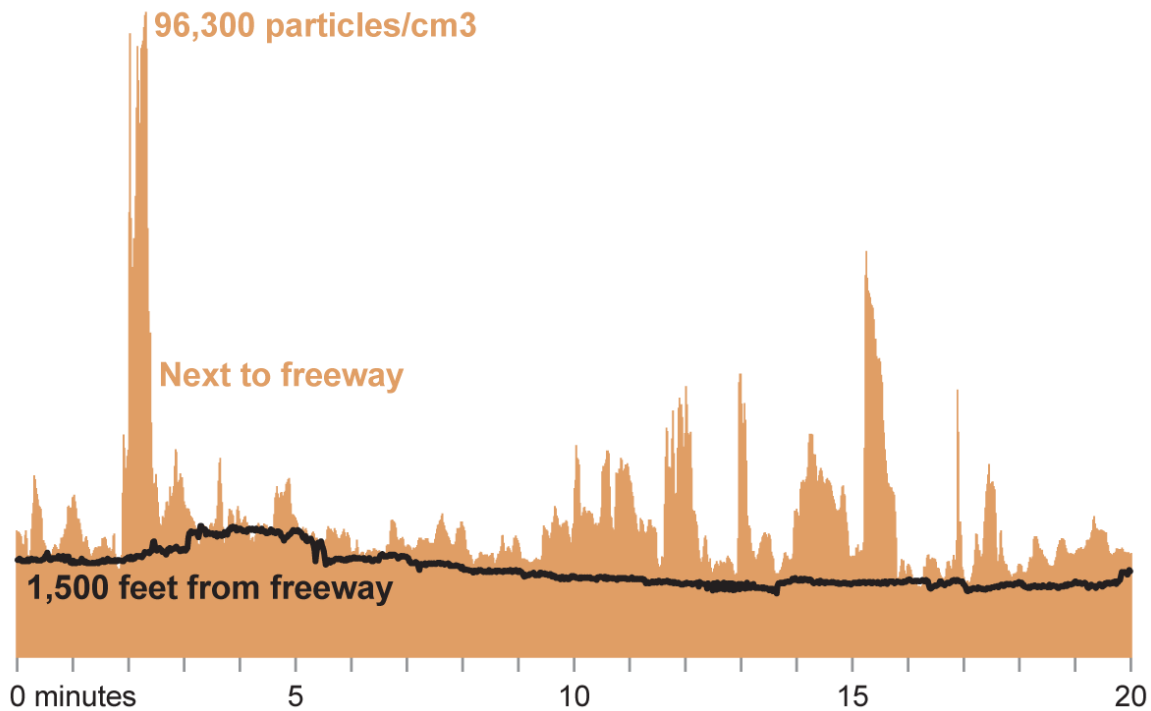
To learn more about the problem, The Times conducted air quality testing at sites where new housing is planned near Los Angeles freeways.

In August and September of 2015, reporters collected air samples at several locations using portable pollution sensors that detect ultra-fine particles, the microscopic pollutants in vehicle exhaust. One set of air samples was taken next to stretches of the 110 and 5 freeways and another set was taken 1,500 to 1,800 feet from the freeways.

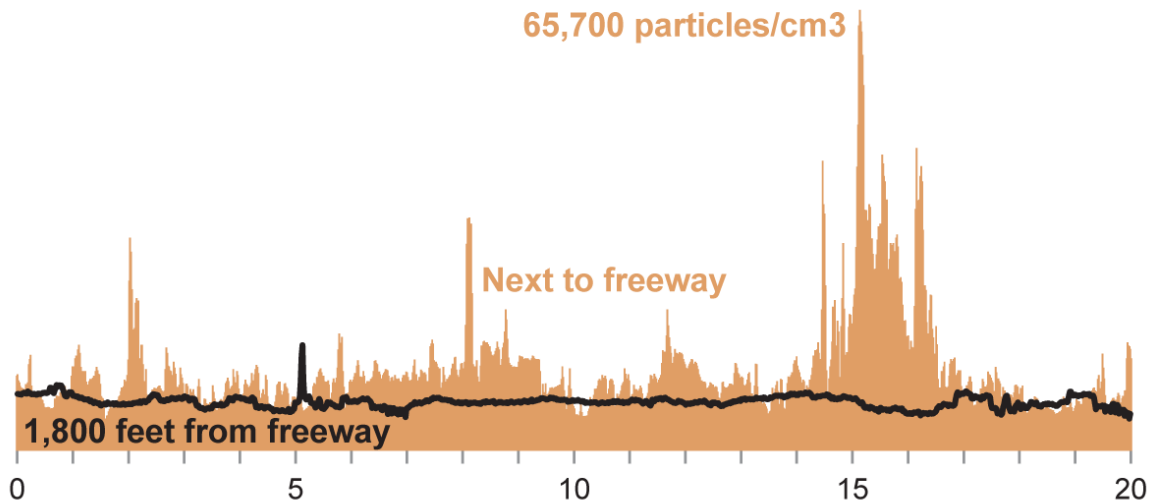
Ultrafine particles spike near freeways

ITEM 11.1.

I-5 in Sun Valley



I-110 in South Los Angeles



Source: TSI P-Trak Ultrafine Particle Counter 8525 readings on Aug. 20, 2015 and Sept. 24, 2015. [See the data](#)

Pollution readings near the freeways were three to four times higher than in neighborhoods at a distance from traffic. Diesel trucks produced the

ITEM 11.1.

most noticeable pollution, coughing out foul plumes of exhaust and soot that could be seen and smelled as pollution readings jumped.

Scientists at USC and the South Coast air district said the readings were consistent with their measurements near freeways.

One of the locations where reporters detected high pollution levels was next to a vacant lot along the 110 Freeway in South Los Angeles where two apartment buildings for low-income residents are being built.

The \$55-million Meta Housing Corp. project, which will bring 160 new housing units to the busy traffic corridor, is partly funded with money from pollution permits sold under the state's cap-and-trade program, among other state and local government subsidies.

ADVERTISEMENT

Among the most visible and controversial projects that have raised traffic pollution concerns in Los Angeles are developer Geoffrey H. Palmer's massive Italianate apartment complexes overlooking downtown freeways. He has built thousands of units and is planning more.

In interviews, current and past residents of Palmer's Orsini development, which hulks over the interchange of the 101 and 110 freeways, said they moved to the complex for its convenient downtown location. But many spoke of keeping windows closed to block noise and pollution, deploying house plants to soak up the bad air and constantly sweeping and dusting the fine black soot that seems to find its way onto every surface.

Felicia Gargani said her pet peeve was the grime that collected on her fourth-floor balcony that looked out over the freeway. "If you walk out there barefoot," she said, "your feet turn black."

ITEM 11.1.

Construction on the Orsini began more than a decade ago, before scientists grasped the extent of the health hazards of building so close to traffic.

In the years since, the South Coast air district has sent dozens of letters to cities sounding alarms about similarly risky home building proposals near freeways in Los Angeles and other communities across its four-county jurisdiction.

Il Villaggio Toscano

- Planned 325-unit apartment complex
 - Approved in 2013 by the L.A. City Council over the objections of air quality officials
 - Developer M. David Paul pledged to use enhanced air filters
- Tell us your freeway story

ITEM 11.1.



The air-quality agency [reserved some of its strongest criticisms](#) for developer M. David Paul's 325-unit Il Villaggio Toscano project proposed near the 405-101 interchange in Sherman Oaks, urging Los Angeles city planners in 2011 to "reconsider placing new housing immediately adjacent to one of the busiest freeway intersections in Southern California."

ITEM 11.1.

The city “is ignoring the abundant health science data that has come out over the past decade that demonstrates serious health consequences for those living near a freeway,” the air district’s Ian MacMillan wrote.



Motorists travel along the 101 Freeway in Hollywood. (Mel Melcon / Los Angeles Times) [View more photos](#) Everett Smith, a renter at the Orsini apartments, looks out from his balcony at rush hour traffic on the 101 and 110 freeway interchange in downtown Los Angeles. (Don Bartletti / Los Angeles Times)

ITEM 11.1.

The City Council approved the project unanimously in August 2013, with its backers pledging to use the highest-rated air filters.

Los Angeles officials now require all homes built near freeways to have air filtration systems that rate at least 13 on the industry's 16-point effectiveness scale.

California air regulators acknowledge that decades of strict vehicle emissions standards have slashed tailpipe emissions, and they say air quality along freeways will continue to improve as the state transitions to cleaner vehicles and fuels.

Health officials say that those mitigating steps are good, but that the only way to solve the problem is for city and county officials to stop residential building near freeways.

And that, say legal experts, is well within their authority.

Planning experts cite a number of possible approaches to the public health problem.

Cities could re-zone areas near heavy traffic to exclude new residential development or change their general plans to prohibit such uses, planning experts say. Officials could adopt ordinances or moratoriums on new residential development. Or they could strengthen building standards — as they have for seismic reasons — forcing developers to design buildings in a way that reduces residents' exposure to polluted air.

“If there's a political will to protect people from this type of development then cities certainly know how to use zoning to accomplish that,” said James Kushner, an expert in land-use, development and urban planning at Southwestern Law School.

ITEM 11.1.

Thousands of homes approved near L.A. freeways

Use the slider to see where the city has issued building permits within a
1,000 feet of a freeway since 2005

ITEM 11.1.

Freeway pollution travels farther than we thought. Here's how to protect yourself

TONY BARBOZA
DEC 30, 2017

If anyone knows where to find refuge from air pollution near Los Angeles freeways, it's Suzanne Paulson.

The UCLA atmospheric chemistry professor has spent years studying how invisible plumes of dirty air from car- and truck-choked roadways spread into surrounding neighborhoods — increasing residents' risk of cancer, asthma, heart disease and other illnesses.

So when she bought a home in the Sunset Park neighborhood of Santa Monica in 2007, she made sure it was on a quiet street far from the 10 Freeway — well beyond the [500-foot zone](#) where California air quality regulators say it's unhealthful to put homes, schools and day cares.

But it wasn't far enough.

In the late night and early morning, it turns out, traffic pollution drifts much farther than during the day, and can extend more than a mile downwind from the freeway.

That discovery, made by Paulson and her colleagues, is one example of new research revealing how much your exposure to harmful levels of vehicle pollution is affected by your specific surroundings. It's not only your distance from traffic, but other details such as wind patterns, freeway design, the time of day and the types of cars, trucks and buildings around you that determine the risk.

ITEM 11.1.

“We’re learning that the pollution you breathe comes down to where you are, when you’re there and what the traffic is like,” Paulson said.

Such findings are prompting new advice from air quality officials and scientists on steps you can take to protect yourself.

Keep your distance from freeways and busy roads

Southern California is experiencing a [surge in home construction](#) near freeways that is pushing more people into high-pollution zones. But just because state and local officials are allowing new housing there doesn’t mean it is safe, health experts say.

When choosing a home, school or day care, aim for locations as far from the freeway as possible.

Avoid sites within 500 feet — where California air quality regulators warn against building — or even 1,000 feet. That’s where traffic pollution is generally highest, along with rates of asthma, cancer, heart attacks, strokes, reduced lung function, pre-term births and a growing list of other health problems.

[See how far you live from the nearest freeway »](#)

Also avoid living near major roads — those carrying more than 100,000 vehicles a day — which, according to air quality regulators, can pose health risks similar to freeways. That includes stretches of some of Los Angeles’ busiest boulevards such as Sepulveda, La Cienega and Wilshire.

Use filters, but know the limitations

If you have a central heating, air-conditioning or ventilation system, install high-efficiency air filters. They should be rated 13 or higher on the 16-point

ITEM 11.1.

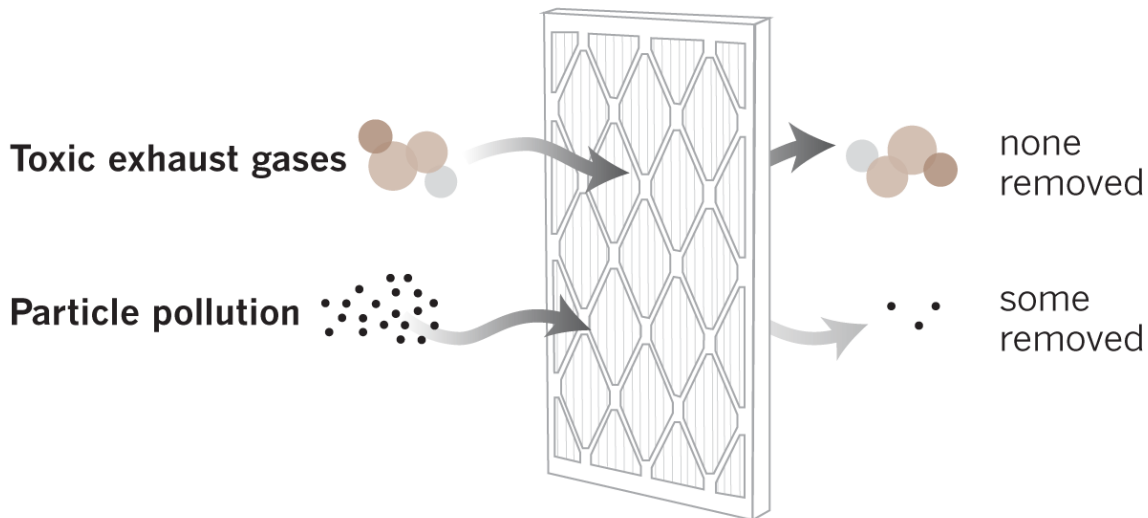
industry MERV scale (Minimum Efficiency Reporting Value) that measures how effectively they block tiny pollution particles.

Make sure to replace them on schedule, about every few months.

But filters remove **only some of the harmful ingredients** in traffic pollution. And they're effective only when the air is running and all doors and windows are closed.

Most will not remove toxic exhaust gases such as benzene and 1,3-butadiene. To screen those out, you need more costly charcoal filters.

High-efficiency air filter



Source: city of Los Angeles, South Coast Air Quality Management District, Times reporting

@latimesgraphics

Also factor in the age of your building. Filters are less effective in older homes, which let in more pollutants, and work better in newer dwellings that seal off more outside air.

If you live in a new home near a freeway in Los Angeles or San Francisco, high-efficiency filters may already be required. And the California Energy

ITEM 11.1.

Commission is moving to require MERV 13 air filtration in all newly constructed dwellings starting in 2020.

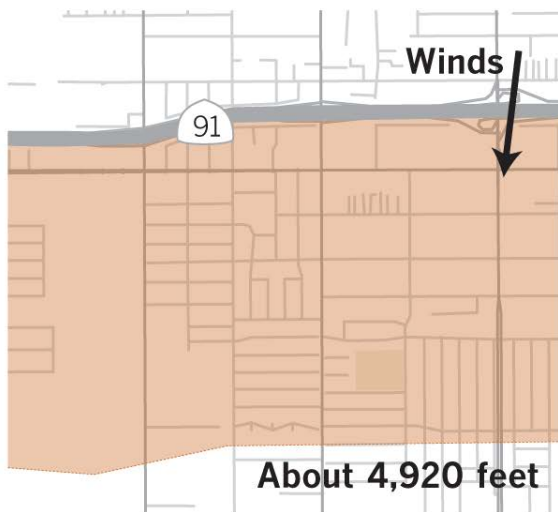
But those rules will do nothing to reduce pollution in existing homes, including those occupied by more than 1.2 million people in Southern California who already live within 500 feet of a freeway.

Don't have central air? Adding one or two stand-alone air-cleaning devices to your home can help reduce particle pollution levels, so long as you keep them running 24/7. But air cleaners are effective at lowering particle levels only in a single room, not an entire home. Make sure the model you choose is [certified](#) by California regulators.

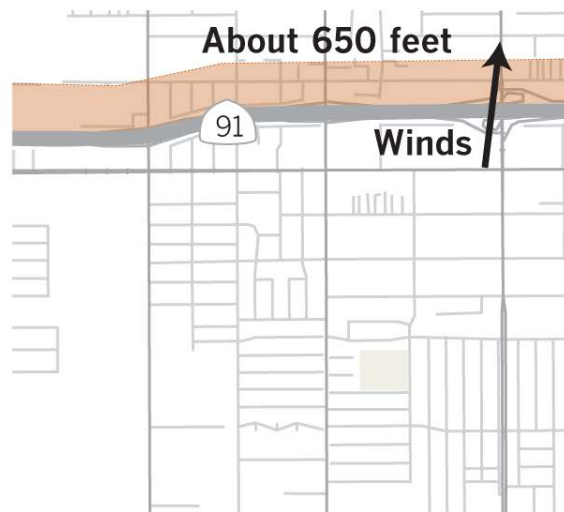
Pollution drift

Freeway pollution can travel farther at night and in the early morning than during the day. Here's one example:

Night and early morning



Daytime



Sources: UCLA, California Air Resources Board, Mapzen, OpenStreetMap

@latimesgraphics

Avoid early morning exercise near traffic

ITEM 11.1.

Postpone outdoor exercise to later in the morning to dodge the spike in traffic pollution in the pre-sunrise hours. That's when stagnant weather conditions, caused by nighttime cooling, trap freeway pollution near the ground. That slows down the dispersal of emissions, allowing them to drift more than a mile downwind, compared to no more than 1,000 feet during the day.

Levels of ultrafine particles, nitric oxide and hydrocarbons are highest in the early morning, aided by a big injection of exhaust from morning rush hour. Those conditions usually break up once the sun has been up for a few hours and winds pick up again.

It's also better to keep your windows closed in the early morning hours. You may think it's safer to leave them open after traffic dies down at night, but [recent research](#) suggests the opposite.

Drive less, and use the 'recirculate' button

Spending time in a car on the freeway can expose you to pollution levels five to 10 times higher than surrounding areas.

Even with the windows up, you could be breathing up to 80% of the levels of pollution found in traffic if your vehicle's ventilation system is drawing in outside air.

So if you can, live closer to work, use public transit or take other steps to limit your driving time.

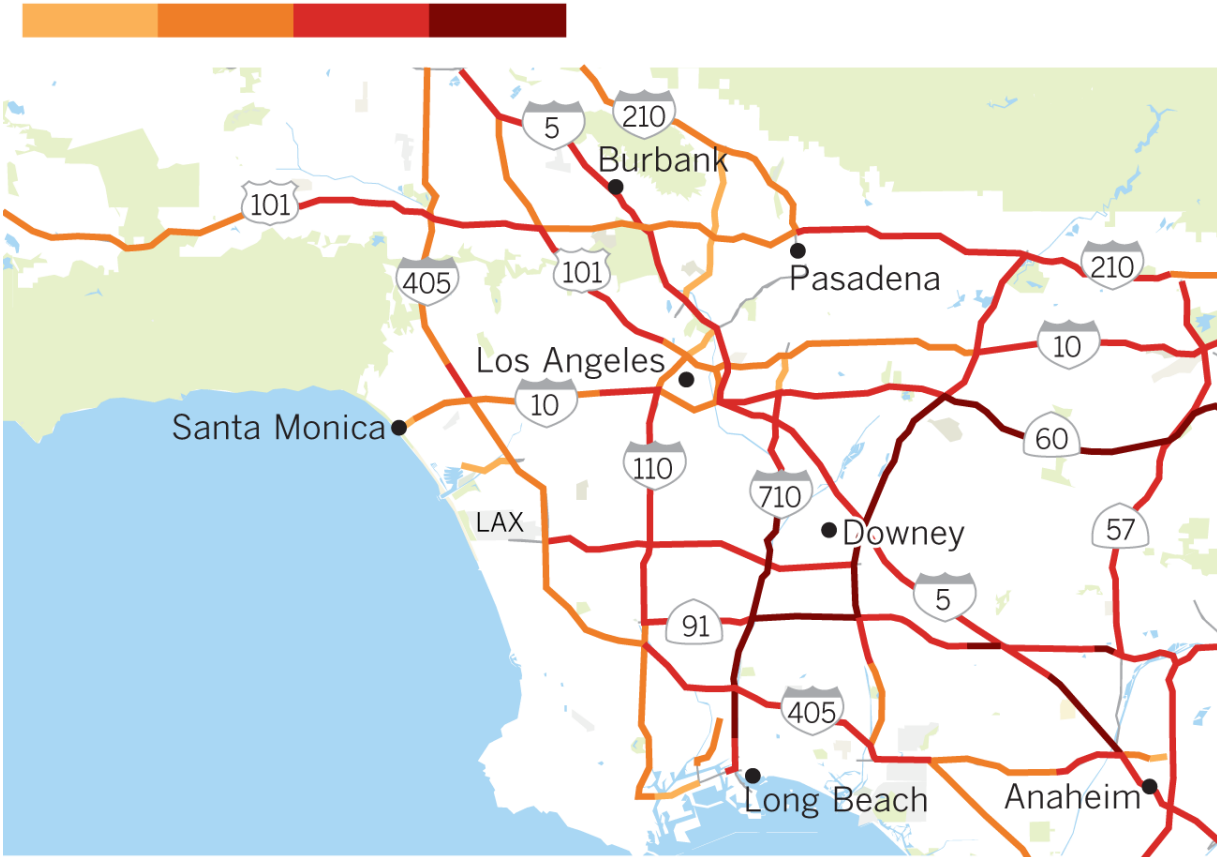
“That's where we still get a big, big share of our exposure, especially if you're driving very far in rush-hour traffic,” said Scott Fruin, a professor of preventive medicine at USC. “If you can reduce that, it helps a lot.”

When you're in the car, roll up the windows and [set your ventilation system to recirculate](#). That button can cut pollution to 20% of on-road levels.

ITEM 11.1.

Trucks per day on Southern California freeways

1,000 5,000 10,000 20,000+



Sources: Caltrans, Mapzen, OpenStreetMap

Avoid truck routes and the ‘diesel death zone’

It’s especially unhealthful to live near freeways and roads frequented by diesel trucks, which spew many times more harmful gases and particles than cars. Diesel particulate matter, carcinogen-laden soot that deposits deep in the lungs, is responsible for the bulk of the cancer risk from air pollution and more than 1,000 early deaths a year in California.

Experts are most concerned about people living near ports, warehouse distribution centers and other freight corridors. Asthma rates and cancer risk there can be so elevated that physicians have labeled it the “diesel death zone.”

ITEM 11.1.

An air-monitoring station next to a truck-congested stretch of the 60 Freeway in Ontario had the highest levels of fine-particle pollution, or soot, of all near-roadway sites in the nation, according to 2015 [U.S. Environmental Protection Agency data](#). About 217,000 vehicles a day passed by in 2015, more than 29,000 of them trucks.

Be aware of the type of vehicles in your neighborhood

The kinds of vehicles traversing your neighborhood can have a big effect on how much pollution you breathe.

Paulson and other scientists have detected huge disparities among L.A. neighborhoods, with some of the lowest levels of traffic pollution in wealthier enclaves such as West Los Angeles, where the roads have more new cars with cleaner engines, and fewer trucks.

Levels of ultrafine particles, the tiny, short-lived particles scientists measure as an indicator of recently emitted exhaust, are several times higher over in the Eastside neighborhood of Boyle Heights, which in addition to being carved up by a freeway interchange has more diesel trucks and older, higher-polluting cars on its surface streets.

Clean the dust, but worry more about the pollution you can't see

The [black road dust](#) that deposits on the windows, shelves and patios of people living near traffic? If it's big enough to see, it probably can get into your mouth or nose, and not much farther than that.

ITEM 11.1.

Clean it up, especially if it's dark or sooty in color, said Fruin, the USC professor. "If you run your finger on your windowsill and it's black, that's a bad sign because it means you're getting a lot of diesel soot."

More important, soot can be an indication of traffic pollution you can't see but may be breathing in. Scientists are especially concerned about ultrafine particles, exhaust pollutants less than one-thousandth the width of a human hair. They're so tiny they can lodge deep in the lungs and move into bloodstream, where they may harm the heart, brain and other organs.

Ultrafine particles are suspected of causing some of the illnesses among people living near traffic, but more research is needed to say for certain.

Don't count on electric cars to eliminate the problem

Cars and trucks keep getting cleaner, but don't count on electric vehicles bringing an end to traffic-related health problems.

Switching to zero-emission vehicles only gets rid of tailpipe-generated pollution. It does nothing to reduce non-exhaust pollutants, including dust from brake pads and tires that contains toxic metals, rubber and other compounds that are kicked up into the air.

Scientists trying to pinpoint the most harmful agents in traffic pollution are just beginning to study the health effects of those non-tailpipe pollutants.

"The switch to electric vehicles will certainly reduce the public's exposure to engine-related emissions," said Ed Avol, a professor of preventive medicine at USC. "But this other kind of pollution generated by the frictional forces of tires and brakes and from lubricating oils is likely to remain in some form for years to come."

ITEM 11.1.

ITEM 11.1.

Information on Residential siting near freeways

Tom Cahill, October, 2017

In this summary, I include in Section A the information provided last year before the Prop A vote. In Section B, I include updates of that information and new information generated since the first summary was prepared.

Section A: Summary published in an Ad in the Enterprise during Prior Prop A vote
Nishi and Health

Davis' own Environmental Impact Report on the Nishi proposal concluded that there are "...**significant and unavoidable**" (4.3-33) ..." air quality impacts based on existing **state and federal air quality regulations**. This alone should have been adequate to force removal of residential use from the proposal. Note that many of the most positive aspects of Nishi do not require a residential component

But there are **new threats not yet properly included in existing regulations**. For the past 20 years, I have been part of a group of perhaps 3 dozen local medical and environmental professionals who have worked with the Sacramento chapter of the American Lung Association and its successor, Breathe California of Sacramento/Emigrant Trails, to better understand the growing evidence of health impacts near freeways and improve current regulations.

We have identified and evaluated these new threats in the peer reviewed literature, based on California freeways, documenting serious illnesses and enhanced death rates for people living within 1,000 ft. of the roads. These include: (*with most likely causes*)

1. ~ **doubling of early heart attacks from ischemic heart disease** (*ultra-fine metals from brakes*),
2. **permanent loss of lung function in children at ~ 5 %/year**, (*probably very fine metals*)
3. **exacerbation of asthma**, (*a variety of vehicular sources*)
4. **increased cancer rates from diesel exhaust**, (*benzo[a]pyrene and other PAHs*)
 - a. The entire site averages > 600 excess cancer deaths/lifetime, 1.5 time the state limit.
 - b. Diesel from trains is more toxic than diesel from trucks, adding to the threat.
5. **86% increased chances for having an autistic baby**, (*ultra-fine metals?*), and other impacts.

These studies also show that areas **downwind of elevated freeways with heavy car and truck traffic required to brake have the worst impact, up to 10 times worse than the average freeway**. The Nishi site hits every hot button issue for freeways, with heavy braking on I-80 eastbound as it necks down from 6 lanes to 3 lanes, and heavy acceleration and enhanced soot south of the site. All of Nishi is within 900 ft of both I-80 and the train tracks.

We have provided freely to the developer and city both information on the threats and the latest information we have on mitigation, vital to protect workers in a research center environment. However, we conclude that such mitigation is inadequate to protect residential use under the unfavorable conditions present in the Nishi site, which are far worse than the average freeways used in the health studies. We conclude that the present Nishi proposal **subjects unsuspecting young future residents to hazardous conditions**, with mitigation only partially able to reduce the impacts of an especially bad site and traffic profile.

ITEM 11.1.

My colleagues and I have collected key information and peer reviewed references that have formed our opinions in a 37 page summary we make available upon request at tacahill2718@gmail.com, We respectfully request Davis citizens use this information to form your own positions on the potential health impacts of Nishi and consider them as you vote on June 7.

References supporting the ad

Short summary of references in support of my position on Nishi

1. The effect of elevated freeways on downwind concentrations

Feeney, P.J., T.A. Cahill, R.G. Flocchini, R.A. Eldred, D.J. Shadoan, and T. Dunn. **Effect of roadbed configuration on traffic derived aerosols.** *Journal of the Air Pollution Control Association.* 25:1145-1147 (1975).

Baldauf, Richard, Greg McPherson, Linda Wheaton, Max Zhang, Tom Cahill, Chad Bailey, Christina Hemphill-Fuller, Earl Withycombe, and Kori Titus, **Integrating Vegetation and Green Infrastructure into Sustainable Transportation Planning**, Transportation Research Bulletin, National Academy of Sciences (2013)

Bowker, George E. , Richard Baldauf, Vlad Isakov, Andrey Khlystov, William Petersen, **The effects of roadside structures on the transport and dispersion of ultrafine particles from highways**, Atmospheric Environment , Volume 41, Issue 37, December 2007, Pages 8128–813

Thomas A. Cahill^{1,2}, David E. Barnes¹, , Leann Wuest¹, Sean Barberie¹, David Gribble¹, David Buscho¹, Jason Snyder¹, Roger S. Miller¹, and intern Camille De la Croix³, **Artificial Ultra-fine Aerosol Tracers for Highway Transect Studies**, in press, *Atm. Environ.* (2016)

2. The effect of braking on “wear” aerosols

Denier Van der Gon, H., Gerlofs Nijland, M, Gehrig R, Gustafsson M, Janssen N, Harrison R, Hulskotte J, Johansson C, Jozwicka M, Keuken M, Krijgsheld K, Ntziachristos L, Riediker M, Cassee F (2013) **The policy relevance of wear emissions from road transport, now and in the Future - an international workshop report and consensus statement.** *J Air Waste Management Assoc.* 63:136–149 (2013).

Cahill, Thomas A., , David E. Barnes, Nicholas J. Spada, **Seasonal variability of ultra-fine metals downwind of a heavily traveled secondary road**, *Atmospheric Environment* 94 173 - 179 (2014)

3. The role of diesel exhaust in excess cancer deaths

ARB Emfac2007 at aeb.ca.gov

Health Effects Institute, (2009)

ITEM 11.1.

H Jung, B Guo, C Anastasio, IM Kennedy -, **Quantitative measurements of the generation of hydroxyl radicals by soot particles in a surrogate lung fluid**, Atmospheric Environment, 2006

4. The role of ultra-fine metals from brakes on ischemic heart disease

Thomas A. Cahill, David E. Barnes, Nicholas J. Spada, Jonathan A. Lawton and Thomas M. Cahill. **Very fine and ultra-fine metals and ischemic heart disease in the California Central Valley 1: 2003 – 2007**. *Aerosol Science and Technology* 45:1125-1134 (2011) doi:10.1080/02786826.2011.5821944.

Thomas A. Cahill, David E. Barnes, Earl Withycombe, and Mitchell Watnik. **Very fine and ultra-fine metals and ischemic heart disease in the California Central Valley 2: 1974 – 1991**. *Aerosol Science and Technology* 45:1135-1142 (2011) doi:10.1080/02786826.2011.582196

US EPA Conference in Ultra Fine Particles (2012)

5. The impact on the lungs of children growing up near freeways

Gauderman, W. J., McConnell, R., Gilliland, F., London, S., Thomas, D., Avol, E., Vora, H., Berhane, K., Rappaport, E. B., Lurmann, F., Margolis, H. G. and Peters, J. (2000). **Association between air pollution and lung function growth in southern California children**. *Am. J. Respir. Crit. Care Med.* 162:1383-1390

Peters, John M., Edward Avol, William Navidi, Stephanie J. London, W. James Gauderman, Fred Lurman, William S. Linn, Helene Margolis, Edward Rappaport, Henry Gong, Jr., and Duncan C. Thomas, "A Study of Twelve Southern California Communities with Differing Levels and Types of Air Pollution I. Prevalence of Respiratory Morbidity, *American Journal of Respiratory and Critical Care Medicine* 159, No. 3 (1999), pp. 760-767.(a).

Peters, John M., Edward Avol, William Navidi, Stephanie J. London, W. James Gauderman, Fred Lurman, William S. Linn, Helene Margolis, Edward Rappaport, Henry Gong, Jr., and Duncan C. Thomas "A Study of Twelve Southern California Communities with Differing Levels and Types of Air Pollution; II. Effects on Pulmonary Function, *American Journal of Respiratory and Critical Care Medicine*, Vol. 159 *American Journal of Respiratory and Critical Care Medicine* 159,, No. 3 (1999), pp. 768-775 (b).

Jessica G. Charrier†, Alexander S. McFall‡, Nicole K. Richards-Henderson†, and Cort Anastasio†, **Hydrogen Peroxide Formation in a Surrogate Lung Fluid by Transition Metals and Quinones Present in Particulate Matter**, *Environ. Sci. Tech.*, 2014, 48 (12), 7010–7017

6. The enhancement of autism chances for near freeways conceptions

Volk, H.E., Hertz-Picciotto, I., Delwiche, L., Lurmann, F., McConnell, R., **Residential Proximity to Freeways and Autism in the CHARGE Study**, *Environmental Health Perspectives*, 119, No. 6, Pg 874 – 877 (2011)

The Economist, Special Issue. autism April, 2016 air pollution as an enhancer

ITEM 11.1.

Section B: New Topics: (2017)

1. Inadequacy of PM_{2.5} mass to protect health - general

Chen, L. C., and Lippmann, M. (2009). **Effects of Metals within Ambient Air Particulate Matter (PM) on Human Health.** *Inhal. Toxicol. Int Forum Resp. Res.*, 21:1-31.

Abstract

We review literature providing insights on health-related effects caused by inhalation of ambient air particulate matter (PM) containing metals, emphasizing effects associated with in vivo exposures at or near contemporary atmospheric concentrations. Inhalation of much higher concentrations, and high-level exposures via intratracheal (IT) instillation that inform mechanistic processes, are also reviewed. The most informative studies of effects at realistic exposure levels, in terms of identifying influential individual PM components or source-related mixtures, have been based on (1) human and laboratory animal exposures to concentrated ambient particles (CAPs), and (2) human population studies for which both health-related effects were observed and PM composition data were available for multipollutant regression analyses or source apportionment. Such studies have implicated residual oil fly ash (ROFA) as the most toxic source-related mixture, and Ni and V, which are characteristic tracers of ROFA, as particularly influential components in terms of acute cardiac function changes and excess short-term mortality. There is evidence that other metals within ambient air PM, such as Pb and Zn, also affect human health. Most evidence now available is based on the use of ambient air PM components concentration data, rather than actual exposures, to determine significant associations and/or effects coefficients. Therefore, considerable uncertainties about causality are associated with exposure misclassification and measurement errors. As more PM speciation data and more refined modeling techniques become available, and as more CAPs studies involving PM component analyses are performed, the roles of specific metals and other components within PM will become clearer.

Health Effects Institute, Traffic Related Air Pollution: **A Critical Review of the Literature on Emissions, Exposure, and Health Effects**, HEI 17, Boston, MA (2009).

ITEM 11.1.

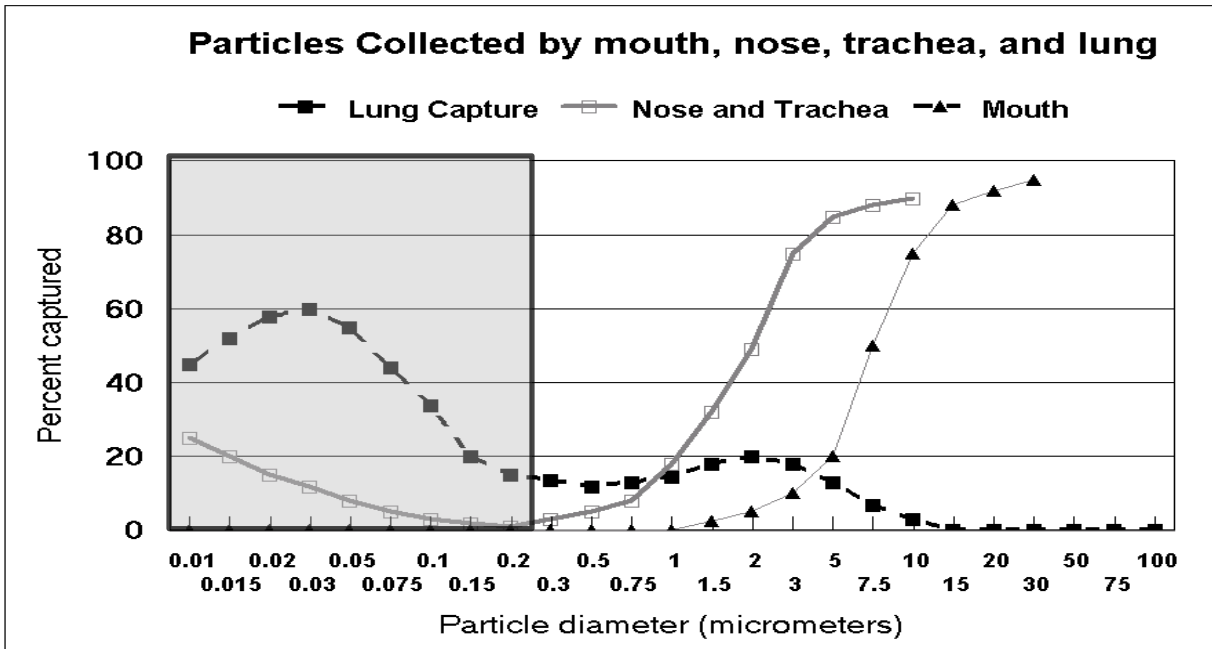


Figure 8-4. The gray shaded area shows the size range and lung deposition for very fine particles with diameters between 0.25 micrometers and 0.1 micrometers, and ultra-fine particles with diameters less than 0.1 micrometers. These are normally written in a short version, for very fine ($0.25 > D_p > 0.1 \mu\text{m}$) and for ultra-fine particles, ($D_p < 0.1 \mu\text{m}$).

Insoluble ultra-fine particles like metals can then pass into the blood stream to cause arterial sclerosis and ischemic heart disease perhaps much more in neo natal.

ITEM 11.1.

2. Why do the study in winter?

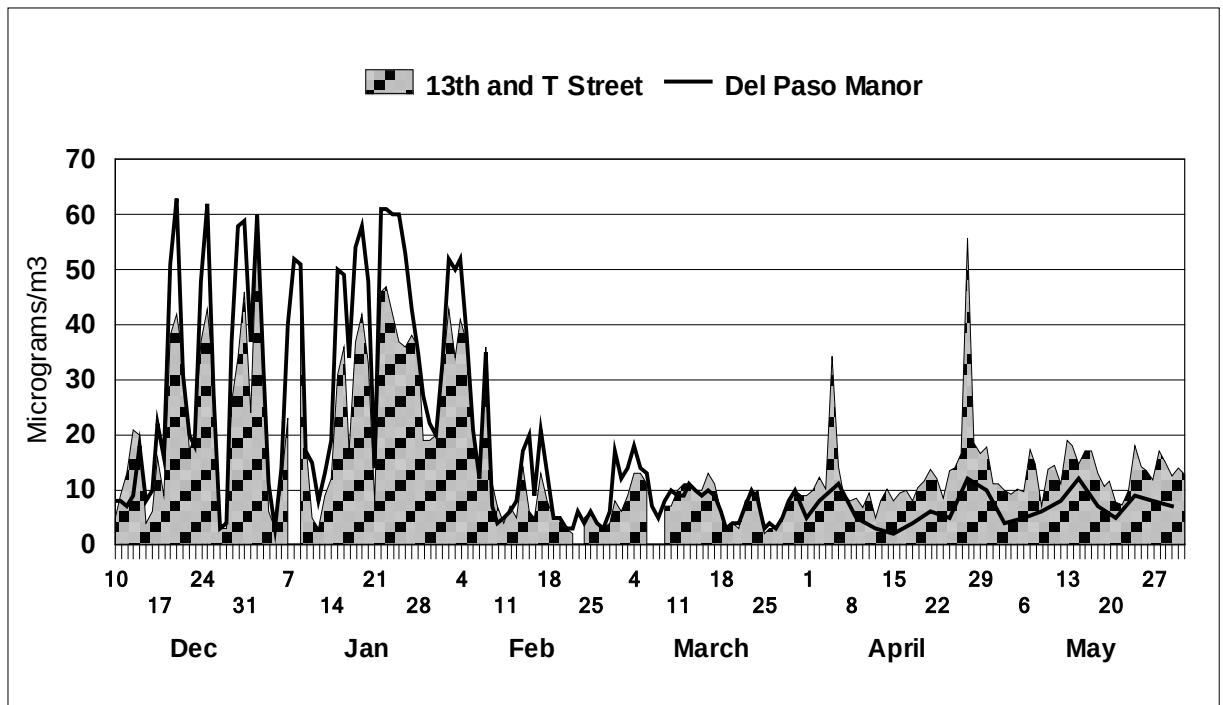


Figure 3-2. Example of PM_{2.5} aerosols at two sites about 5 miles apart in Sacramento. Note the similarity between the sites, showing a regional aerosol, and the effect the inversion breakup in spring.

3. Downwind Transport from freeways

Sacramento Metropolitan AQMD **Emfac2107**

Thomas A. Cahill, David E. Barnes, Leann Wuest, Sean Barberie, David Gribble, David Buscho, Jason Snyder, Roger S. Miller, and intern Camille De la Croix, **Artificial Ultra-fine Aerosol Tracers for Highway Transect Studies**, Atmospheric Environment 136, 21 – 42 (2016)

Feeney, P.J., T.A. Cahill, R.G. Flocchini, R.A. Eldred, D.J. Shadoan, and T. Dunn. **Effect of roadbed configuration on traffic derived aerosols.** *Journal of the Air Pollution Control Association.* 25:1145-1147 (1975).

The key plot is below.

ITEM 11.1.

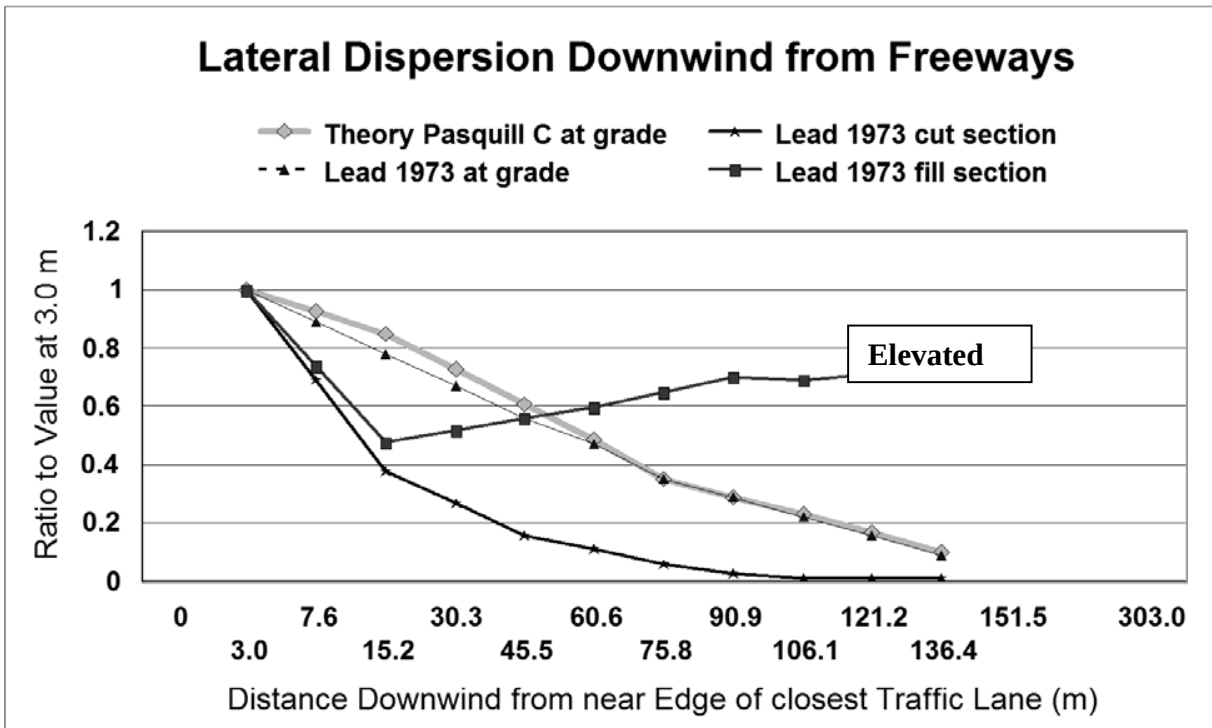


Figure 9 -3. Lead values as a function of freeway configuration, 1972.

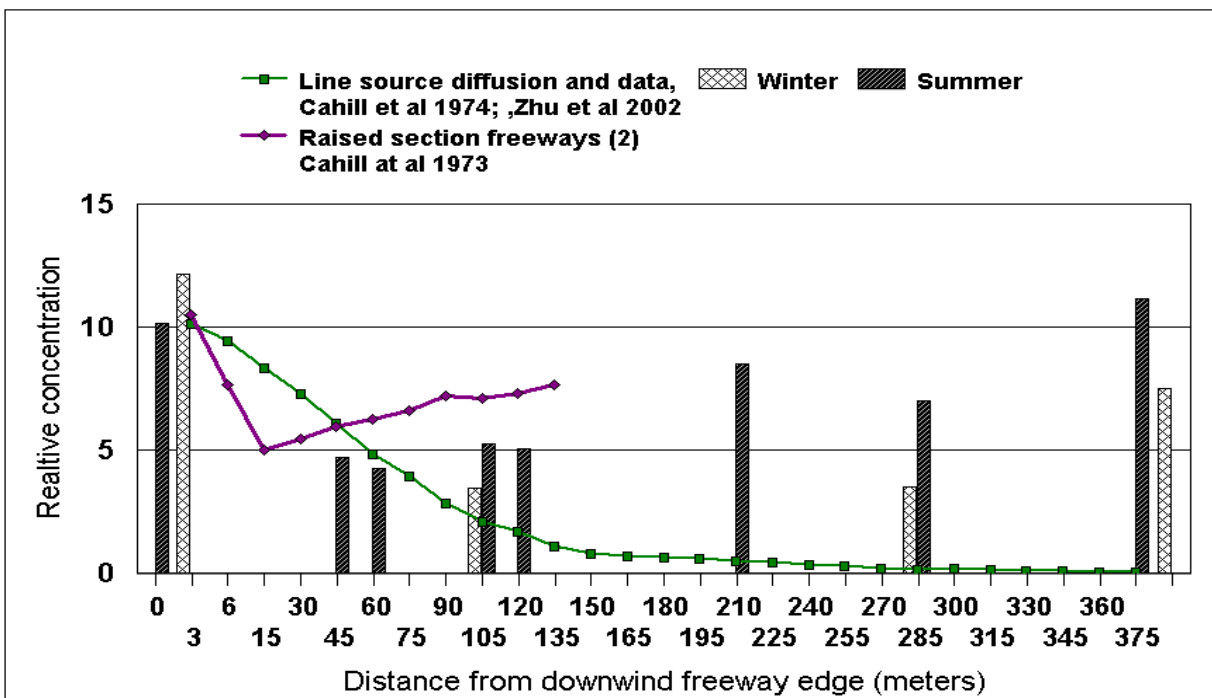


Figure A1-7. Results of the 35th Avenue fill section roadway, summer and winter.

ITEM 11.1.

G.S.W. Hagler^a, R.W. Baldauf^b, E.D. Thoma, T.R. Long, R.F. Snow, J.S. Kinsey, L. Oudejans, B.K. Gullett, **Ultrafine particles near a major roadway in Raleigh, North Carolina: Downwind attenuation and correlation with traffic-related pollutants**, *Atmospheric Environment* **43**, , Pages 1229–1234 (2009)

4. Ultra-fine metals from freeways

Thomas A. Cahill¹, David E. Barnes¹, Jonathan A Lawton¹, Roger Miller¹, Nicholas Spada², Robert D. Willis³ and Sue Kimbrough⁴, Transition metals in coarse, fine, very fine and ultra-fine particles from an interstate highway transect near Detroit, **Atmospheric Environment** **145**, **158 – 175 (2016)**

¹DELTA Group, University of California, Davis CA 95616, ²University of Houston, Houston, TX, ³US Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC27711, ⁴US Environmental Protection Agency, National Risk Management Research Laboratory, Research Triangle Park, NC27711

Abstract: As one component of a study investigating the impact of vehicle emissions on near-road air quality, human exposures, and potential health effects, particles were measured from September 21 to October 30, 2010 on both sides of a major roadway (Interstate-96) in Detroit. Traffic moved freely on this 12 lane freeway with a mean velocity of 69 mi/hr. with little braking and acceleration. The UC Davis DELTA Group rotating drum (DRUM) impactors were used to collect particles in 8 size ranges at sites nominally 100 m south, 10 m north, 100 m north, and 300 m north of the highway. Ultra-fine particles were continuously collected at the 10 m north and 100 m north sites. Samples were analyzed every 3 hr. for mass (soft beta ray transmission), 42 elements (synchrotron-induced x-ray fluorescence) and optical attenuation (350 to 800 nm spectroscopy). A three day period of steady southerly winds along the array allowed direct measurement of freeway emission rates for coarse ($10 > D_p > 1.0 \mu\text{m}$), $\text{PM}_{2.5}$, very fine ($0.26 > D_p > 0.09 \mu\text{m}$), and ultra-fine ($D_p < 0.09 \mu\text{m}$) particles. The $\text{PM}_{2.5}$ mass concentrations were modeled using literature emission rates during the south to north wind periods, and averaged $1.6 \pm 0.5 \mu\text{g}/\text{m}^3$, versus the measured value of $2.0 \pm 0.7 \mu\text{g}/\text{m}^3$. Using European freeway emission rates from 2010, and modeling them at the I-96 site, we would predict roughly $3.1 \mu\text{g}/\text{m}^3$ of $\text{PM}_{2.5}$ particles, corrected from the 4.9 PM_{10} value by their measured road dust contributions. Using California car and truck emission rates of 1973, this value would have been about $16 \mu\text{g}/\text{m}^3$, corrected down from the $19 \mu\text{g}/\text{m}^3 \text{ PM}_{5.0}$ using measured roadway dust contributions. This would have included $2.7 \mu\text{g}/\text{m}^3$ of lead, versus the $0.0033 \mu\text{g}/\text{m}^3$ measured. Very fine particles were distributed across the array with a relatively weak falloff versus distance. For the ultra-fine particles, emissions of soot and metals seen in vehicular braking studies correlated with traffic at the 10 m site, but only the soot was statistically significant at the 100 m north site. Otherwise, the 10 m north and 100 m north sites were essentially identical in mean concentration and highly correlated in time for most of the 5 week study. This result supports earlier publications showing the ability of very fine and ultra-fine particles to transport to sites well removed from the freeway sources. The concentrations of very fine and

ITEM 11.1.

ultra-fine metals from brake wear and zinc in motor oil observed in Detroit have the potential of being a significant component in statistically established PM_{2.5} mortality rates.

Cahill, Thomas A., , David E. Barnes, Nicholas J. Spada, **Seasonal variability of ultra-fine metals downwind of a heavily traveled secondary road**, *Atmospheric Environment* 94 173 - 179 (2014)

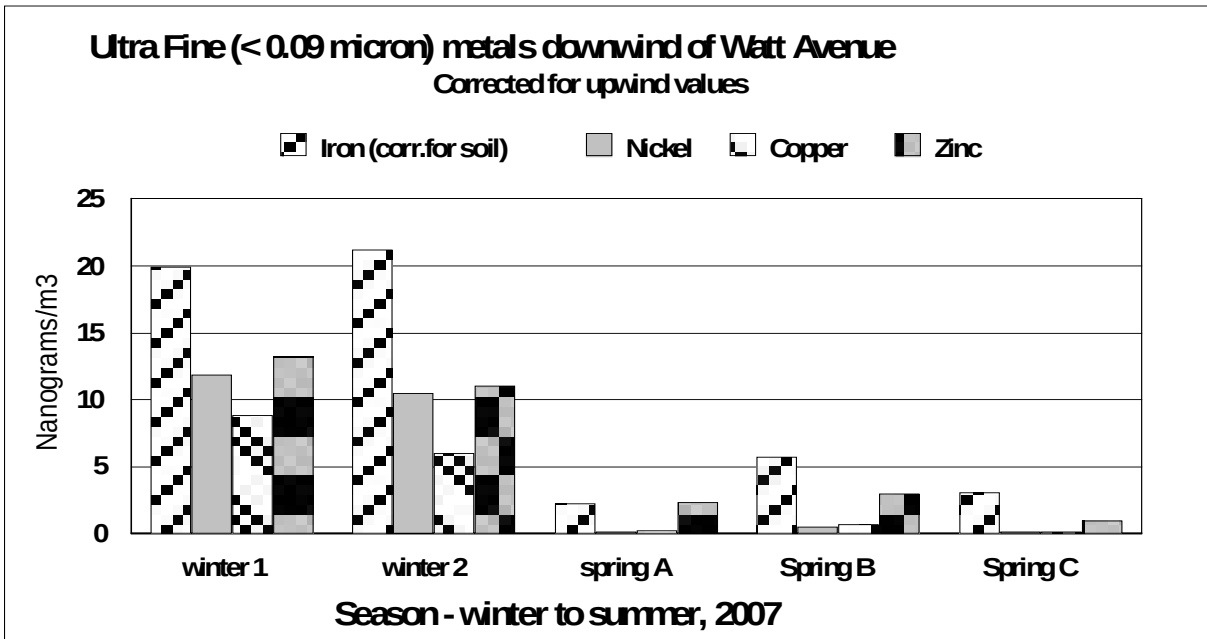


Figure 8-1. Ultra fine metals at Arden Middle School 50 feet downwind of Watt Avenue

Cahill, Thomas M., and Thomas A. Cahill. **Seasonal variability of particle-associated organic compounds near a heavily traveled secondary road**. *Aerosol Science and Technology*, (2013) doi: 10.1080/02786826.2013.857757

Thomas A. Cahill, David E. Barnes, Earl Withycombe, and Mitchell Watnik. **Very fine and ultra-fine metals and ischemic heart disease in the California Central Valley 2: 1974 – 1991**. *Aerosol Science and Technology* 45:1135-1142 (2011)
doi:10.1080/02786826.2011.582196

Thomas A. Cahill, David E. Barnes, Nicholas J. Spada, Jonathan A. Lawton and Thomas M. Cahill. **Very fine and ultra-fine metals and ischemic heart disease in the California Central Valley 1: 2003 – 2007**. *Aerosol Science and Technology* 45:1125-1134 (2011) doi:10.1080/02786826.2011.582194

ITEM 11.1.

5. Mitigation by vegetation

Baldauf, Richard, Greg McPherson, Linda Wheaton, Max Zhabg, Tom Cahill, Chad Bailey, Christina Hemphill-Fuller, Earl Withycombe, and Kori Titus, **Integrating Vegetation and Green Infrastructure into Sustainable Transportation Planning**, Transportation Research Bulletin, Nat. Acad. of Sciences (2013)

Thomas A. Cahill, David E. Barnes, Leann Wuest, Sean Barberie, David Gribble, David Buscho, Jason Snyder, Roger S. Miller, and intern Camille De la Croix, **Artificial Ultra-fine Aerosol Tracers for Highway Transect Studies**, Atmospheric Environment 136, 21 – 42 (2016)

Summary: The best mitigation from both studies was an intact tree canopy of deciduous trees, which reduced freeway aerosols by about a factor of 2.

6. Toxicity of diesel exhaust

Thomas A. Cahill, Thomas M. Cahill, David E. Barnes, Nicholas J. Spada and Roger Miller. **Inorganic and organic aerosols downwind of California's Roseville Railyard**. *Aerosol Science and Technology* 45:1049-1059 (2011)
doi:10.1080/02786826.2011.580796

Abstract

In 2004, the California Air Resources Board staff, at the request of the Placer County Air Pollution Control District, estimated the health impacts of the Roseville, CA Union Pacific Rail Road's (UPRR) J. R. Davis rail yard. The results showed excess cancer rates downwind of the rail yard as high as 800 excess cancer cases per million, lifetime. In a Memorandum of Understanding, mitigation was promised by UPRR, to be verified by the Roseville Railyard Air Monitoring Project (RRAMP). In 2005, RRAMP initiated a project to measure aerosols upwind and downwind of the yard in three successive summers. Separation of rail yard activities from other sources such as nearby Interstate 80 was accomplished by taking advantage of stable downslope winds blowing laterally across the rail yard for about 8 hours each night. We requested permission to use the study sites to advance our understanding of rail yard emissions with additional aerosol collection and analysis techniques beyond the NO, NO₂, black carbon, and PM_{2.5} measurements of RRAMP. We sampled from July through August at the Pool site (a city swimming pool upwind of rail yard), and from July through October 2005 and January 2006 at the Denio site (downwind of rail yard). Very fine aerosols were routinely enhanced over the upwind site of materials associated with diesel exhaust, including mass, sulfur at about 3.3% of the aerosol very fine ($0.26 > D_p > 0.09 \mu\text{m}$) mass. Many metals exhibited sharp spikes of short duration at the Denio site only. Three separate campaigns were performed for size resolved organic matter, PAHs, alkanes, sugars, and acids. Benzo[a]pyrene aerosols were present at $5.5 \pm$

ITEM 11.1.

0.7 times more than from diesel trucks per unit mass, and unlike truck diesel exhaust, almost all were present in the ultra fine ($< 0.1 \mu\text{m}$) size mode. The coarse soil aerosols were contaminated with many anthropogenic metals at levels many times that of standard soil. Additional mitigation options have been proposed to reduce downwind health threats.

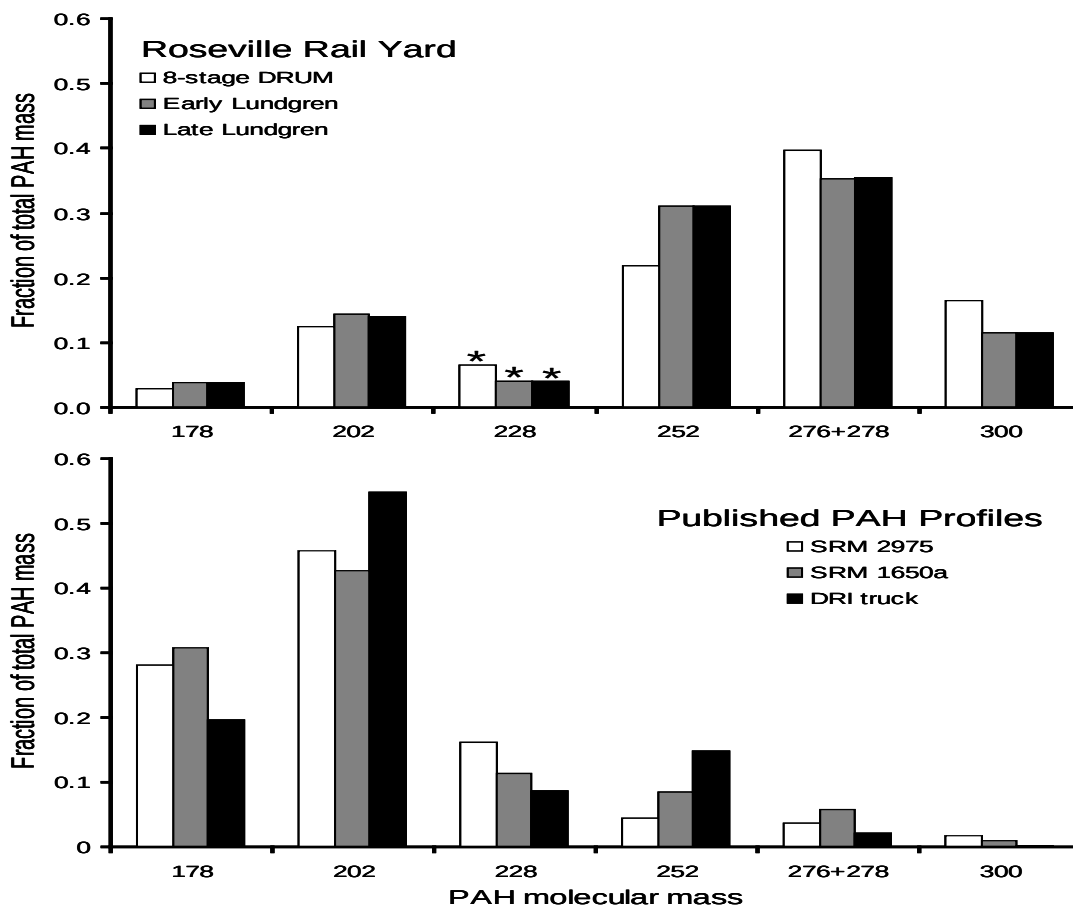


FIG. 19. Profiles of PAHs as a function of Molecular Mass. *

7. Neo natal Health

Mònica Guxens, Akhgar Ghassabian, Tong Gong, Raquel Garcia-Esteban, Daniela Porta, Lise Giorgis-Allemand, Catarina Almqvist, Aritz Aranbarri, Rob Beelen, Chiara Badaloni, Giulia Cesaroni, Audrey de Nazelle, Marisa Estarlich, Francesco Forastiere, Joan Forns, Ulrike Gehring, Jesús Ibarluzea, Vincent W.V. Jaddoe, Michal Korek, Paul Lichtenstein, Mark J. Nieuwenhuijsen, Marisa Rebagliato, Rémy Slama, Henning Tiemeier, Frank C. Verhulst, Heather E. Volk, Göran Pershagen, Bert Brunekreef, and Jordi Sunyer, **Air Pollution Exposure during Pregnancy and Childhood Autistic Traits in**

ITEM 11.1.

Four European Population-Based Cohort Studies: The ESCAPE Project,
Environmental Health Perspectives • volume 124 | number 1 | January 2016

Original Investigation

October 16, 2017

Dries S. Martens, MSc¹; Bianca Cox, PhD¹; Bram G. Janssen, PhD¹; et al Diana B. P. Clemente, MSc^{1,2,3}; Antonio Gasparrini, PhD^{4,5}; Charlotte Vanpoucke, MSc⁶; Wouter Lefebvre, PhD⁷; Harry A. Roels, PhD^{1,8}; Michelle Plusquin, PhD¹; Tim S. Nawrot, PhD^{1,9}, **Prenatal Air Pollution and Newborns' Predisposition to Accelerated Biological Aging**, *JAMA Pediatr*. Published online October 16, 2017. doi:10.1001/jamapediatrics.2017.3024

Key Points

Question Is telomere length at birth (a marker of biological aging) influenced by exposure to particulate matter air pollution during in utero life?

Findings In this birth cohort study of 641 mother-newborn pairs, mothers with higher residential exposure to PM_{2.5} (particulate matter with an aerodynamic diameter ≤ 2.5 μm air pollution) gave birth to newborns with significantly lower telomere length that could not be explained by other factors including socioeconomic class. For a 5- $\mu\text{g}/\text{m}^3$ increase in residential PM_{2.5} exposure during pregnancy, cord blood telomeres were 9% shorter and placental telomeres 13% shorter.

Meaning Improved air quality may promote molecular longevity from birth onward.

ITEM 11.1.

Characterization of Exposures to Vehicle-Related Pollutants Near Roadways



January 2010

Air Resources Board

California Environmental Protection Agency



Case# - 00000378

1

Why are we concerned about the near-road environment?

- Fixed sites $\neq$ Near-road pollutant levels
- Limited spatial resolution from fixed site monitors
- Elevated pollutant levels near roadways can contribute significantly to exposure
- Where people live and spend their time
- Health impacts



Previous Near-Road Studies Show Significant Impacts From Busy Roadways

- Wind direction and wind speed are major determinants of where and when elevated pollution levels occur
- Traffic-related pollutants during the day decrease significantly within 500 ft of freeway
- Diesel traffic associated with roadside levels
- Roadside barriers reduce CO and PM by 15-50%, but can potentially cause elevated pollution levels further downwind



Hitchins et al., 2000; Zhu et al., 2002a,b, 2004, 2006; Levy et al., 2003, Baldauf et al., 2008; Wu et al., 2009, Bowker et al., 2007

ITEM 11.1.

What is the Mobile Platform?

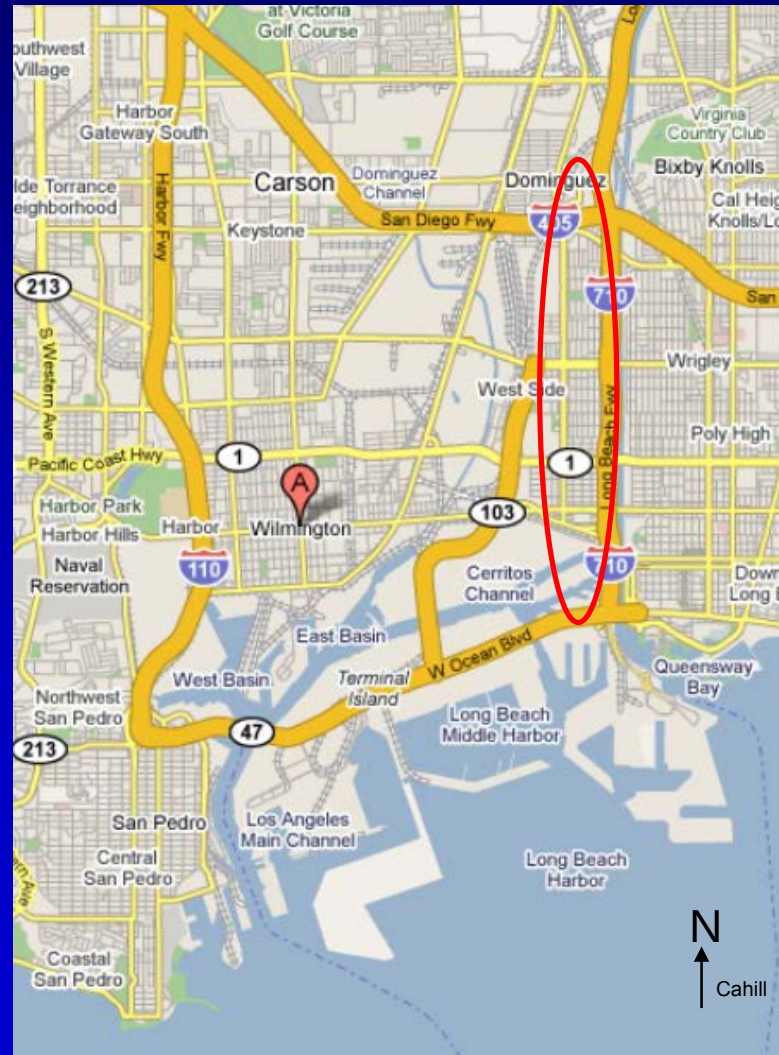
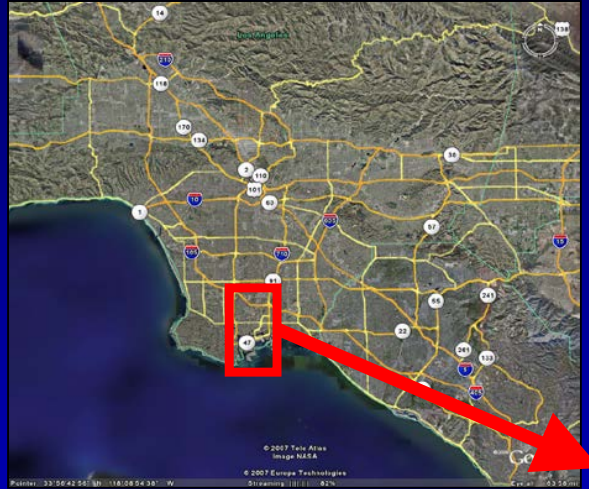


- Measures pollutants at high temporal and spatial resolution
 - Particle Size, PM_{2.5}, Black Carbon
 - CO, NO_x, CO₂, HC



ITEM 11.1

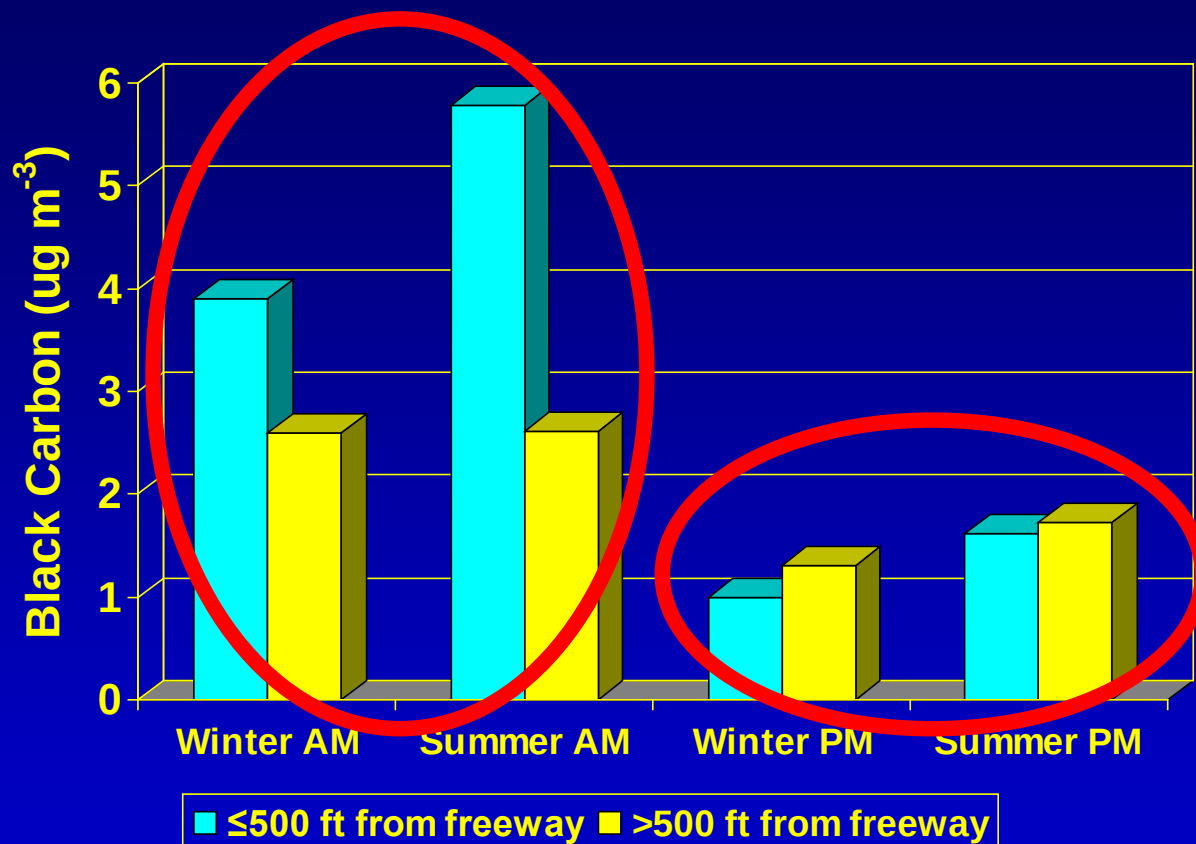
2007 Study Area Adjacent to Ports Focuses on the West Side of I-710 freeway



Cahill - 00000382

5

Meteorology Drives Black Carbon Levels on the West Side of the I-710



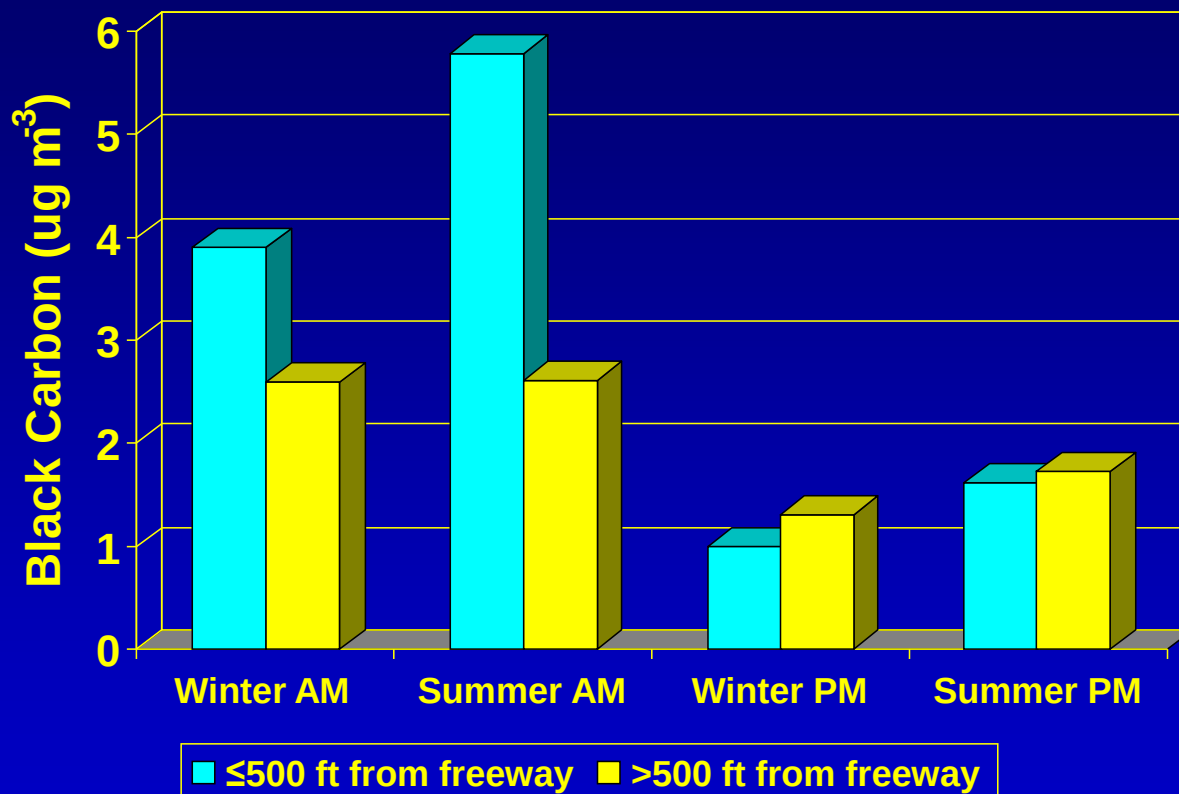
- Morning pollution levels > Afternoon



Adapted from Kozawa et al. Near-road air pollution impacts of goods movement in communities adjacent to the Ports of Los Angeles and Long Beach. *Atmos. Env.* 2009 43, 2960-2970. Supported by CARB.

envi_00000383

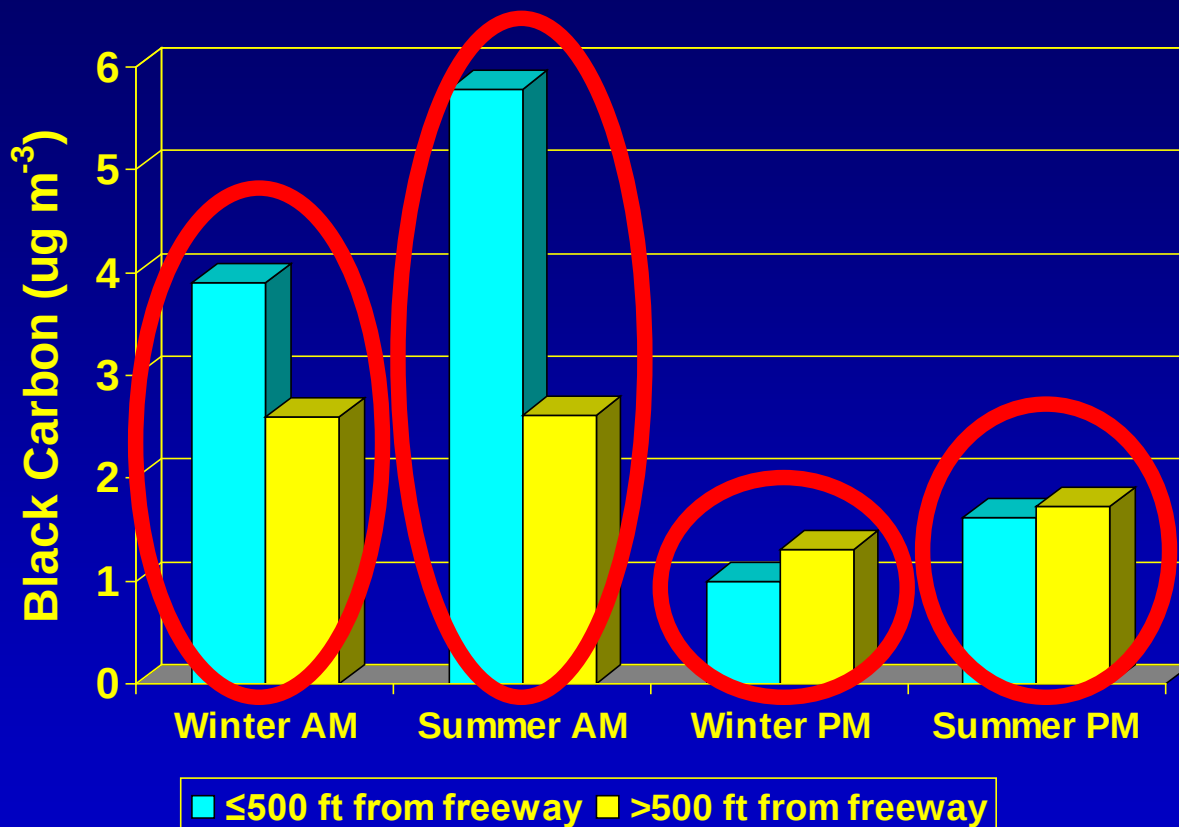
Meteorology Drives Black Carbon Levels on the West Side of the I-710



- Morning pollution levels influenced by freeway; afternoon pollution levels >500 ft from freeway may be influenced by nearby arterial roadways



Meteorology Drives Black Carbon Levels on the West Side of the I-710



- Summer pollution levels > Winter pollution levels

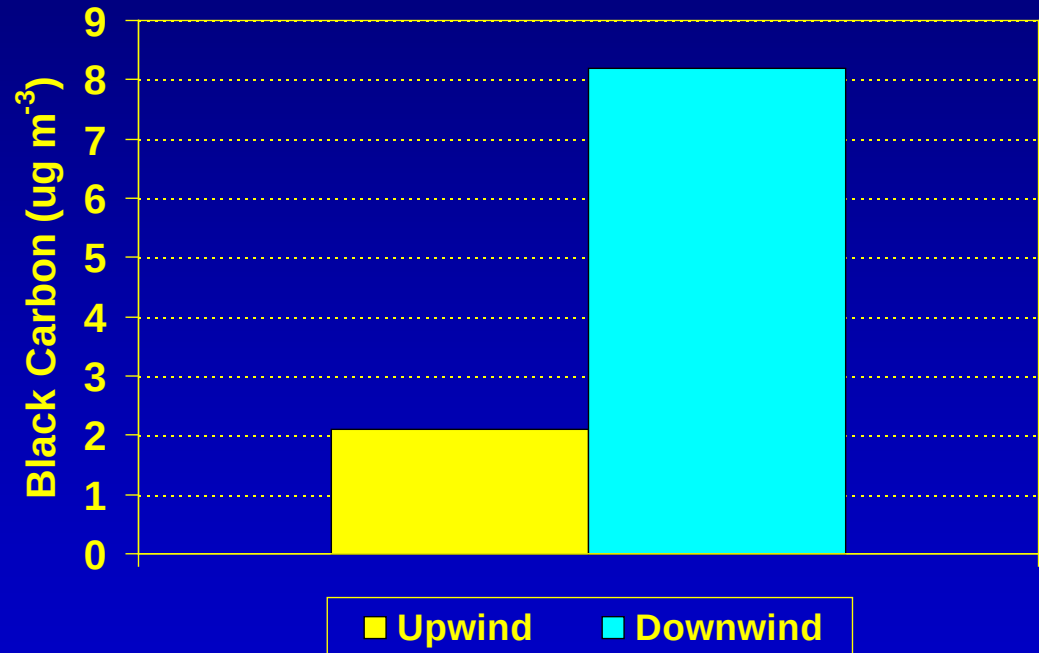
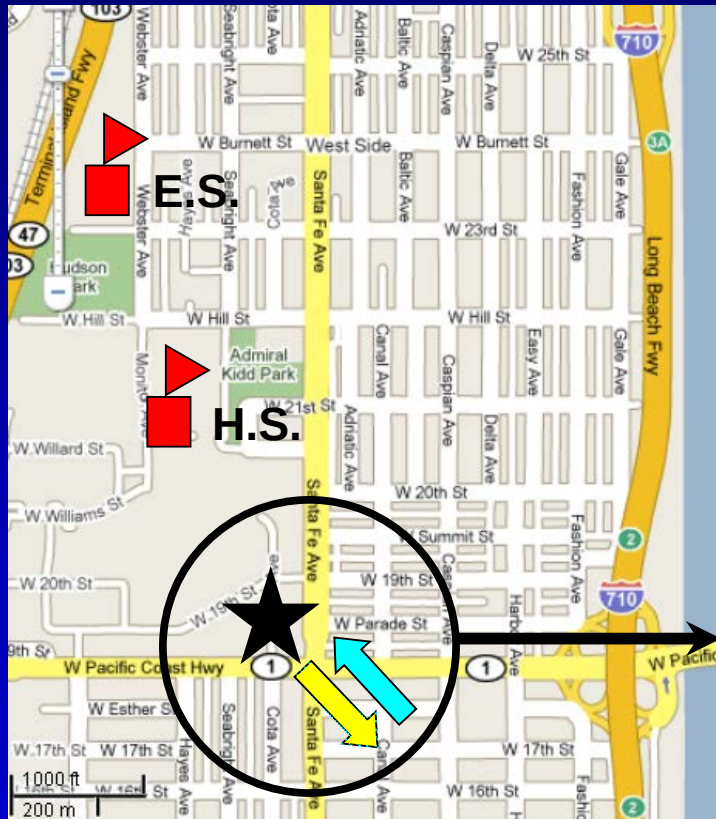


Adapted from Kozawa et al. Near-road air pollution impacts of goods movement in communities adjacent to the Ports of Los Angeles and Long Beach. *Atmos. Env.* 2009 43, 2960-2970. Supported by CARB.

envi_00000385

ITEM 11.1.

Potentially High Exposures to Vehicle-Related Pollutants at Busy Intersections



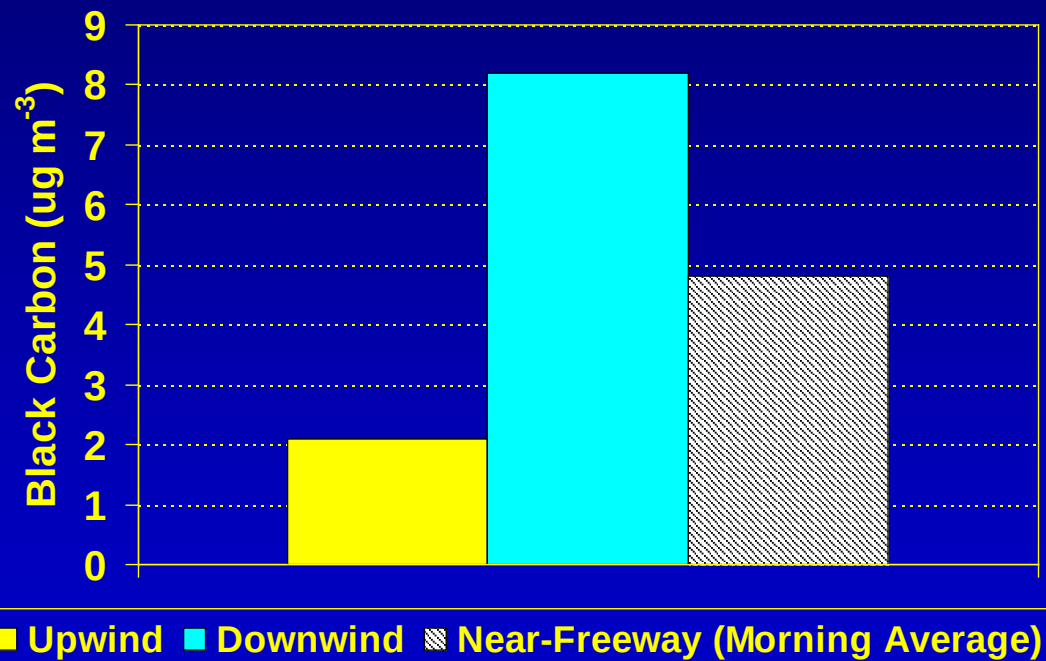
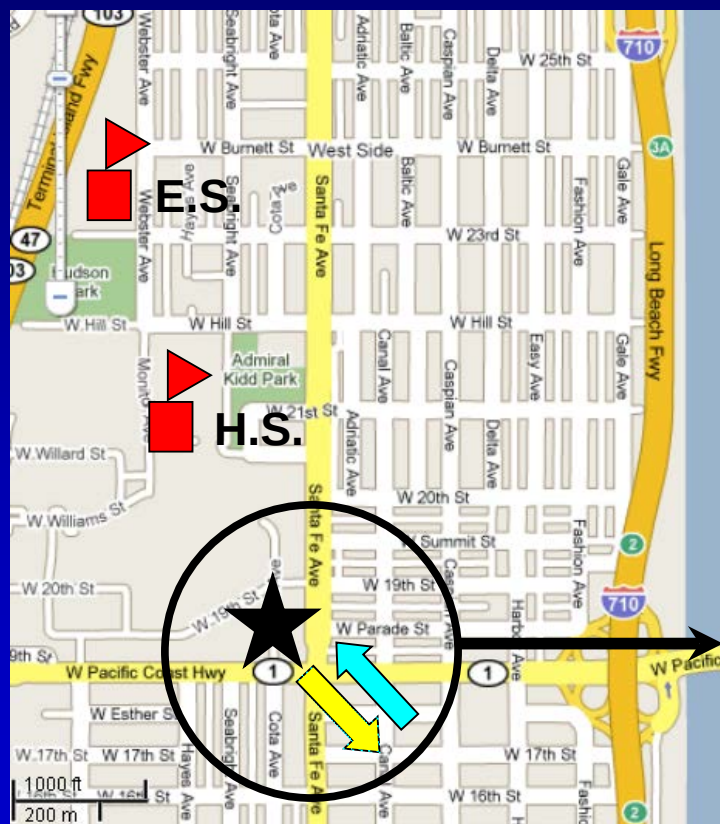
Adapted from Kozawa et al. Near-road air pollution impacts of goods movement in communities adjacent to the Ports of Los Angeles and Long Beach. *Atmos. Env.* 2009 43, 2960-2970. Supported by CARB. Note: Near-Freeway data provided for reference.

CAIR-00000386

9

ITEM 11.1.

Potentially High Exposures to Vehicle-Related Pollutants at Busy Intersections



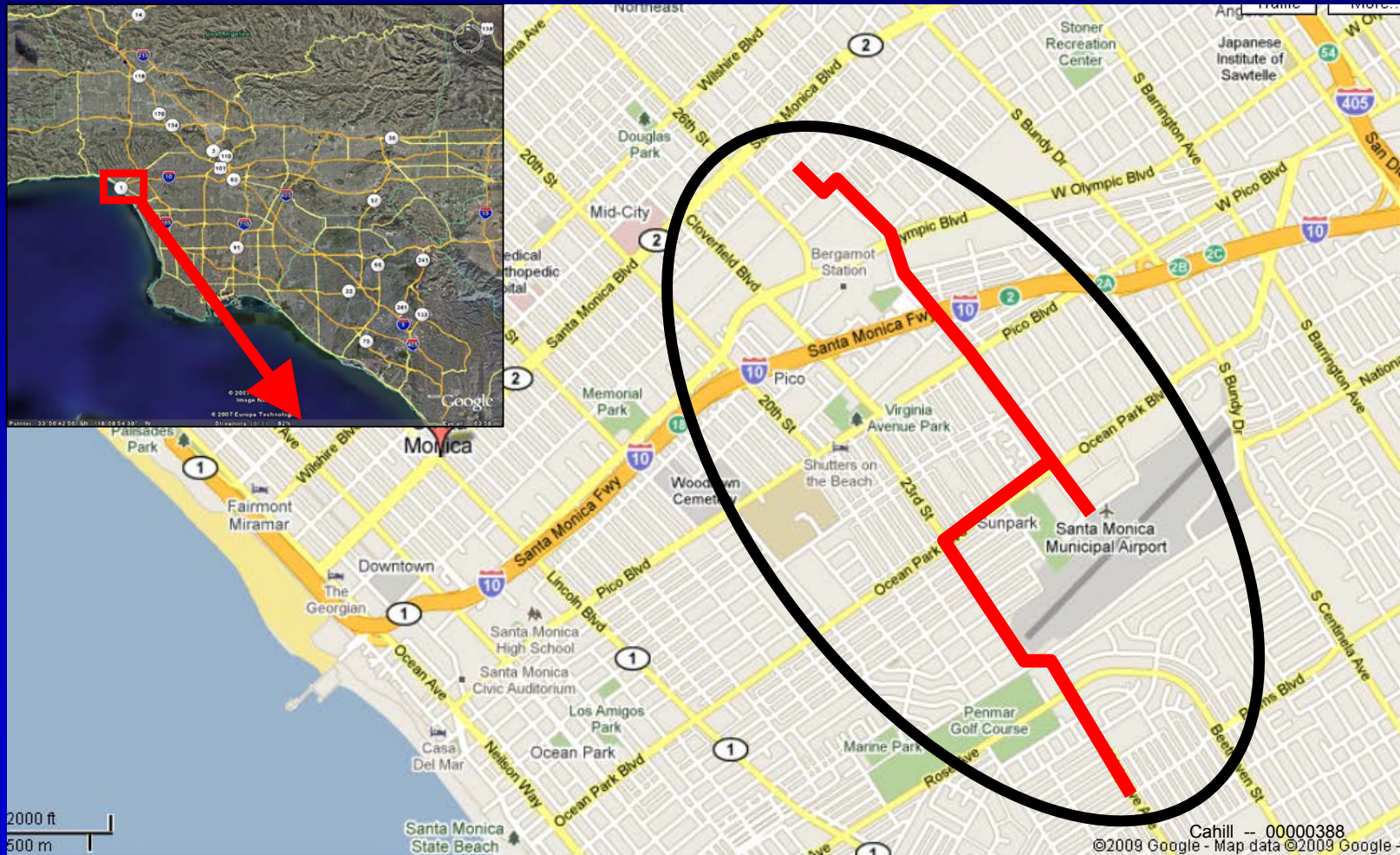
Adapted from Kozawa et al. Near-road air pollution impacts of goods movement in communities adjacent to the Ports of Los Angeles and Long Beach. *Atmos. Env.* 2009 43, 2960-2970. Supported by CARB. Note: Near-Freeway data provided for reference.

CAIR-00000387

10

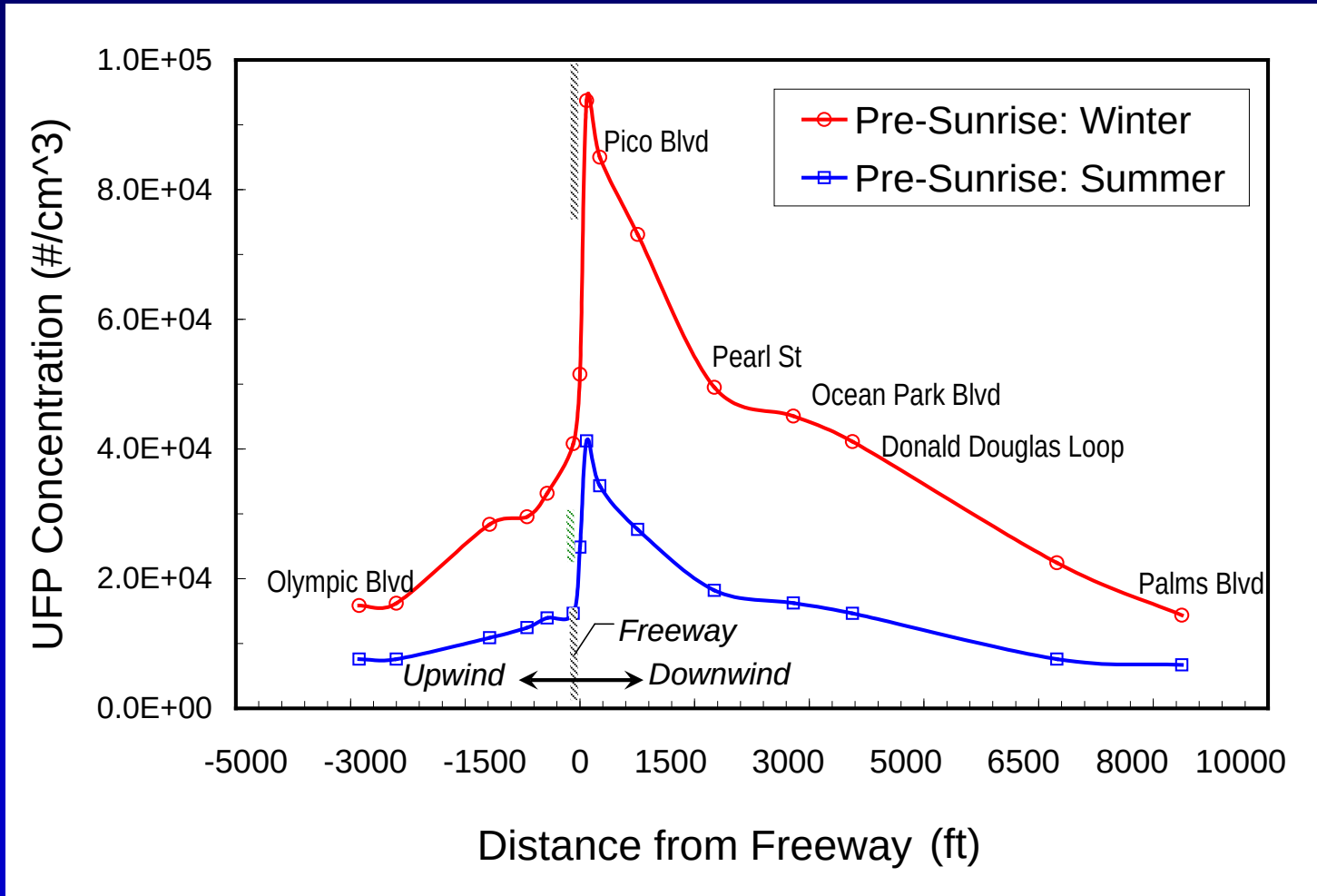
ITEM 11.1

2008 Study Area: Pre-sunrise Measurements in West Los Angeles



ITEM 11.1.

A Wide Area of Impact Observed Before Sunrise near the I-10 Freeway



Hu et al. A wide area of air pollutant impact downwind of a freeway during pre-sunrise hours. *Atmos. Env.* 2009 43, 2541-2549. Supported by CARB.

Small - 00000389

12

Conclusions

- Exposure near roadways varies significantly based on meteorological conditions.
- Measurements conducted near the I-710 freeway in Long Beach show little impact >500 ft from the source (freeway).
- Measurements observed near the I-10 freeway in West LA during early morning hours show impacts up to 1.5 miles from the source.
- Need for future studies



References

- Baldauf et al. Impacts of noise barriers on near-road air quality. Atmos. Env. 2008 42, 7502-7507. EPA and NOAA MOU.
- Bowker et al. The effects of roadside structures in the transport and dispersion of ultrafine particles from highways. Atmos. Env. 2007 41, 8129-8139. EPA and NOAA MOU.
- Hu et al. A wide area of air pollutant impact downwind of a freeway during pre-sunrise hours. Atmos. Env. 2009 43, 2541-2549. Supported by CARB.
- Hitchins, J. et al. Concentrations of submicrometre particles from vehicle emissions near a major road. Atmospheric Environment 2009 34, 51-59. Supported by the Built Environment Research Institute, Queensland Department Housing.
- Kozawa et al. Near-road air pollution impacts of goods movement in communities adjacent to the Ports of Los Angeles and Long Beach. Atmos. Env. 2009 43, 2960-2970. Supported by CARB.

References

- Levy et al. Influence of traffic patterns on particulate matter and polycyclic aromatic hydrocarbon concentrations in Roxbury, Massachusetts. J. Exp. Anal. and Env. Epi. 2003 13, 364-371. Supported by the US EPA.
- Wu et al. Exposure of PM2.5 and EC from diesel and gasoline vehicles in communities near the Ports of Los Angeles and Long Beach, California. Atmos. Env. 2009 43, 1962-1971. Supported by UC Transportation Center and NIEHS.
- Zhu, Y. et al. Concentration and size distribution of ultrafine particles near a major highway. J. Air and Waste Mgmt. Assoc. 2002a 52, 1032-1043. Supported by the Southern California Particle Center and Supersite, US EPA, CARB.
- Zhu, Y. Study of ultrafine particles near a major highway with heavy-duty diesel traffic. Atmos. Env. 2002b 36, 4323-4335. Supported by the Southern California Particle Center and Supersite, US EPA, CARB.
- Zhu, Y. et al. Seasonal trends of Concentration and Size Distribution of Ultrafine Particles Near Major Highways in Los Angeles. J. Aerosol Sci. Tech. 2004 38(S1), 5-13. Supported by the Southern California Particle Center and Supersite, US EPA, CARB, NIEHS.

ITEM 11.1.

Responses to Larry Greene comments on Nishi

I have great respect for the many years of service our area has had from Larry Greene, and I am sorry that during that entire period he was bound to follow state and federal regulations that are now known to be seriously deficient in protecting public health.

These problems are promulgated into his opinions as they have been related to me. If I am in error in his opinions, please provide me corrections. Nevertheless based on what I have, I beg to differ from his analysis on several points (his positions in italics):

1. Air quality regulators are bound to standards that are seriously out of date. Specifically, in terms of aerosols, the PM_{2.5} standard includes many components that are now known to be harmless, and others that are lethal, such as diesel exhaust, the most important Toxic Air Contaminant in California. Until the standards are re drafted to take into account modern medical science, regulators hands are tied. This is especially true for ultra-fine metals from brake drums and pads, a point explicitly accepted in a recent US EPA sponsored and co-authored study of Detroit freeways, "The concentrations of very fine and ultra-fine metals from brake wear and zinc in motor oil observed in Detroit have the potential of being a significant component in statistically established PM_{2.5} mortality rates".
2. A recent multi-year CA Air Resources Board/UCLA study has just appeared supporting in some detail the positions I took regarding the prior Nishi controversy, including the transport much farther downwind than the models predicted and the health impacts of living near freeways. (Dec. 30, 2017 article in the LA Times "Freeway pollution travels farther than we thought. Here's how to protect yourself")
3. Even based on flawed PM_{2.5} mass standards, the study identified a site in Ontario, CA on Hwy 60 that was the most polluted near freeway site in the United States. Nishi is only about ½ as bad as Hwy 60, based on traffic, but Nishi includes 3 factors not present in Ontario that all push Nishi up towards the worse site in the USA:
 - a. There is a major lane reduction from 6 lanes to 3 upwind of Nishi with common slow downs and braking of cars and heavy trucks, generating toxic ultra-fine metals. No such neck down occurs in the Ontario Hwy 60 site.
 - b. There are winter inversions in Davis that trap pollutants close to the ground and local sources for days in winter, meteorology that is rare in Ontario, and
 - c. Nishi has upwind trains directly next to the housing. Train diesel was shown by an EPA Region IX study to be 6 times more carcinogenic than truck diesel.
4. The operational method of the US EPA is called "the Precautionary Principle", where actions must assume a predicted negative impact until clarified by new data. It is for this reason that I am proposing a 2 year delay at Nishi to make the measurements clearly required by modern medical science necessary to quantify the level of threat.

ITEM 11.1.

Now to Larry's comments:

(1) Most air pollution risk studies assume lifetime [i.e., 70-year] exposure, whereas students living at Nishi would at most live there sophomore through senior year [3 or 4 years depending on how long it takes them to graduate].

5. Nothing in the Federal Register requires an analysis of occupation at a site when considering violations of the Clean Air Act.
6. The duration of student residences at Nishi depends on parameters unknown at this time, and could include far longer residency if students go on the advanced degrees.
7. Loss of lung function in young adults (~ 5%/year) is permanent.
8. When the students wise up to what a miserable noisy and dirty site Nishi is and leave, what guarantee that young families, lured by bargain rate rents, might move in?

(2) Air pollution primarily impacts the very young and elderly, whereas Nishi residents would be health young adults.

9. Exacerbation of asthma occurs at all ages.
10. It is not unheard of for young female students to become pregnant. Impacts in pregnancy requires only a few months of exposure, but can result in greatly increased (86%) chances of autism, impact on brain development, shortened life spans, behavioral changes, etc that the young mother much handle for many years to come.
11. Since Nishi residents are (presumably) healthy young adults, how about developing the EPA Superfund site on 2nd Street near Target for student housing? They could probably survive a few years of toxic exposure.

(3) The students will only be in their apartments a short period each day, spending the majority of each day in class, UCD library, visiting downtown venues, etc.

12. . The proposed development includes play areas and amenities designed to take students out of their apartments. Vigorous outdoor exercises often result in mouth breathing which defeats some of the lung's defenses.

(4) Plus, much of the time they are in their apartments they AC or heat will be on and the windows closed.

13. With balconies and patios? Note that the health data reported also are based on people living in houses with at least furnace filters, and in mature neighborhoods with tree canopies that could not be available at Nishi for decades.

(5) High capacity filters will capture most of the particulates.

14. Most high capacity filters suitable for more than a single room do a poor job on the most dangerous ultra-fine particles

ITEM 11.1.

15. I have not seen any indication that tests of efficacy are proposed before students move in.

(6) Trucks and cars are becoming increasingly "clean," thereby reducing diesel fine particulate emissions from I-80.

16. For big trucks, yes. But 2 and 3 axel diesels are in heavy use and essentially without effective controls. Note that Ford is now offering a diesel option to its popular F-150 line.

17. The worst death rate in California from diesel that I can find is downwind of the San Bernardino BNSF multimodal facility, namely 2,700 excess cancer deaths per lifetime, or about a 1% increase in the cancer rate. The worst death rate that I can find from ultra-fine metals from brake pads and drums is Bakersfield, in which the death rate from ischemic heart disease is ~ 35% greater than the Central Valley average. Incidentally, the number for Sacramento is 11%.

18. No controls are in place for most ultra-fine metals that are far more dangerous than even diesel exhaust, and their emission rates will rise with increasing traffic and congestion.

A final and very important point. Working with the Ca Attorney General, we just forced a modification of road traffic heavy with diesels that would impacted an existing Latino community Loma Rica in Riverside County. I won an award a few years ago for my work in East Oakland controlling idling diesels in residential areas. There are serious "Environmental Justice" aspects to near freeway housing that need to be addressed. The concerns at Nishi are similar in nature to a series of unwise planning decisions being made all over California based on flawed and inadequate air quality standards, and this needs to be addressed, now.

On a personal note, I have been working on the impact of aerosols on global climate for 40 years, including at the request of the NSF running the aerosol site on Greenland until 2021. I expect that there are few if any "climate deniers" in Davis that contest my work. I have been working of the health impacts of freeways in California for 50 years. I regret to say that there are a number of "medical deniers" in Davis who feel free to contest my work.

Please don't force me to add a peer reviewed publication (#267 in my career) focusing on Nishi and the City of Davis.

ITEM 11.1.

Meeting with Tim Ruff, John Whitcomb, and Sandy Whitcomb, 11 AM January 4, 2019 Expressed the need of an air quality study before any effort to place residential housing on the Nishi site. Provided them with a copy "I can breathe clearly now! Protecting yourself from air pollution.", Thomas A. Cahill, EditPros, Dec 2016

ITEM 11.1.

Comment

Is Nishi in the running for the most polluted near-roadway site in the nation? It certainly is not that far behind a freeway site on Hwy 60 in Ontario, CA, which currently holds the title. This startling fact is based on data in a long awaited report on freeways from the Air Resources Board and UCLA, and reported in a Dec 30 LA Times article “Freeway pollution travels farther than we thought. Here's how to protect yourself”.

The story proposes that one way to protect yourself is “...avoid truck routes” and gives an example . “An air-monitoring station next to a truck-congested stretch of the Hwy 60 freeway in Ontario, (CA), had the highest levels of fine-particle pollution, or soot, of all near-roadway sites in the nation, according to 2015 [U.S. Environmental Protection Agency data](#). About 217,000 vehicles a day passed by in 2015, more than 29,000 of them trucks.”

So let’s compare the worst near-roadway site in the nation, Hwy 60 at Grove Boulevard, Ontario, to Nishi, I-80 from looking west from the Solano/Yolo line:

The sites have several similarities. In terms of annual average PM_{2.5}, Yolo County and LA County near Ontario (Glendora) are almost identical over the last decade, ~ 9.5 µg/m³, so the background fine mass cannot skew the comparison. They are both elevated east-west trending freeways with under-crossings, Grove Ave in Ontario, UPRR tracks at Nishi, and both sites are based on California cars, trucks, and fuels.

The traffic data, Annual Average Daily Traffic (AADT), shows Hwy 60 exceeds Nishi.

	Nishi	Hwy 60
Total AADT traffic	136,700	217,000
Truck AADT number	11,989	29,121
Truck AADT percent	8.8 %	13.4%

So Nishi is only 41% (trucks only) or 63% (trucks plus cars) as bad as the worst near freeway site in the entire USA? That’s like looking to buy a house near a water body that the developer boasts is only 41% or 63% as bad as the Love Canal – infamous Superfund site near Buffalo that sickened hundreds.

ITEM 11.1.

But before we sign off on Hwy 60's victory lap to infamy, there are three factors that impact Nishi that are absent from Hwy 60 and propel Nishi closer to the "worst in the USA" leader:

1) the neck down of I-80 west of Nishi from 6 lanes to 3 forces heavy braking and stop and go traffic. Why is that important? The article states "Ultrafine particles are suspected of causing some of the illnesses among people living near traffic," These include "....dust from brake pads..". All that grinding to a stop upwind of Nishi is a recipe for several types of lung, heart and reproductive distress.

2) Davis, like all Central Valley cities, has its worst air quality in winter stagnation events and very shallow pollution inversions. Why is that important? The winter inversions at Davis trap pollutants near the ground and near the sources, so all those diesel soot and ultra-fine metals will persist and build up to high levels until cleared out by the next rain storm or strong north winds, which could be days or even weeks away.

3) Nishi has heavy train traffic on its north edge, with both idling and accelerating Amtrak trains, and heavy freight trains accelerating out of the Davis curve. This use is increasing. Why is that important? Both because train diesel was shown to be 6 times more carcinogenic than truck diesel per unit mass by Region IX in the Roseville railyard.

Davis readers will find much more in the article that seems familiar, that even up to 1,000 feet, impacts include "...asthma, cancer, heart attacks, strokes, reduced lung function, pre-term births and a growing list of other health problems." This is a pretty good summary of information in the Davis Nishi DEIR and our summaries.

Allowing students to live in what is certainly one of the most polluted near roadway sites in the nation is not a viable answer to UCD housing needs, even assuming the students are forced to live in hermetically sealed boxes with no patios, balconies, or windows that open. As always, my colleagues and I will provide full copies of this and other articles from the e mail account tacahill2718@gmail.com.

ITEM 11.1.

PIXE from Lund;

Efforts of Tom Cahill to ask the developers and the City of Davis to do an air quality evaluation at the Nishi site before any residential housing is built

1. Circa 2010: Met with Tim Ruff and John Whitcomb at their request circa 2010 regarding air quality at the Nishi site. Expressed my concerns about housing supported a research park.
2. Early fall, 2015: When Nishi 1 was proposed, met with Tim Ruff and again recommended an air quality study in conjunction with the DEIR. Proposed a cost circa \$60 K including measurements of both ultra-fine metals and diesel. Suggested Dr. David Barnes as a contractor. A short study of soot was done at a site on the west end of Olive Drive, and included in the DEIR. The soot levels confirmed the enhancement of soot as trucks accelerated away from the upwind neck down. No measurements were made anywhere near where the students would be housed or for ultra-fine metals.
3. Jan 4, 2018: Met with Tim Ruff John and Sandy Whitcomb at their request. Gave them a copy of my new book "I can breathe clearly now! Protecting yourself from air pollution" which covers threats from soot and ultra-fine metals from freeways. Shared new data in the past 2 years about health threats, again proposed a delay and a complete study, ideally a Nishi-New Harmony comparison suitable for the peer reviewed literature. Offered to help support the costs of the study, which would be of benefit all over the state and nation. Mentioned that I thought he site was valuable for a major UCD facility at the high visibility site, leaving the rest for a research park development.

Efforts of Tom Cahill towards the City Council

1. 2015-2016: Contacts with the City Council and planning commission (files appended sorted by the date submitted)
2. Jan 12, 2018: Personally sent a copy of my book, "I can breathe clearly now! Protecting yourself from air Pollution" to all members of the City Council.
3. Jan 10, 2018: Sent my comments to the City Council (file appended)
4. Jan 12, 2016: Responded to specific questions from Robb Davis. (files appended)

Efforts of Tom Cahill towards the Planning Commission (files appended sorted by data of submitted, and including the files appended to the specific questions I addressed)

ITEM 11.1.

Nishi proposal – draft of 10/26/2017



★ Sampling sites

● Tracer site

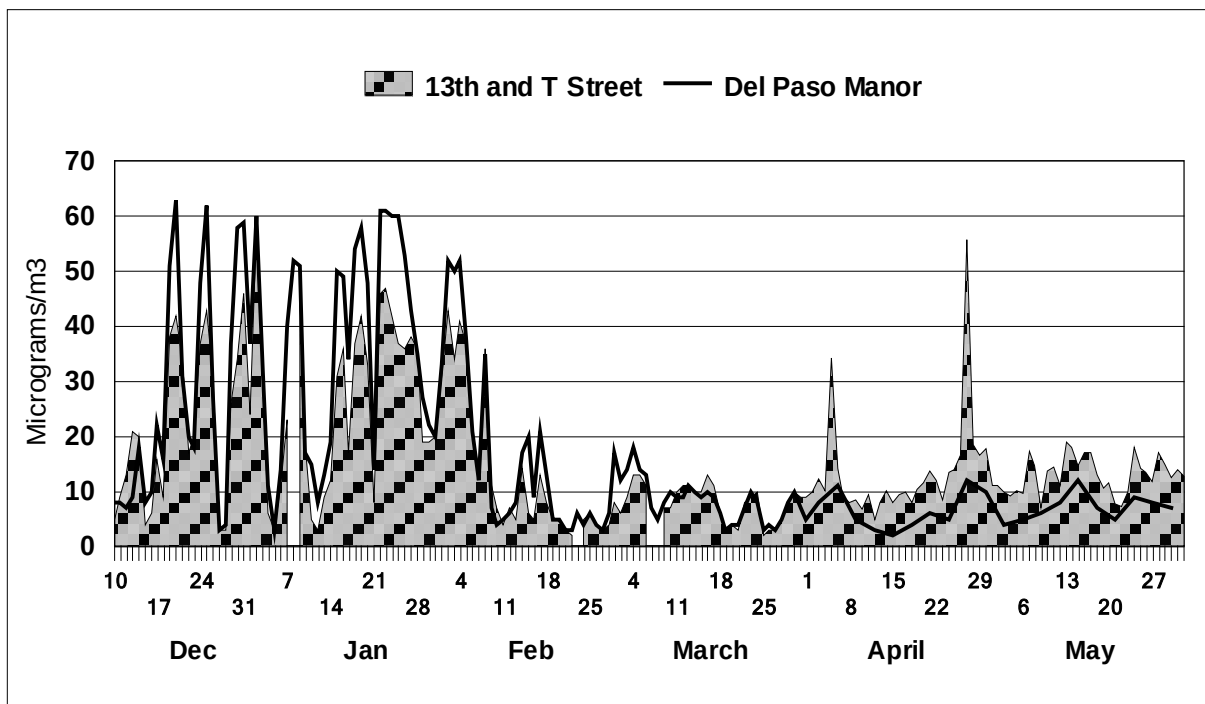
Purpose:

To take data necessary for comparisons with other sites with ultra-fine metals measurements, and especially sites with solid health impact data.

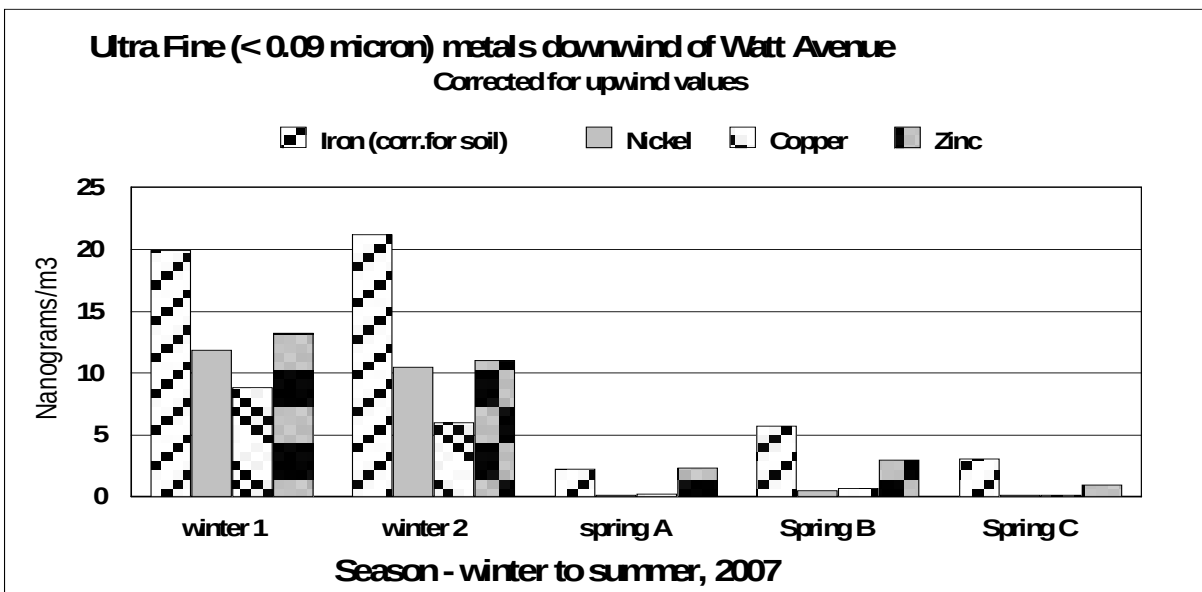
Timing:

To get the base possible measure of the worst air quality each year, and match the prior Central Valley transects and Watt Avenue ultra-fine data, winter, the study should be done between Dec 1 and Feb 15.

ITEM 11.1.



Example of PM_{2.5} aerosols at two sites about 5 miles apart in Sacramento. Note the similarity between the sites, showing a regional aerosol, and the effect the inversion breakup in spring.



Cahill, Thomas A., , David E. Barnes, Nicholas J. Spada, **Seasonal variability of ultra-fine metals downwind of a heavily traveled secondary road**, Atmospheric Environment 94 173 - 179 (2014)

ITEM 11.1.

Infrastructure:

Since the study is focused in fine, very fine, and ultra-fine aerosols, one can use a simple portable shade structure to protect instruments against rain. The instruments can sit on a plastic table.

Since power requirements are low and based on 110 volts, one can run a very long extension cords from a rented outlet on Olive drive to the sites, using tall poles to keep wires above the bike path and short (2 m) poles to keep the wires off the ground.

Site access is once/week to change the after filters on the DRUM units, giving 5 ultra-fine ($< 0.09 \mu\text{m}$) samples from each site and 320 very fine ($0.26 > D_p > 0.09 \mu\text{m}$) samples, which includes the artificial tracer elements.

Methods:

Use as much as possible methods used in peer reviewed publications:

a. Valley Transects

Teflon filter downstream of an 8 DRUM for ultra fines, 17 days

Thomas A. Cahill, David E. Barnes, Nicholas J. Spada, Jonathan A. Lawton and Thomas M. Cahill. **Very fine and ultra-fine metals and ischemic heart disease in the California Central Valley 1: 2003 – 2007**. *Aerosol Science and Technology* 45:1125-1134 (2011)
doi:10.1080/02786826.2011.582194

b. Detroit

Continuous ultra-fine behind 8 DRUM, 5 week 3 hr resolution

Thomas A. Cahill, David E. Barnes, Jonathan A. Lawton, Roger Miller, Nicholas Spada, Robert D. Willis and Sue Kimbrough, **Transition metals in coarse, fine, very fine and ultra-fine particles from an interstate highway transect near Detroit**, *Atmospheric Environment* 145, 158 – 175 (2016)

Proposed protocol

1. Two sites. Central at south edge of residences, and 75% to the east, same orientation
2. Central site
 - a. 8 DRUM with ultra-fine after filter
 - b. 8 DRUM with continuous stage
 - c. IAS $\text{PM}_{2.5}$ filter
 - d. Yolo Solano - CO?
3. Eastern site
 - a. 8 DRUM with ultra-fine after filter
4. Mid December to early February

ITEM 11.1.

Nishi tracer experiment

Purpose: To provide an unambiguous and quantitative measurements of the rate at which highway aerosols impact Nishi

Methods: Use the methods used on I-5 in Sacramento

Thomas A. Cahill, David E. Barnes, Leann Wuest, Sean Barberie, David Gribble, David Buscho, Jason Snyder, Roger S. Miller, and intern Camille De la Croix, **Artificial Ultra-fine Aerosol Tracers for Highway Transect Studies**, Atmospheric Environment 136, 21 – 42 (2016)

1. Choose typical winter meteorology, avoiding rain storms and strong north winds
 2. Place 4 highway flares on a circa 30 ft pole.at a site directly upwind of the congested section on the overpass.
 - a. Replace every 15 minutes with a new set
 - b. Continue for 4 hr
 3. Repeat at least 3 times
 4. Run HYSPLIT trajectory and diffusion models for these times
 5. Analysis: PIXE at CNL, S-XRF at SSRL
 6. Combine these data with Watt Avenue emission rates to predict concentrations in Nishi
- Cahill, Thomas A., , David E. Barnes, Nicholas J. Spada, **Seasonal variability of ultra-fine metals downwind of a heavily traveled secondary road**, Atmospheric Environment 94 173 - 179 (2014)

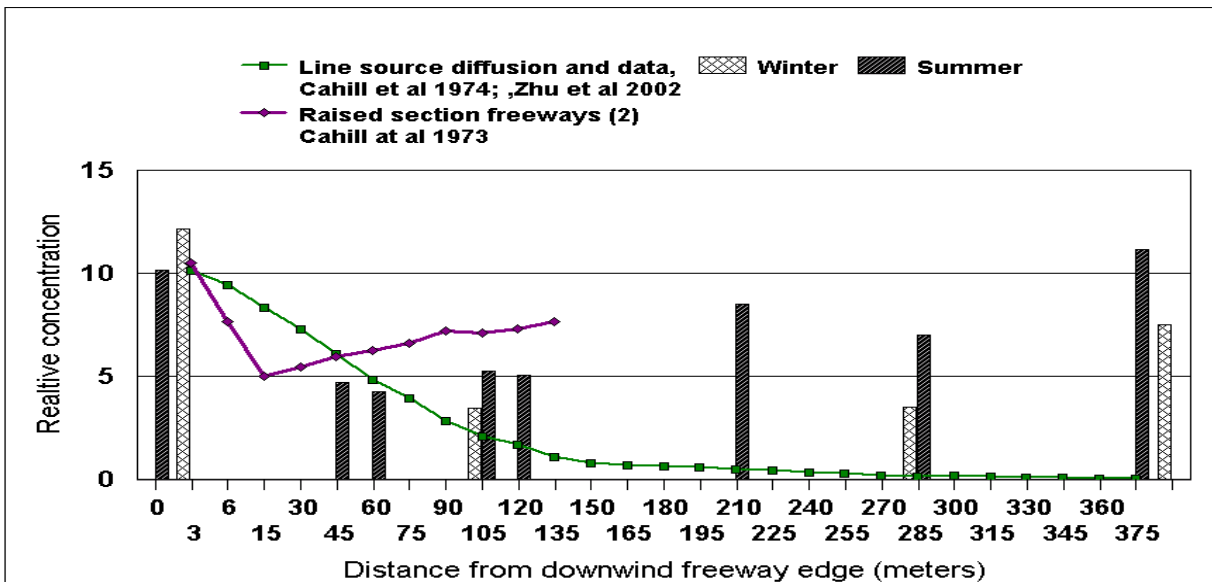


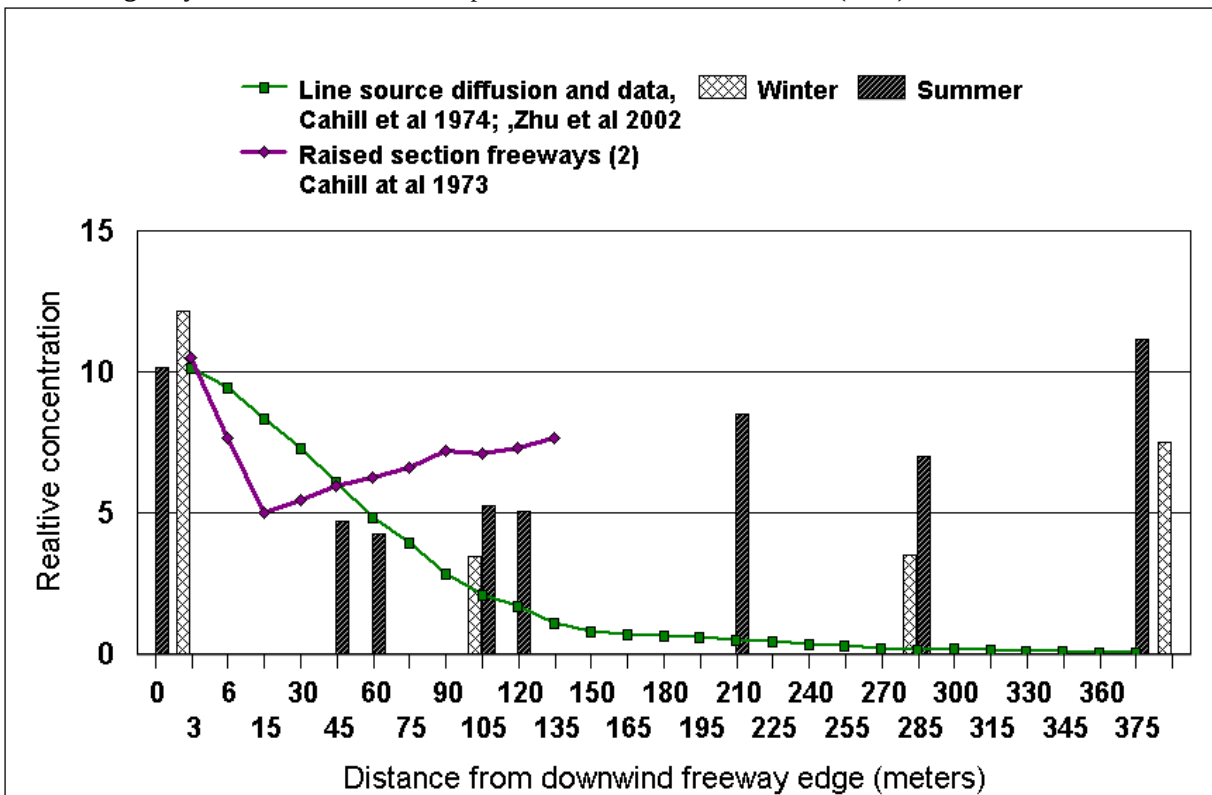
Figure A1-7. Results of the 35th Avenue fill section roadway, summer and winter. Based upon these results, the EMFAC2007 table **distances must be multiplied by a factor of ~ 20** for the same health impact (Cahill et al., 2016).

ITEM 11.1.

Nishi Submission # 2. New information on downwind transport from freeways plus information on mitigation .

I originally thought that based upon current EPA models the freeway influence would attenuate in the far northeast corner, perhaps allowing for some residential use. New studies by both my group and the ARB/UCLA study (Submission #3) show downwind transport with minimal attenuation all the way to the end of the Nishi property. Below I show a plot from our work at an elevated section of I-5 along 35th Avenue in Sacramento.

Thomas A. Cahill, David E. Barnes, Leann Wuest, Sean Barberie, David Gribble, David Buscho, Jason Snyder, Roger S. Miller, and intern Camille De la Croix, **Artificial Ultra-fine Aerosol Tracers for Highway Transect Studies**, Atmospheric Environment **136**, 21 – 42 (2016)



Note: 390 m = 1287 feet Note: There was a massive redwood barrier roughly 15 meters (50 ft) wide downwind of the freeway. Note also that the enhanced stability in winter delayed the in distance the worst impact downwind of the freeway.

5 Thomas A. Cahill, David E. Barnes, Leann Wuest, Sean Barberie, David Gribble, David Buscho, Jason Snyder, Roger S. Miller, and intern Camille De la Croix, **Artificial Ultra-fine Aerosol Tracers for Highway Transect Studies**, Atmospheric Environment **136**, 21 – 42 (2016)

Summary: Elevated freeways pitch pollutants far downwind with little attenuation, summer and winter despite the presence of a massive redwood barrier.

ITEM 11.1.

#6: **Information on Residential siting near freeways**, Tom Cahill, October, 2017

Summary, I include in Section A the information provided last year before the Prop A vote. In Section B, I include updates of that information and new information generated since the first summary was prepared.

#7 **California officials say housing next to freeways is a health risk — but they fund it anyway** By TONY BARBOZA and DAVID ZAHNISER, LA TIMES DEC 17, 2017 | 5:00 AM

#8: **Mitigation of Roadside Aerosols: New data, new challenges, new opportunities**, A presentation for the joint US EPA and Breathe California meeting on Vegetation for Mitigation, Tom Cahill, June 2, 2015

#9 **Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality**, US EPA (2016) Rich Baldauf

Summary: The latest EPA thoughts on the matter, but showing that vegetation has only limited impact. Further, the closed canopy effect that Rich and we saw were for deciduous trees, and thus ineffective in winter when pollution impacts at Nishi are maximum. Rich also did not have out discouraging data from I-5.

ITEM 11.1.

Nishi Submission #3. New information on health impacts near freeways

The last 3 years have seen rapid advances in our understanding of the health impacts of freeways and heavily traveled roadways. These include new information and studies known 3 years ago (labeled old): at conception (new, shortened life span), (old, 86% increase in autism), (new, birth defects), neonatal (new, attention deficit), youth (old, 5% loss of lung function/year), (old, enhanced asthma), adult (old, early heart attacks), (new, dementia), (new, shortened life span). Note that these data are based on average freeways, not the extreme conditions downwind of I-80 at Nishi with its heavy braking. In my opinion, predictions of the level of the most hazardous pollutants at Nishi are so extreme as to make any residential use at Nishi hazardous, even with massive and intrusive indoor mitigation.

Some peer reviewed studies I found in the best journals – I am sure there are more.

9 AIR POLLUTION**Fine particulates raise birth defect risk — study**

Sean Reilly, E&E News reporter Dec 11, 2017

Summary: In this birth cohort study of 641 mother-newborn pairs, mothers with higher residential exposure to PM_{2.5} (particulate matter with an aerodynamic diameter ≤ 2.5 μm air pollution) gave birth to newborns with significantly lower telomere length that could not be explained by other factors including socioeconomic class. For a 5- $\mu\text{g}/\text{m}^3$ increase in residential PM_{2.5} exposure during pregnancy, cord blood telomeres were 9% shorter and placental telomeres 13% shorter

#10: **Air pollution takes a double toll on babies' brains,** greater developmental and behavioral problems, a study suggests. Above, a Long Beach school near an oil refinery, freeway, railroad line and seaport. (Don Bartletti / Los Angeles Times), **By GEOFFREY MOHAN**

Summary: “Those physical changes in the brain's internal wiring also were correlated with slower cognitive processing and with symptoms of attention deficit and hyperactivity, according to the [study](#) published Wednesday in the journal JAMA Psychiatry”.

#11 October 16, 2017

Prenatal Air Pollution and Newborns' Predisposition to Accelerated Biological Aging

Dries S. Martens, MSc¹; Bianca Cox, PhD¹; Bram G. Janssen, PhD¹; et al Diana B. P. Clemente, MSc^{1,2,3}; Antonio Gasparini, PhD^{4,5}; Charlotte Vanpoucke, MSc⁶; Wouter Lefebvre, PhD⁷; Harry A. Roels, PhD^{1,8}; Michelle Plusquin, PhD¹; Tim S. Nawrot, PhD^{1,9}

Author Affiliations [Article Information](#)

JAMA Pediatr. Published online October 16, 2017. doi:10.1001/jamapediatrics.2017.3024

ITEM 11.1.

#12 **Researchers find link between dementia and exposure to vehicular pollution**

SHERYL UBELACKER, TORONTO — The Canadian Press, Published Wednesday, Jan. 04, 2017 9:22PM EST, Last updated Wednesday, Jan. 04, 2017 9:23PM EST

Summary: People who live in close proximity to high-traffic roadways appear to have a higher risk of dementia than those who live farther away, say researchers, suggesting that air pollution from vehicles may be a factor in the development of the neurological disease.

#13: **Very Fine and Ultrafine Metals and Ischemic Heart Disease in the**

California Central Valley 1: 2003–2007 Thomas A. Cahill, David E. Barnes , Nicholas J. Spada , Jonathan A. Lawton & Thomas M. Cahill , *Aerosol Science and Technology* 45:1125-1134 (2011) doi:10.1080/02786826.2011.582194

Summary: The enhancement of mortality associated with cardiovascular and specifically ischemic heart disease (IHD) has been seen for decades in the southern San Joaquin Valley. Very fine and ultrafine iron, nickel, copper, and zinc were identified as vehicular and were highly correlated with enhanced IHD mortality.

#14 **Inorganic and organic aerosols downwind of the Roseville rail yard**

Thomas A. Cahill, Nicholas J. Spada, David E. Barnes, Roger Miller, and Thomas M. Cahill *Aerosol Science and Technology* 45:1049-1059 (2011) doi:10.1080/02786826.2011.580796

Summary: Diesel exhaust from trains was about 6 times richer in the major carcinogen benzo[a] pyrene than diesel from trucks per unit mass.

#15 **Very Fine and Ultrafine Metals and Ischemic Heart Disease in the California Central Valley 2: 1974–1991,**

Thomas A. Cahill , David E. Barnes , Earl Withycombe & Mitchell Watnik, *Aerosol Science and Technology* 45:1135-1142 (2011) doi:10.1080/02786826.2011.582196

Summary: Removal of nickel and vanadium ultra-fine metals from petroleum extraction after 1990 dramatically (30 %) reduced ischemic heart disease death rates in the oil extraction regions of the southern San Joaquin Valley..

ITEM 11.1.

ITEM 11.1.

Nishi - Submission # 4. Information from analyses of the prior Nishi proposal

This submission includes the materials I developed for the Planning Commission and Ascent Environmental from the previous Nishi proposal. Most of it is still relevant

16 Summary included in the Nishi summary we prepared as an advertisement in the Enterprise.

17 Information on Health Impacts, Nishi proposal, June, 2016

Tom Cahill, May 8, 2016 tacahill2718@gmail.com

Summary: Davis completed its Environmental Impact Report showing “...**significant and unavoidable**” (4.3-33) ...” air quality impacts based on existing **state and federal air quality regulations**. This result was supported by measurements of diesel soot. My analysis of the freeway impact has been completed, and the **Nishi health threat is roughly 10 times the average California freeway**. (see Atm. Env, April, 2016); Mitigation is ineffective in situations of high risk

18 Planning Commission

City of Davis Planning Commission, October 16, 2015

Testimony of Thomas A. Cahill, Prof Emeritus of Physics and Atmospheric Sciences, UC Davis.

My recommendation: If the Planning Commission should decide to support the Nishi proposal, the threats from air pollution (diesel and ultra-fine metals) are so grave that it should be modified to eliminate all residential housing

ITEM 11.1.

Response #1

Freeway pollution travels farther than we thought. Here's how to protect yourself, TONY BARBOZA

DEC 30, 2017

“In the late night and early morning, it turns out, traffic pollution drifts much farther than during the day, and can extend more than a mile downwind from the freeway.

That discovery, made by Paulson and her colleagues, is one example of new research revealing how much your exposure to harmful levels of vehicle pollution is affected by your specific surroundings. It’s not only your distance from traffic, but other details such as wind patterns, freeway design, the time of day and the types of cars, trucks and buildings around you that determine the risk.

Keep your distance from freeways and busy roads

Southern California is experiencing a [surge in home construction](#) near freeways that is pushing more people into high-pollution zones. But just because state and local officials are allowing new housing there doesn’t mean it is safe, health experts say.

When choosing a home, school or day care, aim for locations as far from the freeway as possible.

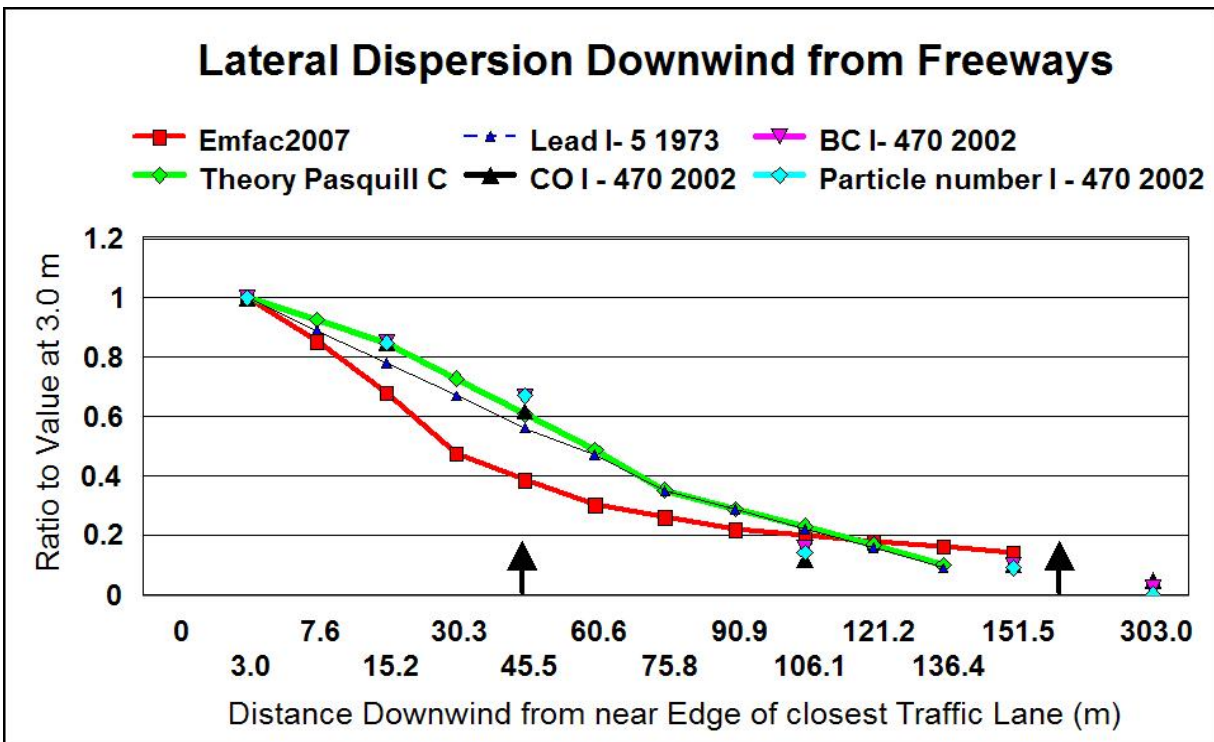
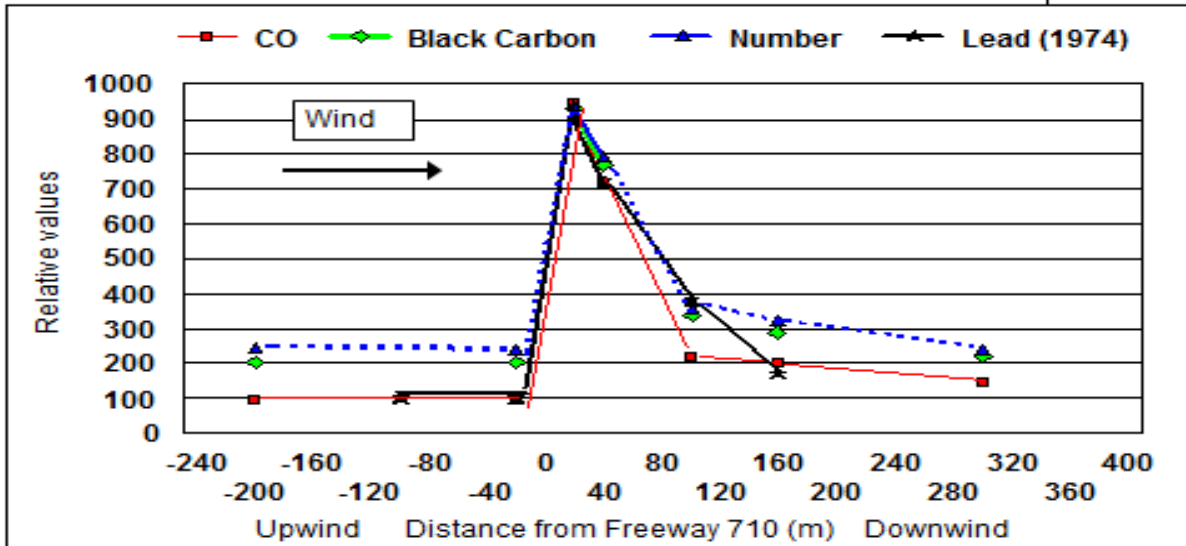
Avoid sites within 500 feet — where California air quality regulators warn against building — or even 1,000 feet. That’s where traffic pollution is generally highest, along with rates of asthma, cancer, heart attacks, strokes, reduced lung function, pre-term births and a growing list of other health problems.”

This report strongly supports my comments on the prior Nishi proposal, and extends them in several directions. I am pleased to have the ARB and UCLA on board.

This study also corrects a problem in the Emfac2007 model. Our data on at grade freeways (Feeney et al 1976) and recent work from Zhu et al 2002 are imbedded in Emfac2007.

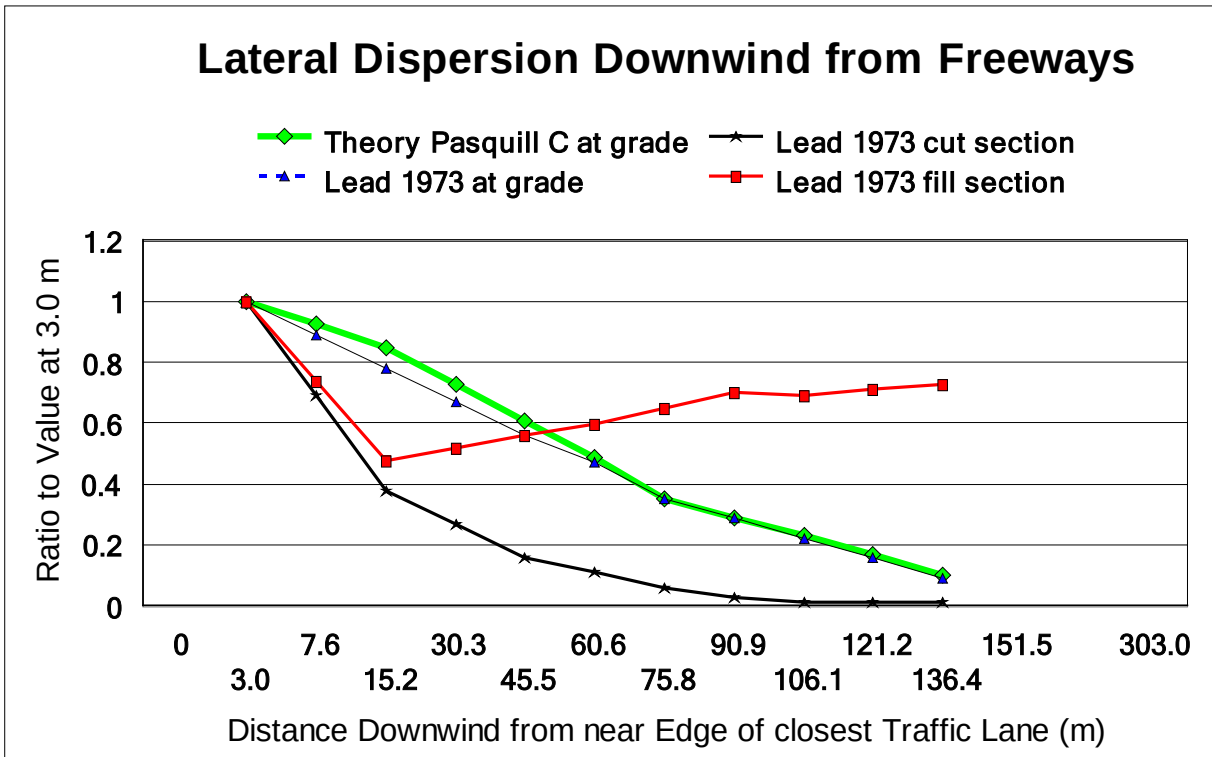
ITEM 11.1.

Lateral transport of ultra fine particles – efficient transport, no coagulation!



However, these same studies showed elevated freeways transported materials much farther downwind than at grade freeways (Cahill et al 1973, Feeney et al 1976)

ITEM 11.1.

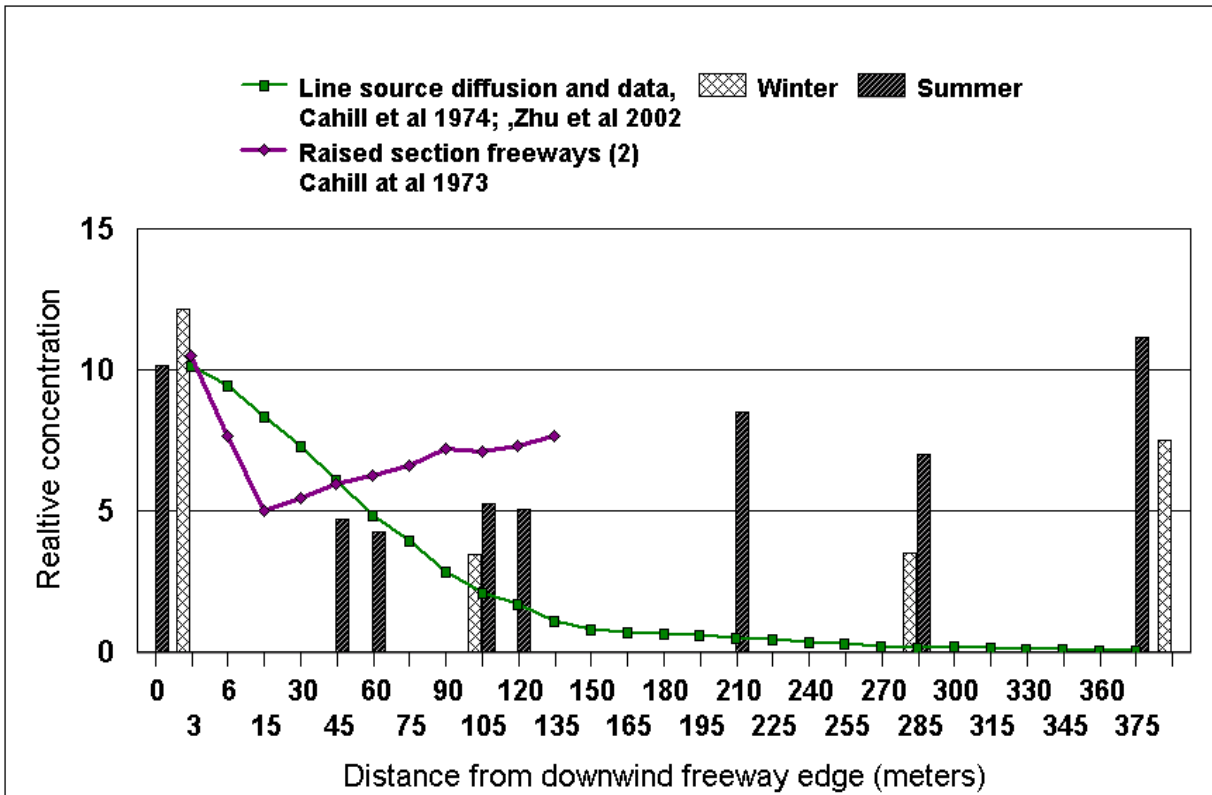


These data showed gross violations in nearby homes from elevated freeways, and caused Ronald Ragan to cut off all my ARB funding.

The new health data caused our Health Effects Task Force to team with Dr. Rich Baldauf and his US EPA team in North Carolina and have a series of annual meetings looking at freeways transport and the mitigation effects of vegetation. **Baldauf, Richard, Greg McPherson, Linda Wheaton, Max Zhabg, Tom Cahill, Chad Bailey, Christina Hemphill-Fuller, Earl Withycombe, and Kori Titus**, Integrating Vegetation and Green Infrastructure into Sustainable Transportation Planning, **Transportation Research Bulletin, National Academy of Sciences (2013)**

Relevant to the Nishi proposal, here are the data downwind of an elevated section of I-5 at 35 Ave with a massive redwood vegetation barrier. Note that I have included our 1974 data from an elevated section whci ndod not have a vegetation barrier. **Thomas A. Cahill, David E. Barnes, Leann Wuest, Sean Barberie, David Gribble, David Buscho, Jason Snyder, Roger S. Miller, and intern Camille De la Croix**, Artificial Ultra-fine Aerosol Tracers for Highway Transect Studies, **Atmospheric Environment** 136, 21 – 42 (2016)

ITEM 11.1.



Note that even at 1300 feet downwind, there is scarcely any diminution of freeways impact.

I am appending a talk I gave at the most recent joint EPA/Breathe California meeting in North Carolina that shows pictures of the sites.

ITEM 11.1.

Responses #2, #3, and #4

The comments I have received from my ARB colleagues were sent to me in confidence, and as they also are not in accord with my attempts to maintain collegiality in all communications, I can not share them with you.

But I can summarize some points in this regard:

1. The famous “Chauncey Starr” factor of 1,000 – people are loathe to accept 1,000th of the impact involuntarily over what they accept voluntarily. An example I use is a vegan bike rider checking his I-phone while not wearing a helmet. I don’t see any indication that students renting the site will have such information provided to them.
2. The CAA act addresses harm, not body counts. Even one preventable death is not acceptable. The same goes for one preventable damaged baby.
3. Ultra-fine metals stay in the body for years, so that the young adults who are losing 5% of their lung function per year are also accepting early heart attacks.

Response #5: I have provided the developers with all my best information on cleaning up indoor air, techniques also provided to the US embassies in China. As long as people stay indoors, harm is reduced almost to zero.

ITEM 11.1.

Response #2

1. What is your estimate of the total number of autism cases attributable to poor air quality per year that will come from the approximately 2000 residents if Nishi were to pass?

Response #3

2. What is your estimate of the total number of new CPOD (or other chronic heart) cases attributable to poor air quality per year at Nishi if the project is approved?

Response #4

3. What is your estimate of the total number of new asthma cases or additional asthma attacks per year attributable to poor air quality at Nishi should the project be approved?

In each case, I am asking for your professional estimates of the absolute risk because this is the best way for us to assess the burden of disease caused by exposure. Saying it is 2x or 3x or 5x of populations not exposed is not helpful because we need to think of actual numbers of people concerned.

Response #5

Could you also, using the studies you have provided, talk about how those cases might be reduced by mitigation measures such as filtering air? I ask this because none of the studies you have provided to date have discussed how appropriate mitigation might reduce impacts of poor air quality on these specific diseases.

Response #6

As most if not all of the studies have been environmental versus case control studies, I am wondering if you would care to comment on the strength of causal inferences that can be drawn from them.

Response #7

I would also appreciate knowing how you compare the health impacts of air quality for someone who works at future companies that might locate to Nishi (for example if the World Food Center were to locate there) compared to students who might live there during their time at UC Davis. I have an interest in seeing commercial activity on the site and wonder if that is ruled out, as well, by air quality concerns.

Thanks for your help in digging into these issues. As policy makers we need to consider the burden of disease as we consider our decisions.

Response #8

Robb

ITEM 011
This article downloaded by: [University of California Davis]

On: 13 July 2011, At: 15:41

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Aerosol Science and Technology

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/uast20>

Inorganic and Organic Aerosols Downwind of California's Roseville Railyard

Thomas A. Cahill^{a b}, Thomas M. Cahill^c, David E. Barnes^a, Nicholas J. Spada^a & Roger Miller^a

^a DELTA Group, University of California, Davis, California, USA

^b The Health Effects Task Force, Breathe California of Sacramento-Emigrant Trails, Sacramento, California, USA

^c Division of Mathematical and Natural Sciences, Arizona State University West Campus, Phoenix, Arizona, USA

Available online: 04 Jul 2011

To cite this article: Thomas A. Cahill, Thomas M. Cahill, David E. Barnes, Nicholas J. Spada & Roger Miller (2011): Inorganic and Organic Aerosols Downwind of California's Roseville Railyard, Aerosol Science and Technology, 45:9, 1049-1059

To link to this article: <http://dx.doi.org/10.1080/02786826.2011.580796>

PLEASE SCROLL DOWN FOR ARTICLE

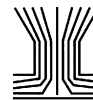
Full terms and conditions of use: <http://www.tandfonline.com/page/terms-and-conditions>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan, sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

ITEM 11.1.

Aerosol Science and Technology, 45:1049–1059, 2011
 Copyright © American Association for Aerosol Research
 ISSN: 0278-6826 print / 1521-7388 online
 DOI: 10.1080/02786826.2011.580796



Inorganic and Organic Aerosols Downwind of California's Roseville Railway

Thomas A. Cahill,^{1,2} Thomas M. Cahill,³ David E. Barnes,¹ Nicholas J. Spada,¹ and Roger Miller¹

¹DELTA Group, University of California, Davis, California, USA

²The Health Effects Task Force, Breathe California of Sacramento-Emigrant Trails, Sacramento, California, USA

³Division of Mathematical and Natural Sciences, Arizona State University West Campus, Phoenix, Arizona, USA

Inorganic and organic constituents of aerosols from a major railway and repair facility were characterized to develop a profile of emissions from railway activities. The railway has very consistent downslope winds blowing laterally across the railway for about 8 hours each night, so two sampling stations were used, one just upwind of the railway and one downwind adjacent to the railway fence line. Aerosol samples were collected by rotating drum impactors (DRUM and Lundgren) in up to 9 size modes for 5 weeks in summer and fall of 2005 in tandem with the Roseville

Railway Aerosol Monitoring Project (RRAMP), which measured, black carbon (BC) PM_{2.5}, as well as NO and NO₂. The DRUM aerosol samples were analyzed for mass, optical absorption, and elemental content in 3 h time resolution to allow separation of day and night. Organic analysis was conducted on another set of time integrated size-segregated samples taken by a Lundgren impactor during nighttime hours. The ratio between the downwind versus upwind sites at night was as high as 21.9 (NO, RRAMP) and 6.4 (optical absorption, DRUM) but many species had ratios greater than 2, demonstrating which aerosols arose from railway activities. The main emissions from the railway consisted of very fine ($0.26 > D_p > 0.09 \mu\text{m}$) and ultrafine ($< 0.1 \mu\text{m}$) aerosols associated with diesel exhaust such as mass, organic matter, transition metals, and sulfur, the latter 3.3% of the mass since locomotive diesel fuel still contained sulfur. There were also coarse soil aerosols contaminated with anthropogenic metals and petroleum-derived *n*-alkanes. The aerosol PAH (polycyclic aromatic hydrocarbons) profile showed higher proportions of the heavier PAHs, such as benzo[a]pyrene, compared to diesel truck exhaust on a per unit mass. These aerosols were mostly in the ultrafine ($< 0.1 \mu\text{m}$) size mode, enhancing lung capture. These results and those of Roseville Railway Aerosol Monitoring Project (RRAMP) largely confirm earlier California Air Resources Board's (ARB) model estimates of health impacts downwind of the railway based on diesel exhaust, while adding data on very fine transition metals and contaminated soils, potentially important to human health.

Received 13 June 2010; accepted 10 March 2011.

The authors wish to acknowledge the continual support, encouragement, and expert scientific guidance of the Health Effects Task Force (HETF) of Breathe California of Sacramento-Emigrant Trails, its Chair, Jan Sharpless, and its Consultant, Betty Turner. HETF is a long term (1994) standing committee of volunteer experts from state and local agencies, universities and medical organizations. It provides high level technical expertise to Breathe California of Sacramento Emigrant Trails, a local NGO that has focused on protecting lungs from disease, smoking, and air pollution since 1917. (<http://www.sacbreathe.org>).

The Detection and Evaluation of Long-range Transport of Aerosols (DELTA) Group is a primarily global climate research association headquartered at UC Davis (<http://delta.ucdavis.edu>) that lends its samplers, analytical capabilities, and expertise to problems of human health. The staff of the Placer County APCD, especially Yushuo Chang, Kurt Schreiber, and Mike Sims, who were exemplary in their support of our field analyses and their provision of meteorology and data from RRAMP. We would like to gratefully acknowledge EPA Region IX for funding the organic analysis (Meredith Kurpius, project manager).

The authors also gratefully acknowledge the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT transport and dispersion model and/or READY website (<http://www.arl.noaa.gov/ready.html>) used in this publication.

This report has benefited greatly from the comments and suggestions of the RRAMP Technical Advisory Committee, but the opinions expressed herein are solely those of the authors.

Address correspondence to Thomas A. Cahill, DELTA Group, University of California-Davis, One Shields Ave., Davis, CA 95616, USA. E-mail: tacahill@ucdavis.edu

[Supplementary materials are available for this article. Go to the publisher's online edition of *Aerosol Science and Technology* to view the free supplementary files.]

INTRODUCTION

The aerosol emissions from railways are largely understudied despite a high density of large diesel engines and associated industrial activities often in close proximity to dwellings. Locally, railroads dominate the pollutant inventory for NO_x (24.2%) and SO₂ (63.3%) for Placer County, including emissions from the Union Pacific Rail Road's (UPRR) J. R. Davis Railway in Roseville (Figure 1), CA (ARB 2010, Supporting

ITEM 11.1.

1050

T. A. CAHILL ET AL.



FIG. 1. The Davis UPRR Roseville Railyard. The locations of the Pool site and Denio site are shown.

Materials 1). The 0.5 km wide by 6 km long railyard just north of Sacramento is the largest maintenance and service yard in the western United States, with over 31,000 locomotives visiting each year for repair and maintenance, with an additional 16,000 trains transiting through the yard each year (2005).

The California Air Resources Board (ARB) initiated a risk assessment study in 2000 of diesel emissions from this site. The results of this assessment study (Hand et al. 2004) concluded excess cancer risk levels of 500 per million in the neighborhood immediately downwind of the railyard, and the 100 per million extended well into Roseville. Through a joint agreement between UPRR and the California ARB, Placer and Sacramento Counties APCDs, and the US EPA, Region IX, a multi-year plan is in place for reduction of pollutants and measuring the improvement through the Roseville Railyard Aerosol Monitoring Project (RRAMP) (Campbell and Fujita 2009).

The Roseville Railyard is a good site to collect emission profiles from diesel locomotive engines for a variety of reasons. The first reason is that the summertime meteorology at the site is both stable and predictable, hence samplers can be sited both upwind and downwind of the railyard to collect paired aerosol data. The second advantage of sampling at the Roseville Railyard is that it is a service depot that conducts engine repairs and maintenance. This site does not have truck traffic that is ubiquitous at other rail depots that are primarily associated with transport of goods. Lastly, the emission profiles collected will represent a fleet of locomotives rather than a single locomotive that would be typical of an emission sample directly from the stack. The main limitation of sampling at this site is that repair activities (e.g. welding, grinding, etc.) could generate aerosols that are not emissions from locomotives.

ITEM 11.1.

The objective of this study was to characterize the aerosol emission from the Roseville Railyard. Size-resolved aerosol samples for elemental analysis were collected upwind and downwind of the railyard. Size-resolved aerosols were also collected downwind of the railyard for organic analysis. The inorganic and organic aerosol data were combined with the gas data (e.g., NO, NO₂, etc.) collected by local agencies to compile a profile of emissions from the railyard.

METHODS AND MEASUREMENTS

RRAMP and Placer County APCD Data

Since the local wind patterns move predictably across the railyard during summertime nights, the RRAMP measurements were conducted during the summers from 2005 to 2008 (Campbell and Fujita 2009; Christofk 2009) in order to track promised reductions in railyard aerosols. RRAMP measured NO, NO₂, and black carbon (BC) hourly on a southeast to northwest transect across the railyard parallel to the regular nighttime downslope winds. The (Figure 1) PM_{2.5} mass was measured at the same sites but over 24 h. Because of the time averaging, it mixed railyard and nonrailyard aerosols. The downwind Denio site was placed close to the location of the maximum excess cancer risk prediction of the 2004 ARB report (Hand et al. 2004). The measurement selected by RRAMP to identify railyard impacts and track reductions in railyard emissions was Elemental Carbon (EC) mass, derived from the BC measurement by Aethalometer, as a surrogate for diesel particulate matter (DPM).

The HETF/UC Davis DELTA Group Data

The HETF/DELTA Group (for information on these organizations see the Acknowledgements) measurements were designed to gain additional information on railyard emissions, including aerosols as a function of size, time, and composition, and time integrated speciated organic aerosols. Samples were collected by a pair of DELTA Group 8 stage rotating drum (DRUM) impactors in 8 size modes, 10–0.09 μm , (Cahill et al. 1985; Raabe et al. 1988), located at the Denio and Pool sites. Aerosols were impacted onto lightly greased Mylar strips, (Wesolowski et al. 1978; Cahill 1979). The 2 DRUM samplers were collocated for 4 days at the Denio site to establish equivalency, but only the very fine ($0.26 > D_p > 0.09 \mu\text{m}$) stage of the Pool sampler met the $\pm 15\%$ equivalency criteria, due to an internal leak later discovered in one DRUM stage. Organics were collected during the July–August period with an identical DELTA 8 DRUM for 8 size modes using fired aluminum strips as the deposition foils, with a Teflon ultrafine after-filter. For the two fall periods, a high flow Lundgren 4 stage impactor plus after-filter (Lundgren 1967) was used, keyed to the night winds from 10 PM to 6 AM. Organic data were averaged over the entire time periods. The sampling enhancements are shown below in Table 1, with the average value of RRAMP parameters at the same site and time.

The DRUM samples were analyzed for mass by soft beta ray transmission, shown to be equivalent to Federal Reference Method (FRM) mass during a 1 year side by side study with the ARB at downtown Sacramento, 2007, (Supplemental Information 2) while elements were analyzed by synchrotron-induced x-ray fluorescence (S-XRF) on the University of California Davis microprobe beam line 10.3.1 at the Advanced Light Source, Lawrence Berkeley NL. The DRUM samples were also analyzed every 3 h for optical absorption by optical spectroscopy. (Cahill and Wakabayashi 1993; Bench et al. 2002; Miller 2002). All aspects of sampling and analysis are validated in DRUM Quality Assurance Protocols ver 1/09 (summarized in the Supplemental Information-2 and intact on the DELTA web site, <http://delta.ucdavis.edu>).

Organic samples were analyzed for selected organics, namely alkanes, PAHs, acids, and sugars, roughly 80 species in all, for each size range using GC-MS. More details on the organic methodology are presented in (Cahill 2010) and Supplemental Information-4.

RESULTS

Meteorology and Trajectory Analysis

The Sacramento meteorological parameters of the study period, 8–12 July (colocated DRUMs at Denio) and from 12 July–17 August, Pool-Denio upwind downwind DRUMs, met the RRAMP design parameters very well. The mean nighttime (10 PM–6 AM) wind direction was 160°P, mean daytime wind direction 270°, WSW, SW, or SSW, with 7 exceptions (10, 16, 24, 26 July; 7, 13, 14 August) when the wind was from the south. The wind velocities were steady, and daytime maximum temperatures ranged from 26°C to 40°C (Campbell and Fujita 2009). A summary of the meteorological data is in the Supplemental Information 3. There were periods of stronger wind velocities and oceanic influences seen in the form of sea salt (July 22, July 25 and 26, August 4 and 13) which can overcome the nighttime cross-railyard profile (Supplemental Information 3).

RRAMP Results

The RRAMP results for summer, 2005, confirmed the soundness of the project design in that it clearly separated railyard diesel emissions from upwind sources such as nearby Interstate 80. (Campbell and Fujita 2009) (Figures 2a and b). Since the Pool site is downwind of the railyard for roughly 16 h each day, the extreme ratio of NO, for example, Denio/Pool, requires some discussion. The low Pool daytime concentrations are caused both by the better ventilation of the stronger daytime winds and the fact that the typical daytime winds from the southwest cross a less active portion of the railyard.

During RRAMP, EC was measured using Aethalometer (BC) data and supplemented by EC from 24 h filters by Sunset Labs. The Aethalometer produces real-time data with high time resolution, but the measurements drift over time as observed by comparing units placed in close proximity to each other

ITEM 11.1.

1052

T. A. CAHILL ET AL.

TABLE 1
Sampling schedule and mean RRAMP monitoring data for the four time periods utilized

Denio site/ Sampling periods	Sampler/Substrate	Analysis	NO (ppb)	NOR _x (ppb)	Black carbon (BC) ($\mu\text{g}/\text{m}^3$)	PMR _{2.5} mass ($\mu\text{g}/\text{m}^3$)
7/8–8/17, 3 h	8 DRUM, 16 L/min, Mylar	Mass, elements	81.0	120.2	1.2	14.4
8/5–9/27 average	8 DRUM, 16 L/min, aluminum	Organics	62.8	94.2	1.4	12.9
9/27–10/7 nights	Lundgren, 150 L/min, aluminum	Organics	87.6	120.8	1.8	11.1
10/7–10/17 nights	Lundgren, 150 L/min aluminum	Organics	69.2	101.3	1.8	14.2
Pool Site						

(Campbell and Fujita 2009). Both the Aethalometer and filter based techniques have the further limitation that there is no separation of the particles by size making it difficult to identify the processes emitting the carbon.

Calculating the downwind-upwind ratios for the July–August RRAMP study period, it is clear that nitric oxide (NO) has the best discrimination between railyard and nonrailyard sources in summer, ($\times 22.1$) (Table 1) with NO₂ close behind ($\times 7.2$). The BC ($\times 2.3$) is significantly worse, while 24 h average PM_{2.5} ($\times 1.5$) is not very specific to the railyard, since the 24 h samples integrate both upwind and downwind times.

HETF/UC Davis DELTA Group Results

Identification of additional railyard emissions above and beyond RRAMP's limited measurements can be obtained by two methods: (1) direct upwind-downwind comparisons, and (2) utilization of the extreme day-night variations at the Denio site, allowed by the ability of the DRUM sampler to gather data on aerosols versus size, time, and composition.

The aerosols collected in the Denio 8 DRUM for July and August are shown below in Figure 3.

The dramatic day-night differences seen on the DRUM strips echo the results of RRAMP for NO and NO₂, but are more regular than the RRAMP BC data (Figure 2b). Note that for the BC, the deposit in the 0.34–0.26 μm size mode is slightly darker than the 0.26–0.09 μm mode, but the pattern is seen for all size modes up to 5.0 μm , above which the width of the DRUM slot averages over day and night. This pattern is largely absent from the Pool site. Thus, with the support of the meteorological analysis, the RRAMP data gas and particulate data, and the qualitative but compelling patterns DRUM samples of Figure 3, we can evaluate emission from the railyard via the upwind-downwind differences and ratios using nighttime hours, circa 10 PM–6 AM.

Railyard Emissions Via Upwind-Downwind Ratios at Night

In order to quantify the average impact of the railyard, the upwind-downwind ratios at night allow a clean separation of the influence of upwind sources. The failure of the coarser DRUM stages at the Pool site to meet quality assurance (QA) criteria

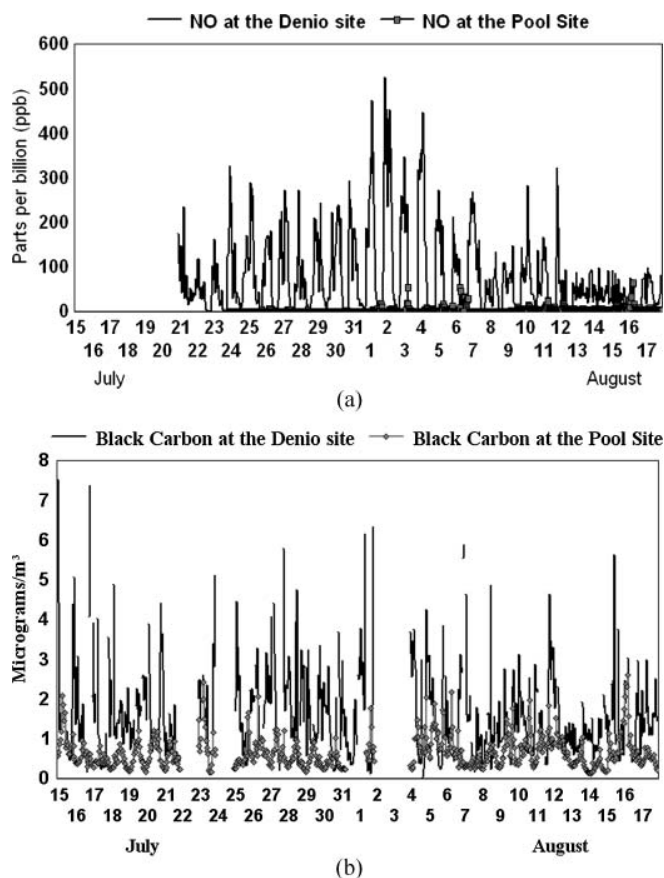


FIG. 2. a and b. RRAMP results for two pollutants, NO_x (top) and BC (via Aethalometer, bottom).

ITEM 11.1.

DELTA Group 8 DRUM, Denio site

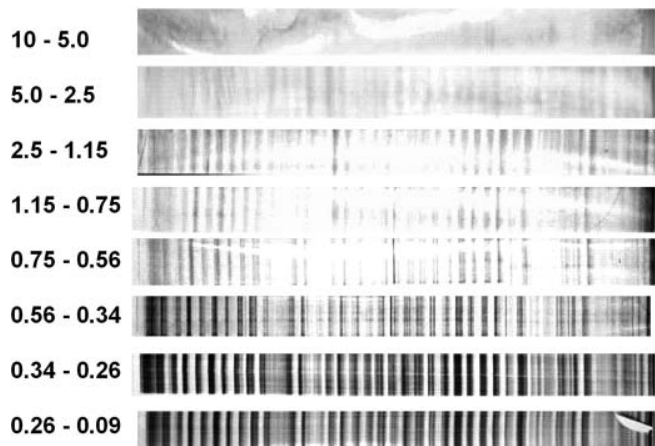


FIG. 3. Photograph of DRUM strips, Stages 1 (top) to Stage 8 (bottom) from the Denio site, 8 July–17 August 2005. There is fiducial marker at the end and slight tear in the end of Stage 8. The black lines are soot each evening.

in a side by side pretest only allowed comparisons of the very fine ($0.26 > D_p > 0.09 \mu\text{m}$) size mode. However, most diesel exhaust occurs in size ranges below $0.26 \mu\text{m}$ (Abu-Allaban et al. 2002; Gertler et al. 2003; Abu-Allaban et al. 2004) with about half in this size mode (Zielinska et al. 2004; Riddle et al. 2007).

In order to analyze the very fine mode DRUM samples in 3 h increments, the 3 major analytical techniques used in our study; mass (by soft beta ray transmission), optical analysis versus wavelength (by optical spectroscopy), and elemental concentrations (by synchrotron-induced x-ray fluorescence, S-XRF). These are described in Supplemental Information 2.

Analysis of Mass

Mass values were processed with a time resolution of $1\frac{1}{2}$ h. Mass can be measured by transmission of beta rays through foils and filters (Chueinta and Hopke 2001). We have developed a soft beta ray (Ni^{63}) source matched in energy to the thin Mylar ($480 \mu\text{g}/\text{cm}^2$) deposition foils and stretched Teflon filters and capable of analysis in 0.5 mm steps. Precision of the beta gauge for very fine particles at the Denio site are included in the Supporting Materials, as are the results of a recent intercomparison, DRUM to FRM, with the California Air Resources Board in Sacramento, 2007. In Figure 4, we show mass measurements at the Pool site (upwind at night) and the Denio site (downwind at night) for the very fine ($0.26 > D_p > 0.09 \mu\text{m}$) aerosols for the July–August campaign.

Except for the periods of strong marine influence starting on 22 July, a strong upwind–downwind difference is seen each night. The extreme day–night pattern seen in the RRAMP data, especially the NO results, is mirrored in the mass data that showed the same sort of pattern. The average downwind minus upwind value at night was about $1.5 \mu\text{g}/\text{m}^3$, but recall that these data omit both the important ultrafine component and all mass

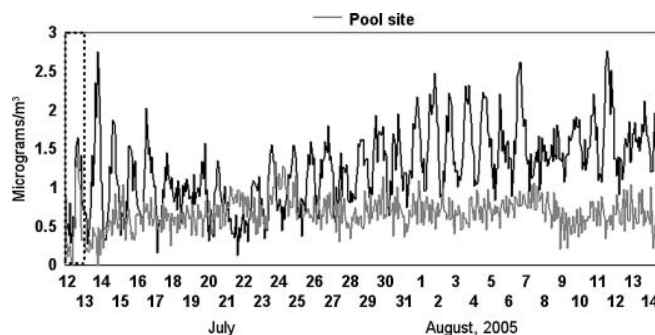


FIG. 4. Mass Comparison, Pool versus Denio, for very fine ($0.26 > D_p > 0.09 \mu\text{m}$) mass. Colocated mass comparisons occur for 12 July (in boxed area).

above $0.26 \mu\text{m}$. The RRAMP mean $\text{PM}_{2.5}$ 24 h mass difference for this period was $4.6 \mu\text{g}/\text{m}^3$.

Optical Analysis

The Mylar strips from the DRUM samplers offer a new approach for quantifying the light absorption pattern seen in Figure 3. Greased Mylar is between 65% and 80% transmission for light from 350 nm to $>800 \text{ nm}$ (Miller 2002). Below 310 nm Mylar is effectively 100% absorptive. Mylar can therefore be used effectively as a substrate from transmission spectroscopy in the ultraviolet A through the near infrared regions of the electromagnetic spectrum. Later, we show the optical attenuation for the summer intensive.

It can be seen that there is good agreement between the measured absorption coefficient at the Denio and Pool strips when the DRUMs were colocated (Figure 5). The impacts of the marine incursions from 22 July to 27 July and 12 August are also clearly in evidence.

Elemental Analysis

Aerosols of special interest are the very fine phosphorus, zinc and sulfur, all tracers of truck diesel emissions (Zielinska

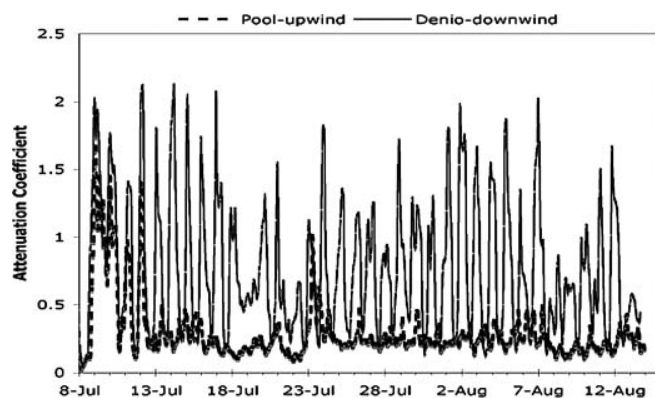


FIG. 5. Attenuation coefficient at 530 nm in the $0.26 > D_p > 0.09 \mu\text{m}$ size at the Pool and Denio sites. The period of the colocated samples is shown in the dashed rectangle. Marine influence is seen degrading the pattern on 22, 25 and 26 July; and 13 August.

ITEM 11.1.

1054

T. A. CAHILL ET AL.

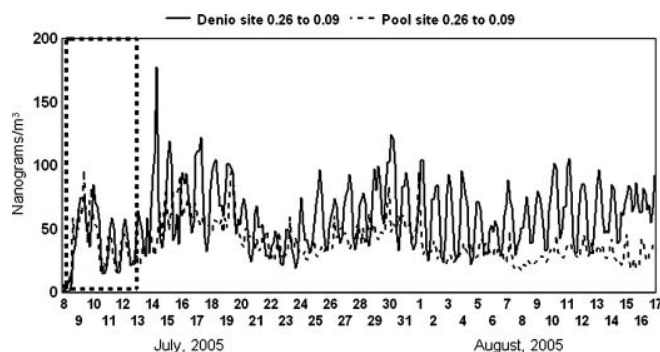


FIG. 6. Sulfur in the very fine ($0.26 < D_p < 0.09 \mu\text{m}$), mode at the Pool site and the Denio site. 9–12 July the samplers were colocated at the Denio site (in the dashed area).

et al. 2004; Brandenberger et al. 2005). Elemental analyses were performed on all DRUM strips with 3 h resolution. The results for sulfur from the Pool site and the Denio site are shown in Figure 6, but other elements also showed this pattern. Note that the first 4 days, the 2 DRUMs were located side by side at the Denio site to validate equivalency.

These results and those from the rest of the S-XRF analyses for the very fine ($0.26 > D_p > 0.09 \mu\text{m}$) size mode are summarized in Table 2, along with RRAMP results for the same period, 12 July–15 August 2005.

Table 2 shows that the very fine optical absorption, dominated by BC, was highly enhanced downwind of the railyard, by a ratio of 6.3, while a number of species known to occur in diesel

engines were typically enhanced by about a factor of 2. However, we note that the zinc to phosphorus ratio is an order of magnitude lower than that seen in diesel trucks (Zielinska et al. 2003).

Time Dependent Analyses of Aerosols

Information can also be gained by examining in detail the time dependency of the aerosol data as a function of size and composition. The 3 contributions to the attenuation coefficient are reflection, scattering, and absorption. For the particles in the smallest 3 size modes, this is the most likely dominated by absorption. This is supported by up to a twenty fold increase in the specific absorption (absorption per unit mass) from the larger size modes to the smaller size modes. This is also consistent with the visual observation of very black deposits on the lower stages, even though there is little mass, and the expectation that the combusted carbon will appear in the smaller particles near its source. This allows time dependent analysis of soot versus RRAMP NO data.

The striking day–night pattern seen in NO and other parameters is also evident in these data. The comparison of NO to 530 nm (Figure 7) absorption echo the results shown by RRAMP in Figure 2a, and show that the NO and BC sources are not always correlated. One possible reason for this may be impact of idling diesel engines versus those under full power, but we do not have enough information to identify the causes.

The sulfur of Figure 6, represents about 3.3% of the mass in this size mode. Typically anthropogenic metals in the very fine mode such as zinc and copper showed occasional spikes of short duration and modest concentrations (a few ng/m^3) at the Denio site absent from the Pool site. One persistent difference was seen in calcium, which in this size mode is not derived from soil (Figure 8). It is, however, commonly used as an antacid in lubricating oil for sulfur-containing fuels and observed in this size mode in diesel tests (Zielinska et al. 2003; Zielinska et al. 2004).

While the very fine aerosols are normally about $\frac{1}{2}$ the total mass of DPM (Zielinska et al. 2003), the diesel aerosols

TABLE 2

Summary of nighttime enhancements of very fine aerosols, Pool (upwind) versus Denio (downwind)

	Pool site (up- wind)	Denio site (down- wind)	Difference, Ratio, Denio – Pool	De- nio/Pool
Nighttime summer 2005				
RRAMP data				
NO ppb	3.7	81	77.3	21.9
NO _x ppb	17	120	103	7.1
BC $\mu\text{g}/\text{m}^3$	0.5	1.2	0.7	2.4
PM _{2.5} $\mu\text{g}/\text{m}^3$	9.7	14.4	4.7	1.5
UC Davis very fine data				
$0.26 > D_p > 0.09 \mu\text{m}$				
Mass $\mu\text{g}/\text{m}^3$	0.69	1.52	0.83	2.2
Optical (rel ~ soot)	0.2	1.25	1.05	6.3
Sulfur ng/m^3	43	83	40.3	1.9
Phosphorus ng/m^3	2.5	3.9	1.5	1.6
Zinc ng/m^3	0.32	0.53	0.21	1.7
Calcium ng/m^3	0.7	1.8	1.2	2.7
Iron ng/m^3	0.6	1.2	0.65	2.1
Lead ng/m^3	3.2	6.5	3.3	2.0

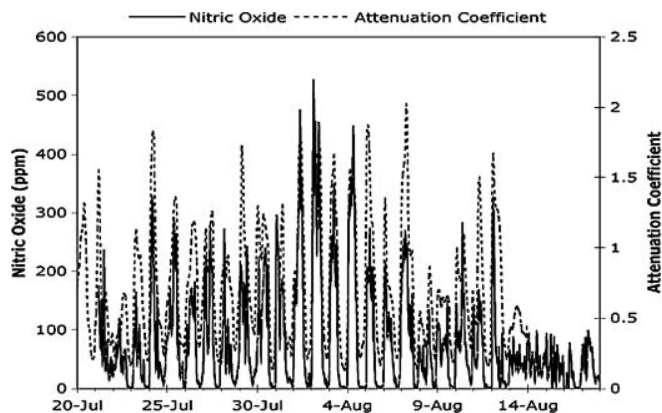


FIG. 7. Nitric oxide and attenuation coefficient at 530 nm in the $0.26 > D_p > 0.09 \mu\text{m}$ size mode measured at the Denio site.

ITEM 11.1.

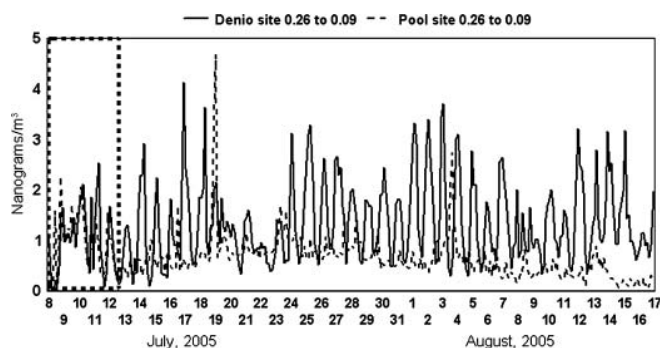


FIG. 8. Denio versus Pool comparison for very fine ($0.26 > D_p > 0.09 \mu\text{m}$) calcium. Note the good agreement for the colocated samplers, 8–12 July, and the interference with the pattern during the period of marine incursions, 22–24 July.

downwind of the Roseville Railyard are coarser, extending well into the accumulation mode, as seen in Figure 3 and in the nighttime railyard sulfur size distribution extended in size up to $2.5 \mu\text{m}$ (Figure 9).

Significant correlated sulfur mass extended in size up to $2.5 \mu\text{m}$. This pattern supports ARB 2004's estimate of the importance of the idling diesel engines in railyard emissions.

The data on sulfur can also be compared to crustal elementals seen at the Denio site (Figure 10).

Looking in detail at the mass to elemental profiles in time, it is clear from the data (Figure 11, below) that the coarser soils dominated Roseville's air during the day when wind speeds were high whereas the fine, very fine, and ultrafine particles dominated at night.

Size Distributions of Elements

The nighttime size distributions at the Denio site (Figure 12) show both the presence of soils that are resuspended on the slow nighttime winds, with considerable admixtures of elements that far exceed the expected earth crustal ratios (Weast 1989) and thus must be considered anthropogenic. Note that the silicon/iron ratio approaches 1:1 for submicron particles, when Enrichment Factor (EF) from earth crustal ratios would be about 5:1. This clearly indicates excess iron in the soil with a likely

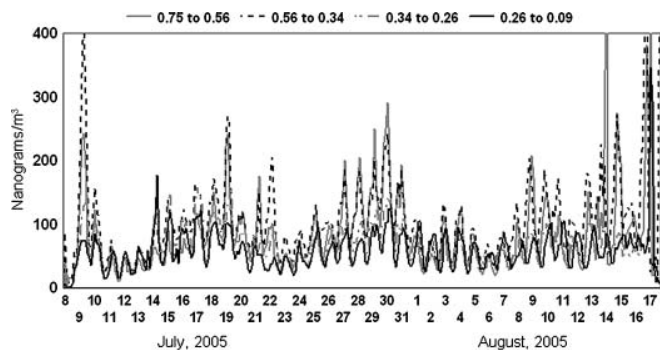


FIG. 9. Size distribution of sulfur at the Denio site.

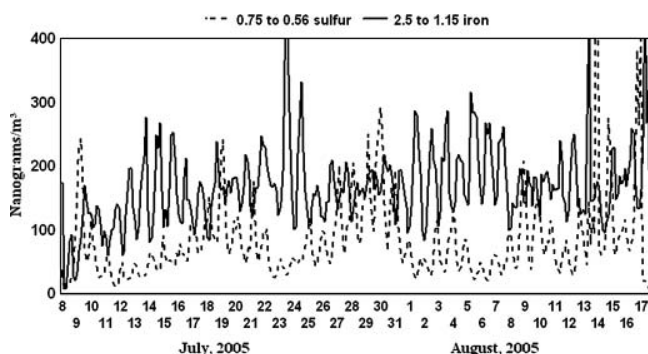


FIG. 10. Sulfur and fine soil at Denio, anti-correlated.

anthropogenic source. Many transition metals had high EFs such as 33:1 (zinc) and 43:1 (copper). The presence of fine potassium is unexplained since the normal submicron source, residential wood burning, is unlikely in temperatures that reached 40°C during the study. The most probable cause is burning of agricultural waste and/or small forest fires in the Sierra Nevada.

Based on the size distribution of the potentially toxic very fine copper, we can anticipate even high levels in the unmeasured ultrafine ($<0.09 \mu\text{m}$) mode. Veryfine and ultrafine copper aerosols are emitted from brake pads in trucks and cars.

Analysis of Organic Components

The analysis of organic components as a function of particulate size required different sample collect techniques than for mass, optics, and elements. Samples were integrated over time, but used nighttime hours identified by the RRAMP and DRUM data. The particulate samples collected were analyzed for four classes of chemicals, namely PAHs (16), alkanes (18), organic acids (22), and sugars (11). Details of the analytical methods and the full data set are in the Supporting Materials 4, and in references (Cahill 2010). A major component of the quality assurance is the recovery of isotopically-labeled internal standards applied directly on the aerosol samples prior to sample extraction. The recoveries of the isotopically-labeled internal standard were calculated relative to an injection standard (pyrene- d_{10})

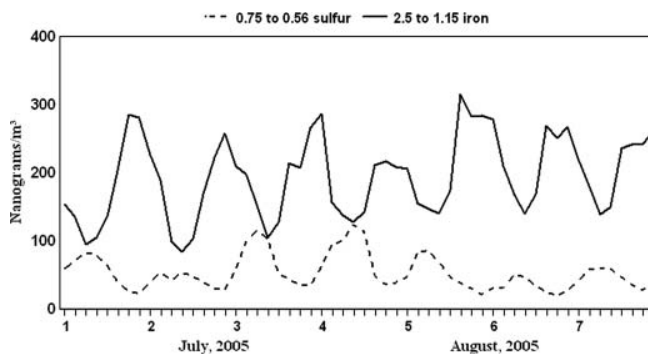


FIG. 11. Detailed time profile of mass, 1–7 August at the Denio site, the coarse mass peaks in daytime, and the accumulation mode mass peaks at night.

ITEM 11.1.

1056

T. A. CAHILL ET AL.

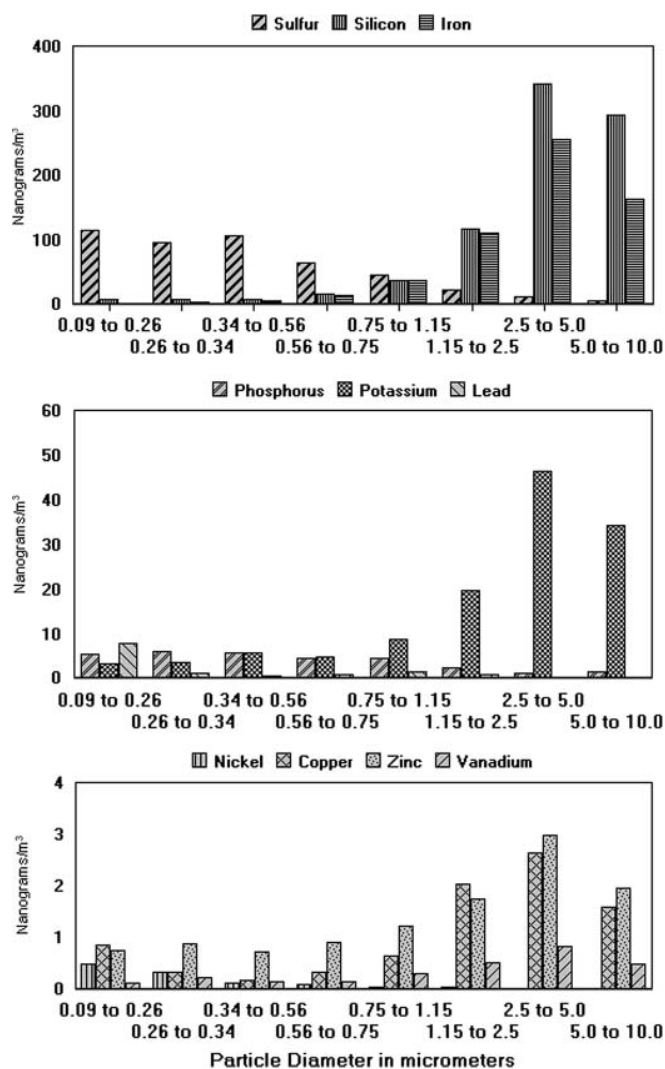


FIG. 12. Typical nighttime size distribution (18 July) at the Denio site.

added to the sample extract just prior to instrumental analysis. These recoveries averaged 77% and are shown in detail in the supplemental information (Supplemental Information 4).

Based on the recovery data of the labeled surrogates from all the sample matrices (aluminum foil and quartz filters), it appears that the analytical method was effective for the heavier PAHs, *n*-alkanes, and some of the organic acids. Since the data are keyed to the isotopically labeled standards, there is no need to scale the results using the above recovery data. The good recovery numbers merely confirm the analytical procedures are efficient. The minimum detection limit (MDL) for this study was defined as the mean field blank signal plus 3 standard deviations (SD) of the field blanks (mean + 3 SD). Therefore, the data reported herein is well above the background contamination of the field blanks.

The relative fraction of the different identified organic constituents shows that the identified alkanes represent the greatest

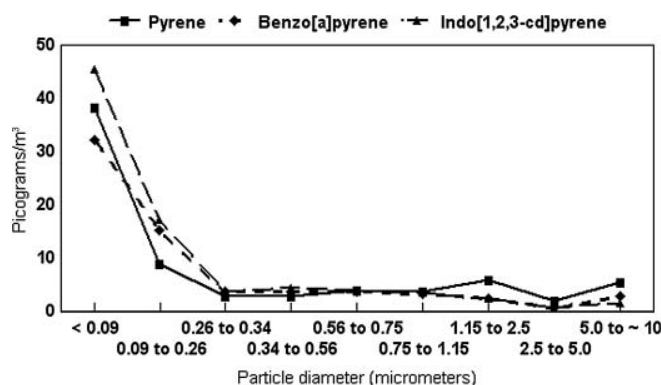
proportion of the identified mass, and using the consumer price index (CPI), most of these are petroleum derived. Sugars represented 18–25% of the identified mass and organic acids were 21–31% of the mass. The PAHs, which are considered one of the more toxic components of the aerosols, were 1.1–2.0% of the identified organic matter. These chemical profiles, supported by size distribution data, show that a considerable fraction of the organic matter probably originated from sites other than the Roseville Railyard. In particular, the sugars and the long-chain alkanic acids are likely biological and/or cooking in origin.

Examining the PAHs in more detail due to their importance as a toxic aerosols, the sampling was done using 2 distinct instruments, both slotted impactors were: (1) the DELTA 8 DRUM at 16 L/min, and (2) The classic Lundgren 4 DRUM at 150 L/min. Both had after-filters. The 8 DRUM integrated over 7 weeks, 5 August–27 September, 24 h/day, and the two Lundgren runs were 10 days each, 27 September–7 October, 7 October–17 October, and nighttime only. The results are shown in Table 3.

The Lundgren PAH concentrations were approximately 4 times higher than the 8-stage DRUM. We propose that this appears to be the result of the 8-stage DRUM samples being “diluted” by the daytime sampling that lacked any railyard influence (Figure 2a, x 2). Note that the median benzo[*a*]pyrene results seen by the ARB at the nearby Roseville sampling site next to I-80 was only 25 pg/m³ for the years 2002–2004, the latest data available (ARB 2010).

One advantage of the 8 DRUM over the Lundgren was additional size information. Figure 13 shows two 3 PAHs, one light, and two heavy versus particles size for summer, 2005. The presence of PAHs in the ultrafine size mode shows a finer aerosol size that may have health consequences (Kilburn et al. 2000; Parent et al. 2007) as indicated by data on PAHs from diesel trucks (Zielinska et al. 2004).

The PAH results from the Lundgren sampler also support these observations. This sampler was only operated during the nighttime hours when the local meteorology brings a weak down-slope breeze across the railyard towards the sampling site.

FIG. 13. Pyrene, benzo[*a*]pyrene, and Indo[1,2,3-*cd*]pyrene concentrations (pg/m³) in the different size fractions of the 8-stage DRUM sampler and the after-filter.

ITEM 11.1.

INORGANIC AND ORGANIC AEROSOLS

1057

TABLE 3

Concentrations (pg/m³) of particulate PAHs observed at the Roseville Railyard. The scaled 8 DRUM data, $\times 2.6$, represents the assumption that there was negligible PAH contamination during daylight hours, based on ambient PAH sampling at a background site, June 2005 (Cahill et al. 2007)

Compound	8-stage DRUM (8/5–9/27)	8-stage DRUM (scaled $\times 2.6$) (8/5–9/27)	Early Lundgren (9/27–10/7)	Late Lundgren (10/7–10/17)
Phenanthrene	21	55	110	100
Anthracene	<MQL	<MQL	20	20
1-methylphenanthrene	<MQL	<MQL	32	28
Fluoranthene	57	147	160	160
Pyrene	74	190	310	300
Benz[<i>a</i>]anthracene	^a	^a	^a	^a
Chrysene+ triphenylene	24	62	130	130
Benzo [<i>b+k</i>]fluoranthene	68	175	350	330
Benzo[<i>e</i>]pyrene	90	231	360	350
Benzo[<i>a</i>]pyrene	68	175	270	280
Perylene	<MQL	<MQL	35	36
Indo[1,2,3- <i>cd</i>]pyrene	84	216	240	230
Dibenz[<i>a,h</i>]anthracene	100	257	270	270
Benzo[<i>g,h,i</i>]perylene	230	591	650	650
Coronene	175	450	380	370

^aUnable to quantify compound due to analytical problem, namely excessive enrichment of chrysene-*d*₁₂ that saturated the ion trap mass spectrometer.

Therefore, the higher concentrations observed by this sampler were expected and support the assertion that they are coming from the site.

The other class of organic chemicals of importance to railyard emissions was the alkanes and related hydrocarbons. Unlike the PAHs, there were appreciable alkanes in the field blanks but the concentrations were generally low enough not to interfere with the quantification of the aerosol alkanes. Both the 8-stage DRUM and the Lundgren samples showed that the C₂₉ *n*-alkane was the most abundant chemical observed with concentrations between 9 and 30 ng/m³. Unlike the PAH data, the concentrations of alkanes were different between the early and the late Lundgren samples with the early sample having concentrations that were almost twice as high as the late sample. The 8-stage and early Lundgren samples had no clear pattern of odd–even carbon number species, suggesting a petroleum source of the hydrocarbons.

DISCUSSION

The RRAMP data (Campbell and Jujita 2009) provide measurements of DPM, roughly 7 $\mu\text{g}/\text{m}^3$ DPM from the Denio-Pool comparison roughly confirms the ARB's 2004 estimate of the impact of the railyard on Roseville, using the conversion 300 excess cancer deaths per 1 $\mu\text{g}/\text{m}^3$ diesel particulate mass. However, one must take into account the different distances involved and an estimated annual average correction in comparing RRAMP

the ARB estimate. The additional data generated by the current studies has added additional information on the nature of the emissions from railyards (Sawant et al. 2007; Sheesley et al. 2008; Umezawa et al. 2008).

First, the presence of the very fine metals from the railyard pose an additional health threat. The concern is that many metals, including nickel, lead, and copper are increasing concentrations as the sizes become smaller (Figure 12). We can anticipate that these concentrations could well be even higher in the important ultrafine mode with very high lung capture efficiencies. Recent studies in the Central Valley of California have tied these very fine metallic aerosols to ischemic heart disease (Cahill et al. Forthcoming)

Second, the presence of the contaminated soil from the railyard in the coarse modes can pose a particle deposition problem in local residences.

Finally, the PAHs from the locomotive diesel engines showed a very different trend in terms of the PAH profile compared to diesel engines used in trucks and other on-road applications (Figure 14). The PAH profile from the locomotives had considerably higher concentrations of the heavy PAHs with molecular weights greater than 252 amu compared to the on-road diesel trucks and the NIST standard reference materials. This trend was observed with all 3 samples collected, namely the 8-stage DRUM and both of the Lundgren samples.

The most likely explanation for most of the size distribution is that our work was the first to our knowledge that used

ITEM 11.1.

1058

T. A. CAHILL ET AL.

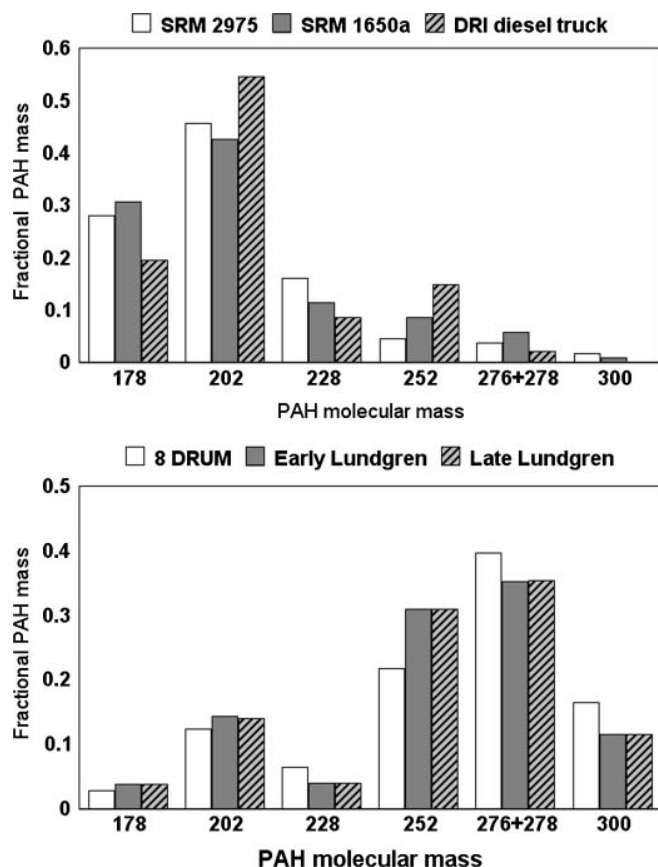


FIG. 14. Profiles of PAHs as a function of Molecular Mass.

artifact minimizing stretched Teflon after-filter for organic speciation. The standard filter is fired quartz, and is roughly twenty times thicker in the areal density in $\mu\text{g}/\text{cm}^2$ than the stretched Teflon filter that was identical to that used by IMPROVE, FRM, and many other networks. Fired quartz has a known and well documented positive artifact effect when volatile materials are present (Finalyson-Pitts and Pitts 2000; Watson et al. 2009). From mass 228 amu and below, an increasing proportion of the PAHs occur in the vapor phase, and thus depending on conditions could be collected as artifact by quartz filters. If this was the collection method for the NIST SRM, it would share the effect. Other effects may be contributory. Since both our data and the ARB 2004 analysis showed that a major fraction of the emissions came from idling diesel engines, this could be a factor in the molecular mass differences. It is also unclear if the locomotive emissions have a higher proportion of heavier PAHs arising from the large-bore engine lubricants or the locomotive fuel, which is different from the diesel fuel used in trucks. Finally, one possible explanation for different PAH profiles is that the lighter PAHs could “blow-off” of the sample during the long sample collection periods. We do not believe this to be a significant effect. First, an analysis of the alkanes shows negligible concentrations of heavy alkanes on the after-filter.

Second, if “blow-off” was significant, then we would expect the samples exposed to the air stream for a longer period of time to have lower proportions of the lighter (178 and 202 amu) PAHs. This was not observed. The 8-stage DRUM sampler collected material for 6 weeks, in high temperature conditions, and its profile is very similar to the Lundgren samples that were only 1.5 weeks in duration and only operated at night. Therefore, the PAH profile does not appear to be affected by “blow-off” during sample collection.

The second important point is the size distribution of the PAHs. The Kelvin Effect demands that ultrafine PAHs have to be non-volatile to survive significant times in the atmosphere, so even if the original PAH emission mix looked like standard diesel emissions, but in the ultrafine mode, the lighter and more volatile PAHs would evaporate more readily. However, it is unclear if this process is rapid enough to cause the observed difference since the samplers were within 100 m of many of the sources. Whatever the reason for the difference, the presence of so much toxic PAHs in the ultrafine mode with highly efficient lung capture increases potential health impacts.

It is also necessary to determine the mass of PAHs in the aerosols, and/or the ratio as a fraction of total aerosol mass, fine mass, and/or EC, to allow estimates of aerosol impacts. The most direct way is to form the ratio of PAHs to the major diesel aerosol component, EC. This is not available from the NIST diesel SRM 1650a and SRM 2975, but these data are available from the Desert Research Institute Report to the National Renewable Energy Laboratory, 2004. (Zielenska et al. 2004). An additional source is from the work of Gertler et al. (2003) in a report to the Health Effects Institute and publications (Gertler et al. 2003). For the Roseville data, EC was measured at the Denio and Pool sites through October 2005. These were calculated using both mass and EC, since the results were compatible when the results were combined.

A raw average of the fifteen values gives a ratio of the RRAMP benzo[a]pyrene to diesel trucks of 7.7 ± 3.5 . However, we conclude that the Denio–Pool difference in EC is not a good match to the Denio-only PAHs. Removing these data, and weighing the averages by errors, we derive 5.5 ± 0.7 , where the latter value is the Standard Error of the mean. This means that there was about 5.5 times more benzo[a]pyrene from the rail yard aerosols than from diesel truck aerosols, per unit very fine/ultrafine mass and per unit EC. Details are in the Supplemental Information 5.

Mitigation of emissions sources and transport out of the rail yard would have health benefits, and four classes of mitigation are proposed (Cahill et al. 2007); source reduction (new engines, better fuels, limitations on idling, . . . the focus of current mitigation), source to right of way fence (paving interior roads and using ground covers to reduce dust, vegetative barriers), right of way fence to receptors (distance, vegetative barriers), and at the receptors (filters for including indoor air mitigation). These could lower the still-elevated diesel cancer risk, reduce very fine inhalable metals, and lower coarse metal laden dusts.

ITEM 11.1.

CONCLUSIONS

The results of this study basically confirm the ARB's estimates of the impacts of the Roseville Railyard on the surrounding community while providing additional information on coarse and fine aerosols from the railyard on the community. The upwind-downwind and day-night study design effectively differentiated ambient aerosols from those emanating from the Roseville Railyard. Elevated NO ratios strongly suggested the diesel emissions from the railyard were the source for toxic aerosols present in the downwind samples. Coarse soils were contaminated with anthropogenic metals and petroleum-based n-alkane organic matter, and very fine ($0.26 > D_p > 0.09 \mu\text{m}$) elements phosphorus, zinc, and sulfur, tracers for diesel emissions, were observed from the railyard. Regretfully, we do not have data on ultrafine metals. Benzo[a]pyrene, which is labeled as one of the most toxic PAHs, was detected at levels 5.5 ± 0.7 times as concentrated as in diesel truck exhaust per unit mass. In addition, the heavy PAHs were almost entirely in the ultrafine mode, enhancing lung capture.

REFERENCES

- Abu-Allaban, M., Coulomb, W., Gertler, A. W., Gillies, J., Pierson, W. R., Rogers, C. F., Sagebiel, J. C., and Tarnay, L. (2002). Exhaust Particle Size Distribution Measurements at the Tuscarora Mountain Tunnel. *Aerosol. Sci. Tech.*, 36:771-789.
- Abu-Allaban, M., Rogers, C. F., and Gertler, A. W. (2004). A Quantitative Description of Vehicle Exhaust Particle Size Distributions in a Highway Tunnel. *J. Air Waste Manage. Assoc.*, 54:360-366.
- ARB. (2010). HTU <http://www.arb.ca.gov> (in the section on Data and Statistics).
- Bench, G., Grant, P. G., Ueda, D., Cliff, S. S., Perry, K. D., and Cahill, T. A. (2002). The Use of Stim and Pesa to Measure Profiles of Aerosol Mass and Hydrogen Content, Respectively, across Mylar Rotating Drums Impactor Samples. *Aerosol. Sci. Tech.*, 36:642-651.
- Brandenberger, S., Mohr, M., Grob, K., and Neukomb, H. P. (2005). Contribution of Unburned Lubricating Oil and Diesel Fuel to Particulate Emission from Passenger Cars. *Atmos. Environ.*, 39:6985-6994.
- Cahill, T. A. (1979). Comments on Surface Coatings for Lundgren-Type Impactors. *Aerosol Meas.*, 131-134.
- Cahill, T. M. (2010). Size-Resolved Organic Speciation of Wintertime Aerosols in California's Central Valley. *Environ. Sci. Technol.*, 44:2315-2321.
- Cahill, T. A., Barnes, D. E., Spada, N. J., Lawton, J. A., and Cahill, T. M. (2011). Very Fine and Ultra-Fine Metals and Ischemic Heart Disease in the California Central Valley 1: 2003-2007. *Aerosol. Sci. Tech.*, 45:1124-1134.
- Cahill, T. A., Cahill, T. M., Barnes, D. E., Spada, N. J., Cliff, S. S., Perry, K. D., and Fujii, E. (2007). Mass, Organic, and Elemental Aerosols by size, time, and composition at the Union Pacific Rail Road's Roseville Railyard. *Final Report to the Health Effects Task Force (HETF), Breathe California of Sacramento-Emigrant Trails*, Sacramento, CA.
- Cahill, T. A., Goodart, C., Nelson, J. W., Eldred, R. A., Nasstrom, J. S., and Feeney, P. J. (1985). Design and Evaluation of the Drum Impactor, in *Proceedings of International Symposium on Particulate and Multi-phase Processes*, T. Ariman and T. N. Veziroglu, eds., Washington, D.C., pp. 319-325.
- Cahill, T. A., and Wakabayashi, P. (1993). Compositional Analysis of Size-Segregated Aerosol Samples, in *Measurement Challenges in Atmospheric Chemistry*, L. Newman, ed., American Chemical Society, Washington, DC, 211-228.
- Campbell, D., and Fujita, E. M. (2009). Roseville Rail Yard Air Monitoring Project (RRAMP). *Final Report Summary of Data QA and Trend Analysis*. Desert Research Institute, Reno, NV.
- Christofk, T. (2009). Final Update Pertaining to the Mitigation Measures and Monitoring Activities for the Union Pacific Roseville Railyard. <http://www.placer.ca.gov/apcd>
- Chueinta, W., and Hopke, P. K. (2001). Beta Gauge for Aerosol Mass Measurement. *Aerosol. Sci. Tech.*, 35:840-843.
- DELTA Group. (2010). <http://delta.ucdavis.edu>
- Finalyson-Pitts, B., and Pitts, J. (2000). *Chemistry of the Upper and Lower Atmosphere*. Academic Press, San Diego, CA (Chapter 10, Figure 10.3).
- Gertler, A., Abu-Allaban, M., Coulombe, W., Gillies, J. A., Pierson, W. R., Rogers, F. C., Sagebiel, J. C., Tarnay, L., and Cahill, T. A. (2003). Measurements of Mobile Source Particulate Emissions in a Highway Tunnel. *Int. J. Vehicle Des.*, 27:86-93.
- Hand, R., Di, P., Servin, A., Hunsaker, L., and Suer, C. (2004). *Roseville Rail Yard Study*. California Air Resources Board, Sacramento, CA.
- Kilburn, K. H. (2000). Effects of Diesel Exhaust on Neurobehavioral and Pulmonary Functions. *Arch. Environ. Health*, 55:11-17.
- Lundgren, D. A. (1967). An aerosol sampler for determination of particulate concentration as a function of size and time. *J. Air Pollut. Control Ass.*, 17:225-229.
- Miller, R. (2002). Ultraviolet Extinction in Boundary Layer Aerosols: Chromatic Variations in Size and Time Resolved Particulate Matter Collected on Teflon Filters and Greased Mylar Strips. PhD diss, University of California, Davis.
- Parent, M. E., Rousseau, M. C., Boffetta, Cohen, P. A., and Siemiatycki, J. (2007). Exposure to Diesel and Gasoline Engine Emissions and the Risk of Lung Cancer. *Am. J. Epidemiol.*, 165:53-62.
- Raabe, O. G., Braaten, D. A., Axelbaum, R. L., Teague, S. V., and Cahill, T. A. (1988). Calibration Studies of the Drum Impactor. *J. Aerosol Sci.*, 19:183-195.
- Riddle, S. G., Robert, M. A., Jakober, C. A., Hannigan, M. P., and Kleeman, M. J. (2007). Size Distribution of Trace Organic Species Emitted from Heavy-Duty Diesel Vehicles. *Environ. Sci. Technol.*, 42:974-976.
- Rolph, G. D. (2003). *Real-time Environmental Applications and Display System (READY)*. NOAA Air Resources Laboratory, Silver Spring, MD. <http://www.arl.noaa.gov/ready/hysplit4.html>
- Sawant, A. A., Nigam, A., Miller, J. W., Johnson, K. C., and Cocker, D. R. (2007). Regulated and Non-Regulated Emissions from in-Use Diesel-Electric Switching Locomotives. *Environ. Sci. Technol.*, 41:6074-6083.
- Sheesley, R. J., Schauer, J. J., Smith, T. J., Garshick, E., Laden, F., Marr, L. C., and Molina, L. T. (2008). Assessment of Diesel Particulate Matter Exposure in the Workplace: Freight Terminals. *J. Environ. Monitor.*, 10:305-314.
- Umezawa, M., Sakata, C., Tabata, M., Tanaka, N., Kudo, S., Takeda, K., Ihara, T., and Sugamata, M. (2008). Diesel Exhaust Exposure Enhances the Persistence of Endometriosis Model in Rats. *J. Health Sci.*, 54:503-507.
- Watson, J. G., Chow, J. C., Chen, L. W. A., and Frank, N. H. (2009). Methods to Assess Carbonaceous Aerosol Sampling Artifacts for Improve and Other Long-Term Networks. *J. Air Waste Manage.*, 59:898-911.
- Weast, R. C. (1989). *CRC Handbook of Chemistry and Physics: A Ready-Reference Book of Chemical and Physical Data*. 70th ed. CRC Press, Boca Raton, FL (Table F-143).
- Wesolowski, J. J., John, W., Devor, W., Cahill, T. A., Feeney, P. J., Wolfe, G., and Flocchini, R. (1978). Collection Surfaces of Cascade Impactors, in *X-Ray Fluorescence Analysis of Environmental Samples*, Dzuby, T., ed., Ann Arbor Science Publishers, pp. 121-130.
- Zielinska, B., Goliff, W., McDaniel, M., Cahill, T., Kittelson, D. and Watts, W. (2003). *Chemical Analyses of Collected Diesel Particulate Matter Samples in the E-43 Project*. National Renewable Energy Laboratory, Ann Arbor, MI.
- Zielinska, B., Sagebiel, J., McDonald, J. D., Whitney, K., and Lawson, D. R. (2004). Emission Rates and Comparative Chemical Composition from Selected in-Use Diesel and Gasoline-Fueled Vehicles. *J. Air Waste Manage. Assoc.*, 54:1138-1150.

ITEM 11.1.

EXHIBIT 7

ITEM 11.1.



Transportation Concept Report and Corridor System Management Plan United States Route 50 District 3



Disclaimer: The information and data contained in this document are for planning purposes only and should not be relied upon for final design of any project. Any information in this Transportation Concept Report (TCR) and Corridor System Management Plan (CSMP) is subject to modification as conditions change and new information is obtained. Although planning information is dynamic and continually changing, the District 3 Office of System and Freight Planning makes every effort to ensure the accuracy and timeliness of the information contained in the TCR/CSMP. The information in the TCR/CSMP does not constitute a standard, specification, or regulation, nor is it intended to address design policies and procedures.

California Department of Transportation

Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.

Approvals:

Marlon Flourney
per Marlon Flourney
District 3 Deputy Director
Planning and Local Assistance

6-27-14
6-27-14
Date

Jody Jones
Jody Jones
District 3 Director

6/27/14
6/27/14
Date



TABLE OF CONTENTS

About This Document.....5

Stakeholder Participation5

State and Local Responsibility5

EXECUTIVE SUMMARY.....6

 Concept Rationale6

 Proposed Projects and Strategies.....8

CORRIDOR OVERVIEW9

 Route Segmentation.....9

 CSMP Network..... 10

 Route Description 12

 Route Location..... 12

 Route Purpose and Major Route Features..... 12

 Route Designations..... 12

 Community Characteristics 15

 Land Use 15

 System Characteristics..... 16

 Traffic Operations System Elements 24

 Parallel and Connecting Roadways 28

 Transit and Rideshare Facilities 31

 Bicycle Facilities 36

 Pedestrian Facilities..... 42

 Freight..... 45

CORRIDOR PERFORMANCE MANAGEMENT 47

 Performance Measurement 47

 Performance Monitoring..... 48

 Bottleneck and Congestion Analysis..... 52

 Eastbound Bottleneck Analysis..... 54

 Westbound Bottleneck Analysis..... 56

KEY CORRIDOR ISSUES..... 58

 Bus/Carpool Lane Degradation 59

CORRIDOR CONCEPT FACILITY..... 59

ITEM 11.1.

Concept Rationale	59
Projects and Strategies	60
APPENDIX A: GLOSSARY OF TERMS AND ACRONYMS	74
APPENDIX B: RESOURCES	78
APPENDIX C: DATA RESOURCES	79
APPENDIX D: MAPS OF BICYCLE IMPROVEMENTS	80

LIST OF TABLES

Table 1: US 50 Concept Summary	7
Table 2: US Route Segmentation	9
Table 3: US 50 Route Designations and Characteristics	13
Table 4: US 50 Route Agencies, Tribes and Terrain	14
Table 5: US 50 System Characteristics	22
Table 6: US 50 Concept System Characteristics	23
Table 7: Existing US 50 ITS Elements	26
Table 8: US 50 CSMP Parallel Roadway Network	29
Table 9: US 50 Corridor Transit System	34
Table 10: US 50 Bicycle Transportation Network	38
Table 11: US 50 Corridor Pedestrian Facilities	44
Table 12: US 50 Freight Facilities	47
Table 13: US 50 Basic System Operations	49
Table 14: US 50 Truck Traffic Data	50
Table 15: US 50 Peak Hour Traffic Data	51
Table 16: US 50 Bottleneck Analysis Data	54
Table 17: Highway Planned and Programmed Projects and Strategies	62
Table 18: Highway Conceptual and Programmed Projects and Strategies	66
Table 19: Off-Highway Parallel Connecting Roads Projects	68
Table 20: Off-Highway Transit Projects	71
Table 21: Off-Highway Bicycle and Pedestrian Projects	72

List of Figures

Figure 1: US 50 Route Segmentation Map	10
Figure 2: US 50 CSMP Transportation Network	11
Figure 3: Segment 1 Map	16
Figure 4: Segment 2 Map	16
Figure 5: Segment 3 Map	17
Figure 6: Segment 4 Map	17
Figure 7: Segment 5 Map	17
Figure 8: Segment 6 Map	17
Figure 9: Segment 7 Map	18
Figure 10: Segment 8 Map	18
Figure 11: Segment 9 Map	18
Figure 12: Segment 10 Map	18

ITEM 11.1.

Figure 13: Segment 11 Map	19
Figure 14: Segment 12 Map	19
Figure 15: Segment 13 Map	19
Figure 16: Segment 14 Map	19
Figure 17: Segment 15 Map	20
Figure 18: Segment 16 Map	20
Figure 19: Segment 17 Map	20
Figure 20: Segment 18 Map	20
Figure 21: Segment 19 Map	21
Figure 22: Segment 20 Map	21
Figure 23: Segment 21 Map	21
Figure 24: Auxiliary and Transition Lanes	25
Figure 25: US 50 Traffic Operations System Map.....	27
Figure 26: US 50 CSMP Network Transit Routes	32
Figure 27: US 50 Corridor Bicycle Facilities Map	40
Figure 28: US 50 Corridor Bicycle Facilities Map (Inset).....	41
Figure 29: US 50 TCR Portion Bicycle Facilities.....	42
Figure 30: US 50 Truck Network Map.....	46

ITEM 11.1.

ABOUT THIS DOCUMENT

System Planning is the long-range transportation planning process for the California Department of Transportation (Caltrans). The System Planning process fulfills Caltrans' statutory responsibility as owner/operator of the State Highway System (SHS) (Gov. Code §65086) by identifying deficiencies and proposing improvements to the SHS. Through System Planning, Caltrans focuses on developing an integrated multimodal transportation system that meets Caltrans' goals of safety, mobility, delivery, stewardship, and service.

The System Planning process is primarily composed of four parts: the District System Management and Development Plan (DSMDP), the Transportation Concept Report (TCR), the Corridor System Management Plan (CSMP), and the DSMDP Project List. The district-wide **DSMDP** is a strategic policy and planning document that focuses on maintaining, operating, managing, and developing the transportation system. The **TCR** is a planning document that identifies the existing and future route conditions as well as future needs for each route on the SHS. The **CSMP** is a complex, multi-jurisdictional planning document that identifies future needs within corridors experiencing or expected to experience high levels of congestion, and is a foundation document that supports the partnership-based, integrated management of various travel modes (transit, cars, trucks, pedestrians, bicycles) and infrastructure (rail, roads, highways, information systems, bike routes) in a corridor so that mobility along the corridor is provided in the most efficient and effective manner possible. The **DSMDP Project List** is a list of planned and partially programmed transportation projects used to recommend projects for funding. These System Planning products are also intended as resources for external stakeholders, the public, related Caltrans functional units, tribal governments, and partner regional and local agencies.

TCR/CSMP Purpose

California's State Highway System needs long-range planning documents to guide the logical development of transportation systems as required by CA Gov. Code §65086 and as necessitated by the public, stakeholders, and system users. The purpose of the TCR/CSMP is to evaluate current and projected conditions along the route, and communicate the vision for the development of each route in each Caltrans District during a 20-year planning horizon. The TCR/CSMP is developed with the goals of increasing safety, improving mobility, providing excellent stewardship, and meeting community and environmental needs along the corridor through integrated management of the transportation network, including the highway, parallel and connecting roadways, transit, pedestrian, bicycle, freight, operational improvements, and travel demand management components of the corridor. The purpose of the CSMP update portion of this document is to continue with the momentum from the first generation document to achieve a seamless transportation system on urbanized segments of the corridor by revisiting the managed transportation network, updating the traffic forecast and performance measure data, and upgrading the key capital project lists with an emphasis on inclusion of projects such as Intelligent Transportation Systems (ITS) and Traffic Operations Systems (TOS) improvements.

STAKEHOLDER PARTICIPATION

Stakeholder participation was sought throughout the development of the U. S. Highway (US) 50 TCR/CSMP. Outreach involved internal and external stakeholders, regional and local agencies, advocacy groups, and the public. During the initial information resource gathering for the TCR/CSMP, stakeholders were contacted for their input related to their particular specializations, and to verify data sources used and data accuracy. As the document was finalized, stakeholders were asked to review the document for comments, edits, and for consistency with the intent of existing plans, policies, and procedures. The process of including and working closely with stakeholders adds value to the TCR/CSMP, allows for outside input and ideas to be reflected in the document, increases credibility, and helps strengthen public support and trust.

STATE AND LOCAL RESPONSIBILITY

Improvements to the State Highway System are the responsibility of both Caltrans and local agencies. Developments that add cumulative impacts to this route and the regional State Highway System may necessitate that local jurisdictions provide nexus based, proportional fair-share funding for future highway improvements. Developments or local circulation changes that will have significant traffic impacts to the highway should provide improvements to mitigate those impacts.

ITEM 11.1.

EXECUTIVE SUMMARY

This document is a combination of the TCR and the CSMP. These two documents complement each other, with the CSMP providing short- to mid-term planning for the urban section, and the TCR providing long-term planning for the rural section of the facility. These two documents were combined into this combined TCR/CSMP document to create greater planning coordination for the entire length of US 50. The combined TCR/CSMP is a long-term document, with a base year of 2012 and a horizon year of 2035.

US 50 is one of three remaining transcontinental routes signed with the U.S. Highway System shield in California. It begins at Interstate 80 (I-80) in West Sacramento and traverses portions of Yolo, Sacramento, and El Dorado Counties before passing into the State of Nevada. All 108 miles of US 50 in California lie within Caltrans District 3. US 50 serves as a major east-west connector. It is an officially designated Scenic Highway from Downtown Placerville to the western city limit of South Lake Tahoe.

The facility is roughly divided into two sections: the urban half, covered by the CSMP, and the rural half, covered by the TCR. The facility begins as a freeway in West Sacramento in Yolo County and continues through the cities of Sacramento, Rancho Cordova, and Folsom in Sacramento County. It then enters El Dorado County, passing through El Dorado Hills, Cameron Park, Shingle Springs, and Placerville. Approximately six miles east of Placerville the facility becomes a conventional highway to the California/Nevada State line. The Cedar Grove Exit marks the boundary between the CSMP area to the west and the TCR area to the east. The narrower, mountain section traverses small mountain communities and over 30 miles of the Eldorado National Forest, until it intersects with SR 89 near the City of South Lake Tahoe, after which it extends eastward through the City of South Lake Tahoe to the California/Nevada State line. In this section the facility is primarily used for recreational trips, particularly to reach Lake Tahoe during the peak summer travel and winter ski months. As a result, US 50 experiences strong directional peak traffic on weekends and holidays.

Concept Summary

The US 50 TCR/CSMP evaluates current and projected future traffic conditions with 2012 as the base year and with the 20-year build facility. Table 1 provides a summary of the existing facility, the 20-year build facility, and the ultimate facility concept, defined as the facility with projects and management strategies anticipated beyond the 20-year horizon. As discussed further in this document, the concept LOS for US 50 is level of service (LOS) D in rural areas and LOS E in urban areas. We recognize some segments of US 50 will not attain their respective operational concepts after the 20-year buildout of the facility. Therefore, ongoing efforts to manage and improve system performance will emphasize the system operations and management strategies discussed further on in this document.

Concept Rationale

The 20-year build facility for US 50 describes the long-term vision for how the facility will operate and what its configuration will be in the horizon year. This 20-year build facility concept is based on planned and programmed, and conceptual projects. The ultimate facility concept includes the construction of bus/carpool (HOV), and auxiliary (Aux) lanes. In the Corridor Performance section, Concept LOS is given for each segment in the base and horizon year. A minimum acceptable LOS is E for an urban segment and D for a rural one. Given greater accessibility and higher traffic in urban areas, LOS E is more appropriate and realistic for those segments while LOS D is more reasonable for a rural segment.

US 50 is an important transportation facility for the communities of Sacramento County, El Dorado County and of the Sierra Nevada, in particular Meyers, South Lake Tahoe, and the numerous recreational opportunities in those areas. US 50 also provides interregional connectivity to communities located in western Nevada. This TCR proposes change in the facility concept, balancing mobility of those communities, cost of improvements, and community character. In the segments in the Sacramento metropolitan area, a freeway and expressway concept is more appropriate because the facility serves commuters traveling to Sacramento and fewer local uses. In the rural segments (15 through 21), which experience lower traffic and provide access to properties, the conventional highway concept is appropriate due to its lesser impact on operations and the community.

ITEM 11.1.

TABLE 1: US 50 CONCEPT SUMMARY				
Segment #	Segment Description	Existing Facility *	20-Year Build Facility *	Ultimate Facility *
1	Interstate 80 to Yolo/Sacramento County Line	8F (6F btw Jefferson Blvd. ramps)	8F + ITS	8F + 2HOV + Aux Lanes + ITS + ICM
2	Yolo/Sacramento County Line to State Routes (SR) 99 and 51	8F	8F + 2HOV + Aux Lanes + ITS	8F+2HOV+Aux Lanes + ITS + ICM
3	SR 99 and SR 51 to Watt Ave.	8F	8F + 2HOV +ITS	8F + 2HOV + Aux Lanes + Transition + ITS + ICM
4	Watt Ave. to Zinfandel Dr.	8F + 2HOV	8F + 2HOV + Aux Lanes + ITS	8F + 2HOV + Aux Lanes + ITS + ICM
5	Zinfandel Dr. to Sunrise Blvd.	8F + 2HOV	8F + 2HOV + Aux Lanes + ITS	8F + 2HOV + Aux Lanes + Transition + ITS + ICM
6	Sunrise Blvd. to Folsom Blvd.	6F + 2HOV to Hazel Ave, 4F + 2HOV to Folsom Blvd	8F + 2HOV + ITS + Aux Lanes to Hazel Ave., 4F + 2HOV + ITS + Aux Lanes to Folsom	8F + 2HOV + ITS + ICM + Aux Lanes to Hazel Ave., 4F + 2HOV + ITS + ICM + Aux Lanes to Folsom
7	Folsom Blvd. to Sacramento/El Dorado County Line	4F + 2HOV	4F + 2HOV + Aux Lanes + ITS	4F + 2HOV + Aux Lanes + ITS + ICM
8	Sacramento/El Dorado County Line to El Dorado Hills Blvd. (Latrobe Road)	4F + 2HOV	4F + 2HOV + Aux Lanes + ITS	4F + 2HOV + Aux Lanes + ITS + ICM
9	Latrobe Road to Bass Lake Road	4F + 2HOV	4F + 2HOV + Aux Lanes + ITS	4F + 2HOV + Aux Lanes + ITS + ICM
10	Bass Lake Road to Cameron Park Drive	4F + 2HOV	4F + 2HOV + Aux Lanes + ITS	4F + 2HOV + Aux Lanes + ITS
11	Cameron Park Drive to So. Shingle Road (Ponderosa Rd.)	4F	4F + 2HOV + Aux Lanes + ITS	4F + 2HOV + Aux Lanes + ITS
12	Ponderosa Rd to Missouri Flat Road	4F	4F + 2HOV + Aux Lanes + ITS to Greenstone, 4F + Aux Lanes + ITS to Missouri Flat	4F + 2HOV + Aux Lanes + ITS to Greenstone, 4F + Aux Lanes + ITS to Missouri Flat
13	Missouri Flat Road to End of Freeway in Placerville	4F	4F	4F + Aux Lanes + ITS
14	End of Freeway in Placerville to Bedford Ave.	4E + Merge Lanes (Eastbound)	4E + Merge Lanes + ITS	4E + Merge Lanes + ITS + ICM
15	Bedford Ave. to Cedar Grove Exit	4F to Smith Flat, 4E to Camino	4F + to Smith Flat, 4E to Camino	4F + Aux Lanes + ITS to Smith Flat, 4E + ITS to Camino
16	Cedar Grove Exit to 0.67 mi east of Sly Park Road	4F	4F	4F + ITS
17	0.67 miles east of Sly Park Road to Ice House Road	3C, 2.0 mi; 4E, 5.3 mi; 3C, 0.3 mi	3C, 2.0 mi; 4E, 5.3 mi; 3C, 0.3 mi	3C + ITS, 2.0 mi; 4E + ITS, 5.3 mi; 3C + ITS, 0.3 mi
18	Ice House Road to Echo Summit	2C; 0.35 mi of 2-way left turn lane	2C; 0.35 mi of 2-way left turn lane	2C + ITS + ICM; 0.35 mi of 2-way left turn lane
19	Echo Summit to State Route 89 South/Luther Pass Road	2C	2C	2C + ITS + ICM + Bike Lanes
20	State Route 89 South/Luther Pass Road to State Route 89 North/Lake Tahoe Blvd	3C, 0.86 mi; 2C, 3.64 mi; 5C, 0.61 mi	3C, 0.86 mi; 2C, 3.64 mi; 5C, 0.61 mi	3C + ITS + ICM, 0.86; 2C + ITS + ICM, 3.64 mi; 5C + ITS + ICM, 0.61 mi
21	State Route 89 North/Lake Tahoe Blvd to Nevada State Line	5C	5C	5C + ITS + ICM + Bike Lanes

Facility Type Codes: C=Conventional Highway, E=Expressway, F=Freeway, HOV=High Occupancy Vehicle Lanes, Aux=Auxiliary Lanes, ITS=Intelligent Transportation Systems, ICM=Integrated Corridor Management.

ITEM 11.1.**Proposed Projects and Strategies**

The proposed projects and strategies on US 50 are limited by the Right of Way (ROW) constraints on the facility, as well as by financial, environmental, and political factors. In the urban section of US 50, existing development limits land purchases for highway expansion, and in the rural section land purchases are limited by National Forest land and environmental constraints. The largest projects on the facility consists of a bus/carpool (HOV) lane expansion from the SR 99/51 junction to Watt Avenue (Ave.) interchange and from the Cameron Park Road interchange to the Missouri Flat Road interchange. There are also a significant number of operational and Intelligent Transportation Systems (ITS) improvements that will be constructed on the facility. These improvements, to be constructed throughout the facility, include the installation of various ITS technologies, auxiliary lanes, transition lanes, passing lanes, ramp metering, intersection improvements, interchange improvements, ramp widening, bus/carpool lanes and connectors and other improvements appropriate to the context of the interchanges to be improved.

Integrated Corridor Management (ICM) is a part of the ultimate facility concept for the US 50 corridor. As an operational management strategy, it is particularly in locations where the ultimate concept LOS performance is unattainable on the 20-year buildout facility, and where further buildout cannot occur due to constraints and limitations such as those described above. ICM is a multimodal approach to managing transportation assets, allowing partner agencies to manage the transportation corridor as an integrated asset in order to improve travel time reliability and predictability, help manage congestion and provide travelers with better information and more choices.



ITEM 11.1.

CORRIDOR OVERVIEW

ROUTE SEGMENTATION

US 50 is divided into 21 segments, the first 15 of which are on the CSMP corridor and highlighted in Table 2 below. As shown in Figure 1, the facility spans a large cross-section of California and is roughly evenly split between urban and rural sections.

TABLE 2: US 50 ROUTE SEGMENTATION				
Segment #	Location Description	County	Begin Post Mile	End Post Mile
1	Interstate 80 to Yolo/Sacramento County Line	YOL	0	3.16
2	Yolo/Sacramento County Line to State Routes 99 and 51	SAC	L0.00	L2.48 = R0.00
3	State Routes 99 and 51 to Watt Ave.	SAC	R0.00	R5.34
4	Watt Ave. to Zinfandel Drive	SAC	R5.34	R10.92
5	Zinfandel Drive to Sunrise Boulevard	SAC	R10.92	12.5
6	Sunrise Boulevard to Folsom Boulevard	SAC	12.5	17.01
7	Folsom Boulevard to Sacramento/El Dorado County Line	SAC	17.01	23.14
8	Sacramento/El Dorado County Line to Latrobe Road	ELD	0	0.86
9	Latrobe Road to Bass Lake Road	ELD	0.86	R3.23
10	Bass Lake Road to Cameron Park Drive	ELD	R3.23	6.57
11	Cameron Park Drive to Ponderosa Rd	ELD	6.57	R8.56
12	Ponderosa Rd to Missouri Flat Road	ELD	R8.56	R15.06
13	Missouri Flat Road to End of Freeway in Placerville	ELD	R15.06	17.25
14	End of Freeway in Placerville to Bedford Ave.	ELD	17.25	18.11
15	Bedford Ave. to Cedar Grove Exit	ELD	18.11	R25.95
16	Cedar Grove Exit to 0.67 mi east of Sly Park Road	ELD	R25.95	R31.97
17	0.67 miles east of Sly Park Road to Ice House Road	ELD	R31.97	39.77
18	Ice House Road to Echo Summit	ELD	39.77	66.63
19	Echo Summit to State Route 89 South/Luther Pass Road	ELD	66.63	70.62
20	State Route 89 South/Luther Pass Road to State Route 89 North/Lake Tahoe Blvd	ELD	70.62	75.45
21	State Route 89 North/Lake Tahoe Blvd to Nevada State Line	ELD	75.45	80.44

ITEM 11.1.

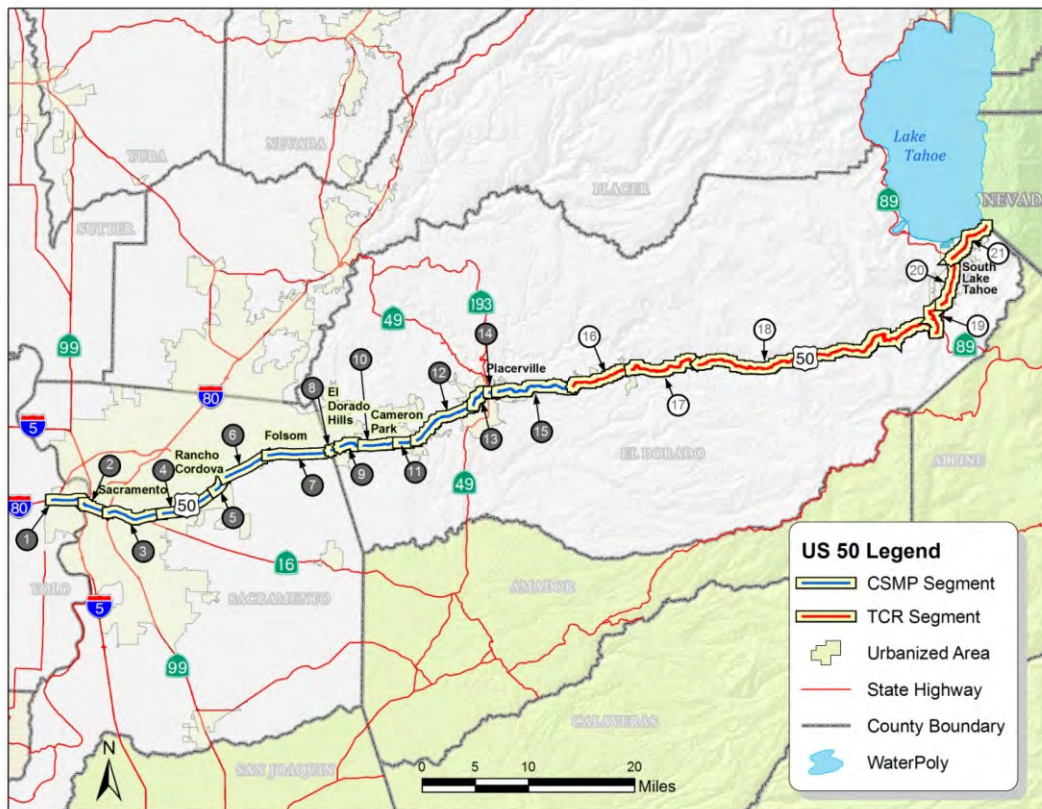


Figure 1: US 50 Route Segmentation Map

CSMP TRANSPORTATION NETWORK

The US 50 CSMP Transportation Network (managed network) includes US 50 from the US 50/Interstate 80 interchange in the City of West Sacramento to the US 50/Cedar Grove exit in the El Dorado County community of Camino, as well as select parallel roads, transit services, and bike routes. The parallel and connector roadways, transit, and bicycle route components of the managed network were selected for inclusion in the corridor in consultation with the respective local agencies. Changes in the managed network from the original US 50 CSMP include the following additions:

- Parallel and connecting roadways to US 50 in downtown Sacramento and in midtown Sacramento to Watt Ave. were added to close a gap that existed in the original CSMP. These roadways include portions of T Street (St.), Alhambra Boulevard (Blvd.), Broadway, Fruitridge Road (Rd.), Stockton Blvd., 65th St., Power Inn Rd., Florin-Perkins Rd., Folsom Blvd. In the City of Folsom, Iron Point Rd. was extended to Empire Ranch Rd. and in the City of Placerville, Jacquier Rd. and Carson Rd.
- Sacramento Regional Transit District bus routes 38 and 74, and an El Dorado County Transit Agency bus route from Placerville to Pollock Pines.
- Bicycle routes in downtown and midtown Sacramento including, but not limited, to 2nd Ave. and T St. In the City of Folsom, the Humbug Willow Creek bicycle trail was added and the American River Parkway trail was extended north. In and near the City of Placerville, the El Dorado bicycle trail was extended to Missouri Flat Rd.

As the CSMP concept matures, additional facilities may be added to the managed network. The CSMP transportation network is displayed in Figure 2.

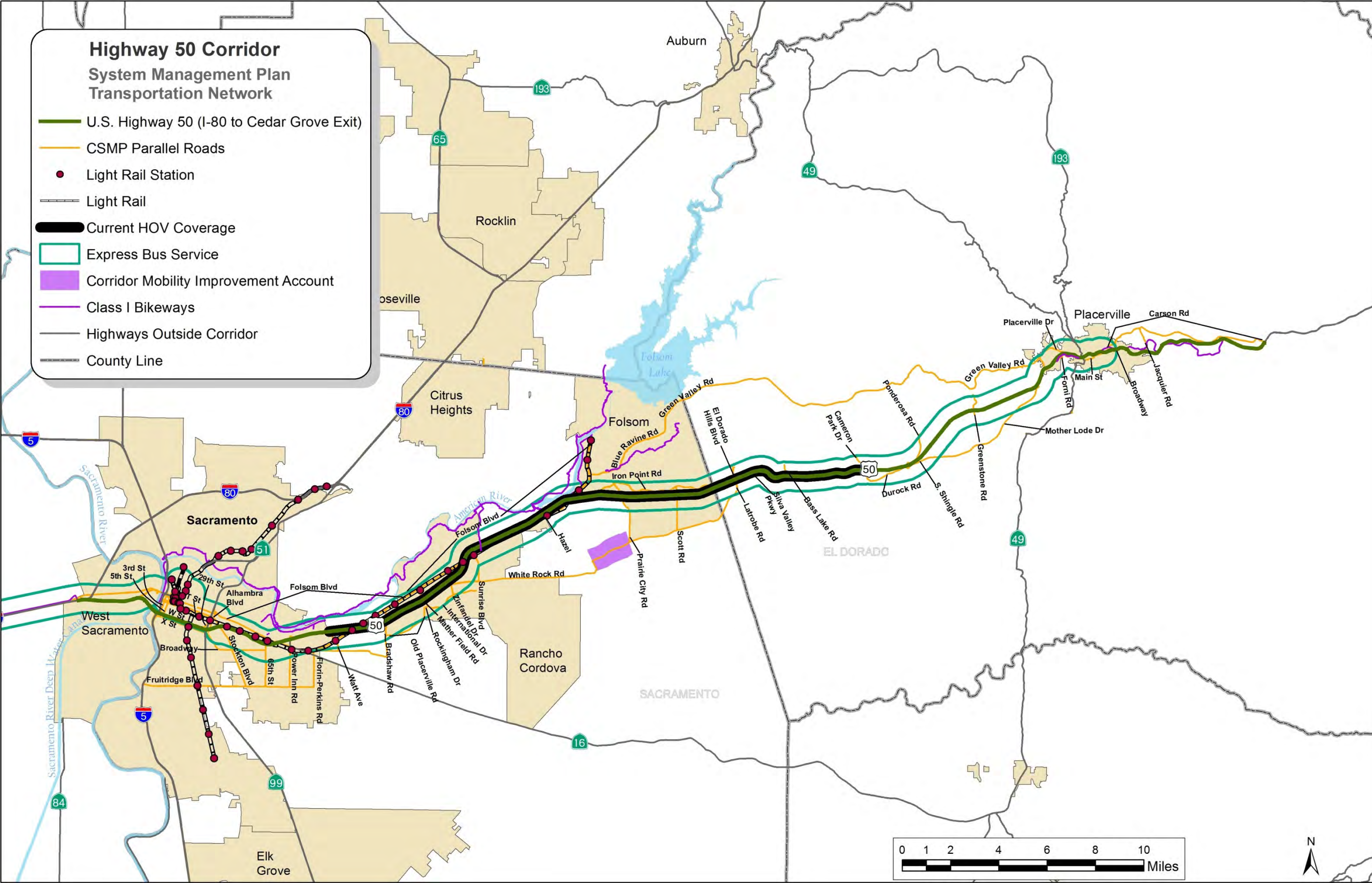


Figure 2: US 50 CSMP Transportation Network

ITEM 11.1.

ROUTE DESCRIPTION

Route Location

US 50 begins at the junction of I-80 and US 50 in West Sacramento and continues to beyond the Nevada state line. The urban CSMP portion runs from the beginning in West Sacramento to the Cedar Grove interchange in Camino. The CSMP portion runs through the Cities of West Sacramento, Sacramento, Rancho Cordova, Folsom, and Placerville. It also serves the unincorporated communities of Rosemont, El Dorado Hills, and Shingle Springs. For most of the CSMP portion the land is flat and begins to rise through the foothills in El Dorado County. US 50 joins with several other state highways, such as I-5, SR 99, SR 51, and SR 16 in Sacramento, and SR 49 in Placerville. The TCR portion starts at the Cedar Grove interchange and continues to Pollock Pines, the last community before the Eldorado National Forest. As US 50 enters the National Forest, it runs parallel to the South Fork American River for over thirty miles. The facility then separates from its parallel proximity to the river and heads north towards the end of the National Forest and junction with SR 89. Just after the SR 89 junction, the facility serves as a principle arterial for the unincorporated community of Meyers and for the City of South Lake Tahoe. SR 89 continues north and US 50 continues east as a conventional urban arterial through the City of South Lake Tahoe wherein it eventually crosses the California/Nevada State boundary.

Route Purpose and Major Route Features

US 50 serves the large Sacramento metropolitan area until east of Placerville, where it primarily serves recreational travel to the Sierra Nevada and Lake Tahoe. The facility provides convenient regional access to jobs and services in downtown Sacramento, Rancho Cordova, and Folsom, with peak hour traffic associated with daily commuting. East of the Sacramento metropolitan area, there are relatively few jobs, shopping, educational facilities, or other trip attractors along the highway until the facility reaches the City of South Lake Tahoe. The main attraction in the largely rural eastern half of the facility is the numerous recreation opportunities. The functional classification of the portion of US 50 between its beginning in West Sacramento and Canal St. in Placerville is classified in the California Road System as an "Other Freeway or Expressway." The portion from Canal St. in Placerville to the California/Nevada State boundary is classified an "Other Principal Arterial."St.

Route Designations and Characteristics

US 50 is designated a High Emphasis Route in the Interregional Transportation Strategic Plan (ITSP), the plan that guides development of the interregional transportation network. This designation means that the facility will be built to minimum standards for an expressway or freeway, in as much as environmental and ROW constraints allow. In terms of goods movement, US 50 is a part of the Surface Transportation Assistance Act (STAA) National Network until Sly Park Road, which permits larger trucks to traverse the route. This designation facilitates freight movement to the large population areas. At Sly Park Road, the designation becomes California Legal Network, which permits shorter trucks that can negotiate the mountain curves. As the route nears South Lake Tahoe, US 50 is designated a Terminal Route at the junction with SR 89, which permits STAA trucks to use the facility to reach their destinations.

Route designations and characteristics of US 50 for both the TCR and CSMP sections of the corridor are identified in Tables 3 and 4.

ITEM 11.1

TABLE 3: US 50 ROUTE DESIGNATIONS AND CHARACTERISTICS

Seg. #	Freeway & Expressway	National Highway System	Strategic Highway Network	Scenic Highway	Inter-regional Road System	High Emphasis	Focus Route	Federal Functional Classification	Goods Movement Route	Truck Designation	Rural/Urban/Urbanized				
1	Yes-F	Yes	No	No	Yes	Yes	No	Other Freeway or Expressway	Yes	National Network	Urbanized				
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14	Yes-E		No: to Jct SR 49; Yes: from Jct SR 49	Other Freeway or Expressway / Other Principal Arterial	No	Urban									
15	Yes-F/E/F		Yes												
16	Yes														
17															
18							No								
19															
20															
21															
										National Network / California Legal	Rural				
										California Legal					
										Terminal Access (STAA)	Urban				

ITEM 11.1.

TABLE 4: US 50 ROUTE AGENCIES, TRIBES AND TERRAIN

Seg. #	Metropolitan Planning Organization	Regional Transportation Planning Agency	Congestion Management Agency	County Transportation Commission	Local Agency	Tribes	Air District	Terrain		
1	Sacramento Area Council of Governments (SACOG)	SACOG	Yolo County Transp. District	N/A	West Sacramento	None	Yolo-Solano	Flat and Low Terrain		
2			Sacramento Transportation Authority		City of Sacramento		Sacramento Metro			
3										
4									Sac. County; Rancho Cordova	
5										Rancho Cordova
6										
7									Folsom	
8		El Dorado County Transp. Commission (EDCTC)	N/A	EDCTC	El Dorado County	Shingle Springs Band of Miwok Indians	El Dorado	Foothills		
9										
10					El Dorado County; Placerville	None				
11										
12										
13					Placerville; El Dorado County					
14					El Dorado County			Steep Terrain		
15										
16										
17					El Dorado County			Rolling or Flat		
18										
19	Tahoe Metropolitan Planning Organization (TMPO)	Tahoe Regional Planning Agency (TRPA)		N/A						
20										
21										

ITEM 11.1.

COMMUNITY CHARACTERISTICS

US 50 begins in West Sacramento, which has mostly low-density residential and industrial land uses. It then continues to the dense urban core of downtown Sacramento, which is made up of a large office district and dense residential neighborhoods. As the facility travels east through Rancho Cordova, Folsom, and El Dorado Hills, the housing density gradually decreases.

Median household income follows a distinct pattern along US 50. It gradually increases from the low \$50,000s in West Sacramento and continuing east through Sacramento and Rancho Cordova to \$112,111 in Gold River, \$95,143 in Folsom and \$115,121 in El Dorado Hills. Median household income then decreases going east to \$72,562 in Cameron Park and \$53,385 in Placerville.

There are four main communities in the eastern rural portion of US 50: Camino, Pollock Pines, Meyers and South Lake Tahoe. Camino, an unincorporated community that is considered a census-designated place for statistical analysis, has over 1,700 residents with a median household income of \$51,742 (2010 Census). Many of the residents work in Sacramento. Lying just east of Camino, Pollock Pines is a slightly larger community, a census-designated place of 6,871 people. Approximately 20 percent (%) of Pollock Pines housing units are vacant. In both Camino and Pollock Pines, the largest source of employment is in the Sacramento area. Camino residents travel on average 25 minutes to work, and Pollock Pines residents travel 34 minutes on average. Meyers has a population of approximately 3,000 while South Lake Tahoe has 21,403 residents. Meyers is an urbanizing community with a rural facility. South Lake Tahoe is a much more diverse community with a variety of trip attractors. The community is primarily oriented toward the tourism and recreation industries. Lake Tahoe, Casinos in Nevada, the Lake Tahoe Vacation Resort, the Lake Tahoe Airport, and the many ski resorts south of Lake Tahoe are the major draws in the South Lake Tahoe area, attracting trips to the facility.

LAND USE

Land uses along US 50 are varied and change from one community to another. West Sacramento has a mix of single family homes with industrial uses such as warehousing and the Port of West Sacramento. In downtown Sacramento there is a concentration of office buildings, entertainment, and a variety of dense, older housing. Continuing to the East Sacramento neighborhood, there is a mix of multi-family homes and single family homes with large trip attractors such as UC Davis Medical Center and California State University Sacramento (CSUS). As US 50 makes its way east to Rancho Cordova, the housing stock becomes predominantly single family home with limited multifamily home development.

In Rancho Cordova between Zinfandel Drive and Hazel Ave., there is significant office park development. Major trip attractors include Aerojet Rocketdyne, an aerospace corporation, and Mather Airport, a major air cargo hub. Further east in Folsom, El Dorado Hills, Cameron Park, and Placerville, residential densities decrease to larger lot single family homes, and most non-residential development is in retail commercial and limited office uses.

The western part of the corridor, near Placerville, has experienced rapid growth in the past decade as an increasing number of workers in the Sacramento area live in Camino and Pollock Pines. The land uses in this section are predominantly single family homes of 1-5 dwelling units (DU)/acre and 1 DU/acre. Growing agricultural and ranch uses increase seasonal visitor traffic, such as at Apple Hill during apple harvest season. In the Pollock Pines area there are some multifamily units and commercial, mostly small, businesses. After the Pollock Pines area, there is a long stretch of undeveloped forest land in the Eldorado National Forest. To the east, the land uses in South Lake Tahoe are more diverse, reflecting a larger community with a more diverse economic base. There are major nodes of commercial activity, such as at the SR 89/US 50 junction, and near the California/Nevada State line. US 50 is locally referred to as "Lake Tahoe Boulevard," and is the main street of the City, connecting these two commercial nodes. The rest of the city is mostly single-family residential housing.

ITEM 11.1.

US 50 is a vital transportation corridor for the economy of Sierra Nevada communities in El Dorado County. US 50 is particularly important to the economy of South Lake Tahoe and the surrounding communities that rely on Lake Tahoe and nearby ski resort tourism. Many of the residents of Camino and Pollock Pines drive west to Placerville and Sacramento for work, whereas the residents of the much more diverse Lake Tahoe communities have shorter commutes to nearby job sites.

SYSTEM CHARACTERISTICS

For the purpose of analysis, US 50 is divided into 21 total segments shown in Figures 3 through 23 below. Each segment is described in terms of its geography, classification, configuration, surrounding land uses, jurisdictions, trip attractors and features contributing to its operational characteristics.

Segment 1 consists of 3.2 miles of eight-lane freeway (six-lane between the Jefferson Blvd. ramps) from the facility's beginning at the junction of I-80 to the Yolo/Sacramento County line, extending through the City of West Sacramento. US 50 provides access to the Port of West Sacramento, several warehouses, and industrial properties along the facility. Raley Field, home to the River Cats baseball team, is also along the corridor and is a major trip attractor. It also allows easy access to downtown Sacramento and points east.

Segment 2 consists of eight lanes and spans the length of downtown Sacramento on 2.5 miles of freeway, from the Yolo/Sacramento County line to I-5 and ending at the intersection of SR 99/51. These important transportation connections from US 50 contribute to high traffic volumes, particularly during peak commute periods. Land uses along this corridor include older single family residential neighborhoods south of US 50 and commercial uses and multi-family residential north of US 50.

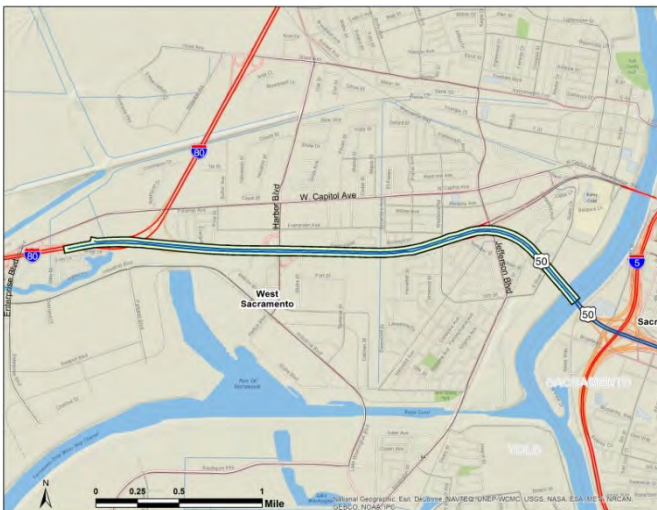


Figure 3: Segment 1 Map

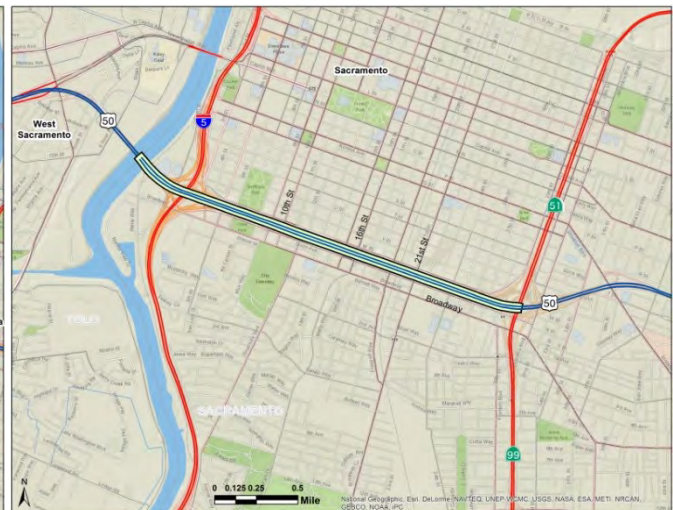


Figure 4: Segment 2 Map

Segment 3 runs for 5.3 miles of eight-lane freeway from the junction of SR 99/51 to the City of Sacramento City line at Watt Ave. Major land uses along this segment include UC Davis Medical Center and CSUS. CSUS has a total of 28,000 students and almost 3,000 staff. There is a mix of land uses along this facility, consisting of mixed commercial and multi-family housing closer to downtown Sacramento with a higher percentage of single family housing and retail land uses as one travels east.

Segment 4 traverses the unincorporated Sacramento County community of Rosemont and half of the City of Rancho Cordova from Watt Ave. to Zinfandel Dr. It is 5.6 miles of freeway consisting of eight mixed flow lanes

ITEM 11.1.

and two HOV lanes, and serves Mather Airport. Land uses along Segment 4 include single family residential with some multifamily residential as well as retail commercial and office commercial.

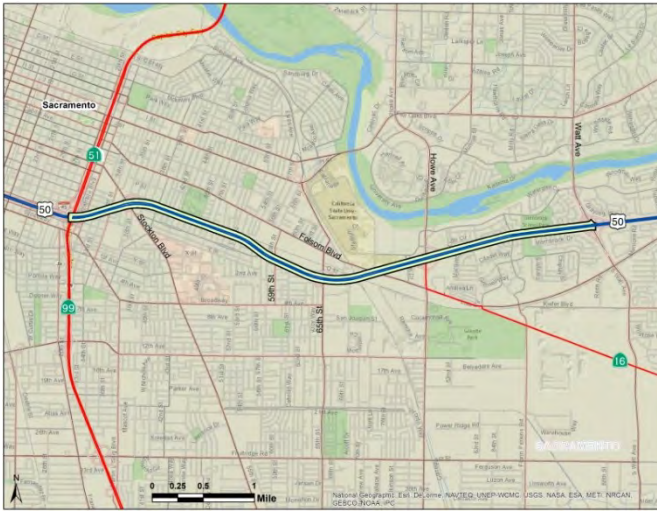


Figure 5: Segment 3 Map



Figure 6: Segment 4 Map

Segment 5 covers the core of Rancho Cordova on 1.6 miles of freeway consisting of eight mixed flow lanes and two HOV lanes from Zinfandel Dr. to Sunrise Blvd. This short segment has no significant single trip attractors. Predominant land uses along the segment consist of single family residential, retail commercial, and office commercial.

Segment 6 consists of 4.5 miles of freeway, from Sunrise Blvd. in Rancho Cordova to the Folsom Blvd. interchange in the City of Folsom. This segment is comprised of six mixed flow lanes and 2 HOV lanes from Zinfandel Dr. to Hazel Ave., and four mixed flow lanes with two HOV lanes from Hazel Ave. to Folsom Blvd. The major land uses along this segment include Aerojet Rocketdyne with its own off-ramp at Aerojet Dr. and big box retail along Sunrise Blvd. Other land uses include low density residential in the unincorporated community of Gold River.

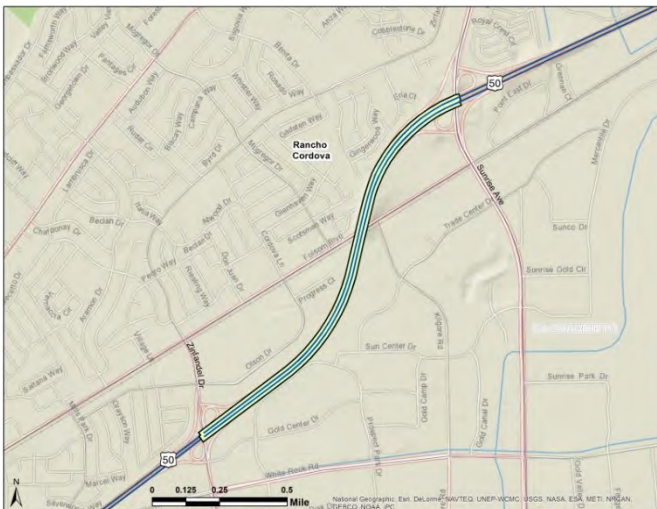


Figure 7: Segment 5 Map



Figure 8: Segment 6 Map

ITEM 11.1.



Figure 9: Segment 7 Map



Figure 10: Segment 8 Map

Segment 7 covers almost the entirety of the City of Folsom over 6.1 miles from the Folsom Blvd. interchange to the Sacramento/El Dorado County line. This segment is a freeway consisting of four mixed flow lanes and two HOV lanes. Major trip attractors along the segment are Intel Corporation on Prairie City Rd., the outlet mall near Folsom Blvd., the Palladio Cinemas, regional commercial facilities along Scott Rd. and numerous small businesses in Old Town Folsom. The predominant land uses along the facility are low density residential and some big box retailers. Currently, most land uses are on the north side of US 50. The south side of US 50 is now mostly occupied by Aerojet Rocketdyne and rangeland, but there are plans for residential and retail development for the area north of White Rock Rd. between Prairie City Rd. and the Sacramento/El Dorado County line.

Segment 8 extends 0.86 miles from the Sacramento/El Dorado County line to El Dorado Hills Blvd./Latrobe Rd. It is a freeway consisting of four mixed flow lanes and two HOV lanes. Land uses along this segment are almost exclusively low density residential with some office or commercial uses.



Figure 11: Segment 9 Map



Figure 12: Segment 10 Map

Segment 9 extends 2.37 miles from Latrobe Rd. to Bass Lake Rd. It is a four-lane freeway with two HOV lanes. Land uses along this segment are almost exclusively low density residential with some office or commercial uses.

ITEM 11.1.

Segment 10 extends 3.34 miles from Bass Lake Rd. to Cameron Park Dr. This segment is a freeway consisting of four lanes with two HOV lanes. Land uses along this segment are almost exclusively low density residential with some office or commercial uses.

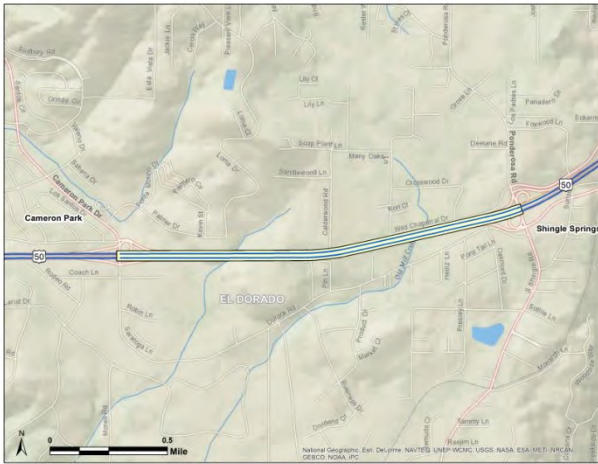


Figure 13: Segment 11 Map

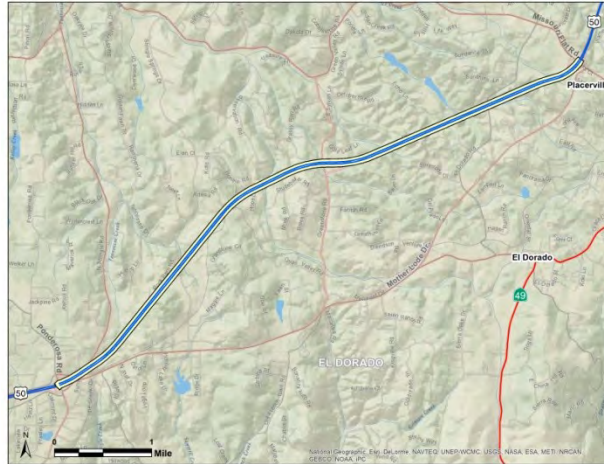


Figure 14: Segment 12 Map

Segment 11 is a four-lane freeway that spans 1.99 miles of rolling hills in El Dorado County from Cameron Park Dr. to Ponderosa Rd. The community of Shingle Springs is an important attractor along this segment. Other land uses along the facility are residential land uses.

Segment 12 is a four-lane freeway spanning 6.5 miles of rolling hills in El Dorado County from Ponderosa Rd. to Missouri Flat Rd. The major attractants along this segment are local and regional commercial land uses along Missouri Flat Rd. Another main trip attractor on the facility is a tribal gaming facility on Red Hawk Parkway. The rest of the land uses along the facility are residential land uses, especially estate residential uses of minimum 5 acre lots.



Figure 15: Segment 13 Map



Figure 16: Segment 14 Map

Segment 13 is 2.2 miles of four-lane freeway that extends from Missouri Flat Rd. to the end of the freeway near Canal St. One of the major attractions along Segment 13 is the El Dorado Fairgrounds between Placerville Dr. and Ray Lawyer Dr. Other land uses include shopping in the vicinity of Missouri Flat Rd. and Placerville Dr. as well as low density residential land uses. The El Dorado County Government Center is adjacent to this segment.

ITEM 11.1.

Segment 14 is a short segment, consisting of 0.9 miles of four-lane expressway in the historic area of Placerville. The historic area has small businesses centered on Main St. with some residential uses north and south of Main St.



Figure 17: Segment 15 Map



Figure 18: Segment 16 Map

Segment 15 concludes the CSMP corridor with 7.8 miles from Bedford Ave. to the Cedar Grove Exit, which is a four-lane freeway from Bedford Ave. to Smith Flat, and a four-lane expressway from Smith Flat to the Cedar Grove Exit. The segment includes retail and office commercial, primarily along Main St. and Broadway, and low density residential land uses. Significant trip attractors and operational considerations occur on a seasonal basis, such as Apple Hill during apple harvest, tree sales during the winter holidays and growing wine industry with associated tourism. EDCTC is currently conducting a study to examine travel impacts of tourism between the San Francisco Bay Area and the Tahoe Basin, from which operational management strategies will be identified.

Segment 16 consists of 6.0 miles and is a four-lane rural freeway that ends at the freeway-to-conventional highway transition east of Sly Park Rd. No capacity increases are envisioned during the 20-25 year to maintain the concept level of service, although major trip attractors include the community of Pollock Pines (via Sly Park Rd.) and Jenkinson Lake (Sly Park Lake), a recreational trip attractor.



Figure 19: Segment 17 Map



Figure 20: Segment 18 Map

Segment 17 is a 7.6 mile facility between east of Sly Park Rd. to Ice House Rd. that switches between conventional highway and expressway. For the first six lane miles, the facility is a three-lane conventional

ITEM 11.1.

highway. For the next 0.4 lane miles, the facility is a four-lane divided expressway, and the facility closes with 1.2 lane miles of two-lane conventional highway with a passing lane. A major attractor along this segment is the Crystal Basin Recreation Area. There are few other land uses that front this facility, so there are few planning conflicts.

Segment 18 is also in the rural environment in the Eldorado National Forest. This segment, which extends from Ice House Rd. to Echo Summit, is a 2-lane, conventional highway of 26.6 miles with six extents of passing lanes in both directions. A major attractor along this segment is Sierra at Tahoe ski resort. Caltrans conducts extensive snow removal operations along this segment during winter, with maintenance facilities including stations, sand houses and chaining areas at various locations.



Figure 21: Segment 19 Map



Figure 22: Segment 20 Map

Segment 19 is a two-lane conventional highway of 5.2 centerline miles. It descends from Echo Summit through the Eldorado National Forest to the SR 89 South junction, and extends through Meyers, an unincorporated community just to the south of South Lake Tahoe. There is an agricultural inspection facility on this segment in the town of Meyers. The Meyers Area Plan proposes intensifications of land use after final approval (to be determined), and increases in trip attraction may be anticipated.

Segment 20 consists of 4.8 miles of conventional highway through low-density residential development and past the Lake Tahoe Airport from the south junction with SR 89 to the north junction with SR 89. This segment begins as a two-lane facility with a two-way left turn lane passing through the unincorporated community of Meyers. At Pioneer Trail, it becomes a two-lane highway with narrow shoulders. Toward the end of the segment, the facility crosses into the City of South Lake Tahoe limits where it becomes four-lanes with a two-way left turn lane. Within the City of South Lake Tahoe, there are a wider variety of land uses, with a commercial strip forming most of the land uses. Numerous businesses have access within the city limits, where recent improvements included bicycle and pedestrian facilities along the highway.



Figure 23: Segment 21 Map

Segment 21 is a four-lane conventional urban arterial with a center turn lane that is 5.0 miles in length that passes through mixed land uses. The facility has sidewalks along some locations and Class II bicycle lanes throughout much of this segment. On this segment, the facility is the main street for South Lake Tahoe. As such, many of the largest commercial and public land uses front US 50 and have access on this conventional highway segment. South Tahoe Middle School, South Tahoe Police Department, numerous small businesses, resorts, and restaurants are located on this facility.

ITEM 11.1.

The System Characteristics for the Existing, 20-Year Build, and Ultimate Facility are summarized in Tables 5 and 6 on pages 22 and 23. The tables provide basic information about US 50 on each segment, including HOV characteristics, auxiliary lanes, and passing lanes. The existing facility identifies the highway under current conditions. The 20-Year Build Facility identifies the highway with improvements planned and programmed to be completed by the horizon year of 2035. The post 25-year Ultimate Facility is also listed to identify how the highway is envisioned for beyond the horizon year. The segments are determined based on logical termini including intersections, jurisdiction, changes in land use, and status of construction. All segment lengths are given in centerline miles.

TABLE 5: US 50 SYSTEM CHARACTERISTICS – EXISTING FACILITY								
Seg. #	Existing Facility ¹⁾							
	Facility Type	General Purpose Lanes	Lane Miles	Centerline Miles	HOV Lanes	HOV Characteristics	Auxiliary Lanes	Passing Lanes
1	F	8 / 6 / 8	23.645	3.156	--	--	--	--
2	F	8	39.664	4.958	--	--	--	--
3	F	8	22.88	2.86	--	--	59.90%	--
4	F	8	44.64	5.58	2	2+; Part-Time	6.40%	--
5	F	8	12.928	1.616	2	2+; Part-Time	--	--
6	F	6 / 4	24.558	4.51	2	2+; Part-Time	--	--
7	F	4	24.504	6.126	2	2+; Part-Time	--	--
8	F	4	3.56	0.89	2	2+; Part-Time	--	100%
9	F	4	9.36	2.34	2	2+; Part-Time	--	--
10	F	4	13.36	3.34	2	2+; Part-Time	--	--
11	F	4	7.96	1.99	--	--	--	--
12	F	4	26	6.50	--	--	4.62%	--
13	F	4	8.76	2.19	--	--	--	--
14	E	4	3.44	0.86	--	--	17.10%	--
15	F / E	4	31.344	7.836	--	--	0.50%	--
16	F	4	24.08	6.02	--	--	--	--
17	C / E / C	3 / 4 / 3	28.1	7.648	--	--	--	--
18	C	2	53.276	26.638	--	--	0.70%	15.70%
19	C	2	7.98	3.99	--	--	1.50%	--
20	C	3 / 2 / 5	11.46	4.83	--	--	--	--
21	C	5	19.96	4.99	--	--	--	--

¹⁾ F = Freeway, E = Expressway, C = Conventional; 3 and 5 lanes include 2-way left turn lane

ITEM 11.1.

TABLE 6: US 50 SYSTEM CHARACTERISTICS – 20-YEAR BUILD FACILITY

Seg. #	20-Year Build Facility ¹⁾								Ultimate Facility
	Facility Type	General Purpose Lanes	Lane Miles	Centerline Miles	HOV Lanes	HOV Characteristics	Auxiliary Lanes	Passing Lanes	
1	F	8	25.248	3.156	--		--	--	8F + 2HOV + Aux Lanes + ITS + ICM
2	F	8	39.664	4.958	2	2+; Part-Time	--	--	8F+2HOV+Aux Lanes + ITS + ICM
3	F	8	22.88	2.86	2	2+; Part-Time	--	--	8F + 2HOV + Aux Lanes + Transition + ITS + ICM
4	F	8	44.64	5.58	2	2+; Part-Time	6.40%	--	8F + 2HOV + Aux Lanes + ITS + ICM
5	F	8	12.928	1.616	2	2+; Part-Time	100.00%	--	8F + 2HOV + Aux Lanes + Transition + ITS + ICM
6	F	6 / 4	24.558	4.51	2	2+; Part-Time	100.00%	--	8F + 2HOV + ITS + ICM + Aux Lanes to Hazel Ave., 4F + 2HOV + ITS + ICM + Aux Lanes to Folsom
7	F	4	24.504	6.126	2	2+; Part-Time	73.29%	--	4F + 2HOV + Aux Lanes + ITS + ICM
8	F	4	3.56	0.89	2	2+; Part-Time	100.00%	10.50%	4F + 2HOV + Aux Lanes + ITS + ICM
9	F	4	9.36	2.34	2	2+; Part-Time	32.48%	--	4F + 2HOV + Aux Lanes + ICM
10	F	4	13.36	3.34	2	2+; Part-Time	100.00%	--	4F + 2HOV + Aux Lanes + ITS
11	F	4	7.96	1.99	--		100.00%	--	4F + 2HOV + Aux Lanes + ITS
12	F	4	26	6.50	--		0.50%	--	4F + 2HOV + Aux Lanes + ITS
13	F	4	8.76	2.19	--	--	6.30%	--	4F + Aux Lanes + ITS
14	E	4	3.44	0.86	--	--	17.10%	--	4E + Aux Lanes + ITS
15	F / E	4	31.344	7.836	--	--	0.50%	--	4F + Aux Lanes + ITS to Smith Flat, 4E + ITS to Camino
16	F	4	24.08	6.02	--	--	--	--	4F + ITS
17	C / E / C	3 / 4 / 3	28.1	7.648	--	--	--	--	3C + ITS, 2.0 mi; 4E + ITS, 5.3 mi; 3C + ITS, 0.3 mi
18	C	2	53.276	26.638	--	--	--	--	2C + ITS + ICM; 0.35 mi of 2-way left turn lane
19	C	2	7.98	3.99	--	--	--	--	2C + ITS + ICM + Bike Lanes
20	C	3 / 2 / 5	11.46	4.83	--	--	--	--	3C + ITS + ICM, 0.86; 2C + ITS + ICM, 3.64 mi; 5C + ITS + ICM, 0.61 mi
21	C	5	19.96	4.99	--	--	--	--	5C + ITS + ICM

¹⁾ F = Freeway, E = Expressway, C = Conventional; 3 and 5 lanes include 2-way left turn lane

²⁾ The number of lanes in the Concept Attainment column is for both directions required to achieve LOS E in Urban and LOS D in Rural areas along the corridor. It is meant to show the severity of future conditions and what it would take to achieve the Concept LOS. Caltrans is not suggesting that it is our plan to build the facility to achieve this LOS. We recognize the difficulty in achieving the desired LOS given the financial, environmental, right of way, and political constraints.

ITEM 11.1.

TRAFFIC OPERATIONS SYSTEM ELEMENTS

Caltrans District 3 seeks to optimize the transportation system. Two cost-effective methods include operational improvements and ITS improvements. Operational improvements include smaller-scale capital improvements that improve efficiency such as auxiliary lanes, express bus/carpool lanes, incident management, traffic demand management, and park and ride projects. ITS improvements can be categorized into four general classifications: driver information, monitoring, vehicle detection, and operations. These traffic operations system (TOS) elements, and transportation management facilities and services are discussed below by transportation mode.

Given the complexity of the corridor and its extensive geographic range, there are a wide variety of system management strategies and elements currently being implemented by jurisdictions and transportation service providers. Strategies and elements range from vehicle detection devices to traveler information systems to traffic flow control mechanisms. A common element among all the strategies and elements is data collection and analysis. Caltrans, SACOG, and local governments have partnered together on corridor performance data and system management in the Sacramento Transportation Area Network (STARNET).

The STARNET web application initial release took place in 2010. Features implemented so far include: Changeable Message Sign (CMS) display, speed data from Caltrans and Google, integration of Regional Transit and Yolo Transit to provide schedule and routing data, California Highway Patrol incident data, connectivity to the 511 systems (web and telephone), personalized traveler information with alerts based on time of day, lane closure data, Closed Circuit Television (CCTV) displays from Caltrans, City of Roseville and County of Sacramento. Near term initiatives include national weather service (NWS) alert data, increased transit data including real time location feed data from Yolo Transit and a City of Sacramento Police Computer Aided Design (CAD) feed. Web based applications include a commercial vehicle page, full feature website, low bandwidth page, mobile device page and under development applications for iPhone and Android smart phones. Caltrans Commercial Web Portal, City of Sacramento Traffic Operation Center (TOC), Sacramento County TOC, Roseville TOC, Elk Grove TOC and Citrus Heights TOC are contributing sources for the STARNET application. STARNET's associated management strategies can and will evolve as the application is implemented throughout the region and as additional features are added as development proceeds.

The SHS has an extensive set of system management strategies in operation. Some cities, counties, and transit operators also have robust system management elements and programs applied to their facilities or services. There are also specific instances of system management linkages among transportation modes and services at particular locations.

These strategies work as a system to gather, analyze, and disseminate information through the Caltrans Transportation Management Center (TMC). Information about collisions, other incidents, road closures, and emergency notifications are fed into this information hub and disseminated to public and private information users. The TMC operates 24 hours a day, seven days a week.

Caltrans is providing the latest in ITS technology to its urban freeways. As summarized in Table 7 and depicted in Figure 25 below, US 50 has had numerous ITS elements installed on the urbanized segments of the facility. Additional ITS elements are planned or programmed for the facility under a 20-Year Build scenario and under the Ultimate Facility Concept. These elements help improve travel times and overall facility performance.

Operational improvements and services utilized by Caltrans along the US 50 corridor are identified as follows:

Auxiliary lanes are used between interchange on- and off-ramps to improve weaving and merging movements to and from adjacent travel lanes. Auxiliary lanes give drivers more room to speed up and slow down when

ITEM 11.1.

getting on or off a freeway. An auxiliary lane makes it easier for drivers to merge into freeway traffic, and reduces ramp congestion.

Transition lanes are similar to auxiliary lanes in function, but facilitate merging transitions for traffic over the distance of two or more interchanges. By functioning as "on-system frontage," transition lanes provide broader service for merging traffic and therefore alleviate bottleneck conditions and enhance travel lane throughput along freeway segments spread out over two or more interchanges. A graphic depiction of auxiliary and transition lanes are shown in Figure 24.

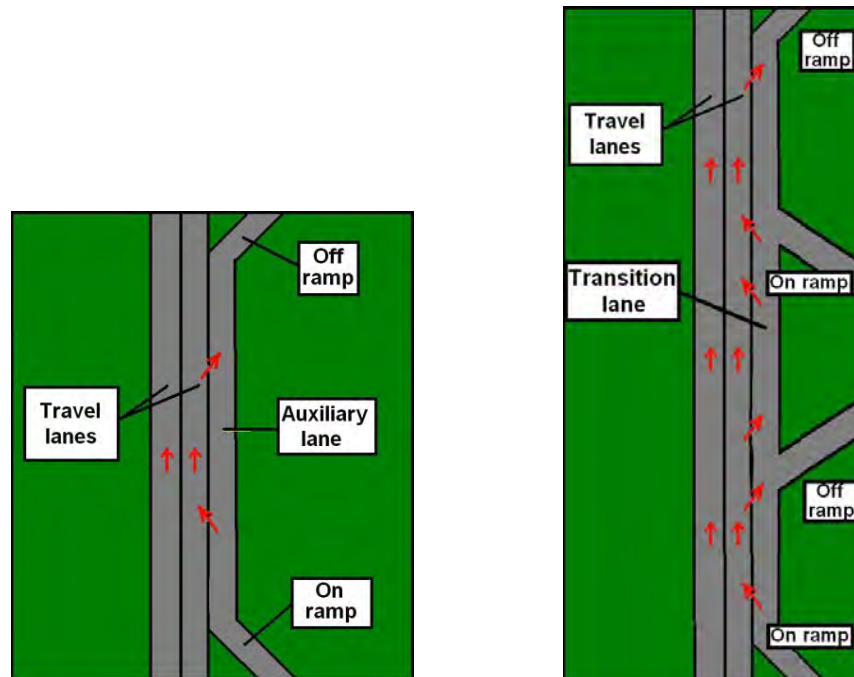


Figure 24: Auxiliary and Transition Lanes

Express Bus/Carpool Lanes sometimes referred to as HOV lanes are lanes for the exclusive use of vehicles carrying two or more occupants during the posted times dedicated to their use and can provide a travel time advantage to people who use the lanes. Express bus/carpool lanes stretch from Watt Ave. in Sacramento County to Cameron Park Dr. in El Dorado County.

Park-and-Ride Lots provide a place for commuters to park their cars and meet carpools, vanpools and buses. Some park and ride lots also provide bike lockers. A listing of lots is identified on Table 9 and shown in Figure 23 below.

Transportation Management Plans (TMP) are required by Caltrans Deputy Directive DD-60-R1 for “all construction, maintenance, and encroachment permit activities on the State Highway System”. All projects must be TMP Certified prior to being designated as “Ready to List”. TMPs detail how a construction project will be implemented so that its impact to existing travel is minimized or mitigated.

Transportation Demand Management services include Transportation Management Associations (TMAs), employer subsidized transit passes and vanpools, the *511 Traveler Information Service*, carpool ride matching, the *Guaranteed Ride Home* program, and vanpool services. The overall intent is to reduce the number of vehicle trips using highways and roads. Many of these services are financially supported by or directly provided by EDCTC and SACOG. Area employers and office complex owners are also key supporters and funders of TDM programs at their work sites. A listing of TMAs is provided in the Stakeholders Acknowledgement section. Additional TMA information including a list of contacts can be found at: <http://www.sacregion511.org/rideshare/tma.html>.

ITEM 11.1.

Incident Management is an essential component of highway operations. Timely response to incidents reduces the amount of time lanes are blocked and speeds emergency response. A popular aspect of this program is the *Freeway Service Patrol*, which assists motorists whose vehicles break down along the highway due to flat tires, out of gas, or mechanical failure.

Traveler Information services for the corridor include web sites, which are hosted by Caltrans, the California Highway Patrol (CHP), the U.S. Weather Service, and a private company. Caltrans provides real-time data feeds to commercial/media information services, such as radio and TV stations, to help inform travelers of highway and traffic conditions. Among these is the Caltrans QuickMap web page, which can be found at the following URL: <http://www.dot.ca.gov/ca511/trafficMapFaq.html>.

TABLE 7: EXISTING US 50 ITS ELEMENTS											
Seg. #	Cnty	PM	ITS Elements ¹								
			CCTV	CMS	EMS	ETR	HAR	RMS	RWIS	TMS	Grand Total
1	YOL	0.00 - 3.16	2	-	-	-	-	3	-	3	8
2	SAC	L0.00 - L2.48/R0.00	5	2	-	-	-	4	-	4	15
3		R0.00 - R5.34	5	2	1	-	-	11	-	8	27
4		R5.34 - R10.92	3	-	1	-	1	7	-	7	19
5		R10.92 - 12.50	1	-	1	-	-	3	-	1	6
6		12.50 - 17.01	2	-	-	-	-	6	-	4	12
7		17.01 - 23.14	1	1	-	-	-	8	-	6	16
8	ELD	0.00 – 0.86	-	1	-	-	-	1	-	1	3
9		0.86 - R3.23	-	-	-	-	-	-	-	2	2
10		R3.23-6.57	-	-	-	-	-	-	-	2	2
11		6.57 – R8.56	-	-	-	-	-	-	-	3	9
12		R8.56 – R15.06	-	-	-	-	-	2	-	4	6
13		R15.06 - 17.25	-	-	1	-	-	-	-	1	2
14		17.25 - 18.11	1	-	-	-	1	-	-	-	2
15		18.11 - R25.95	-	1	2	-	-	-	-	-	3
16		R25.95/31.97	-	1	1	-	1	-	-	-	3
17		R31.97/39.77	-	-	-	-	-	-	-	-	0
18		39.77/66.63	-	1	1	-	1	-	-	-	3
19		66.63/70.62	2	1	-	2	1	-	1	1	8
20		70.62/75.45	-	-	2	2	-	-	-	3	7
21		70.62/80.44	2	2	1	2	1	-	-	3	11
TOTAL			24	12	11	6	6	44	1	53	158

¹ CCTV = Closed Circuit Television, CMS = Changeable Message Sign, EMS = Extinguishable Message Sign, ETR = Electronic Tag Reader, HAR = Highway Advisory Radio, RMS = Ramp Metering Stations, RWIS = Road Weather Information System, TMS = Traffic Management Systems. ITS Elements Inventoried April 2013

ITEM 11.1.

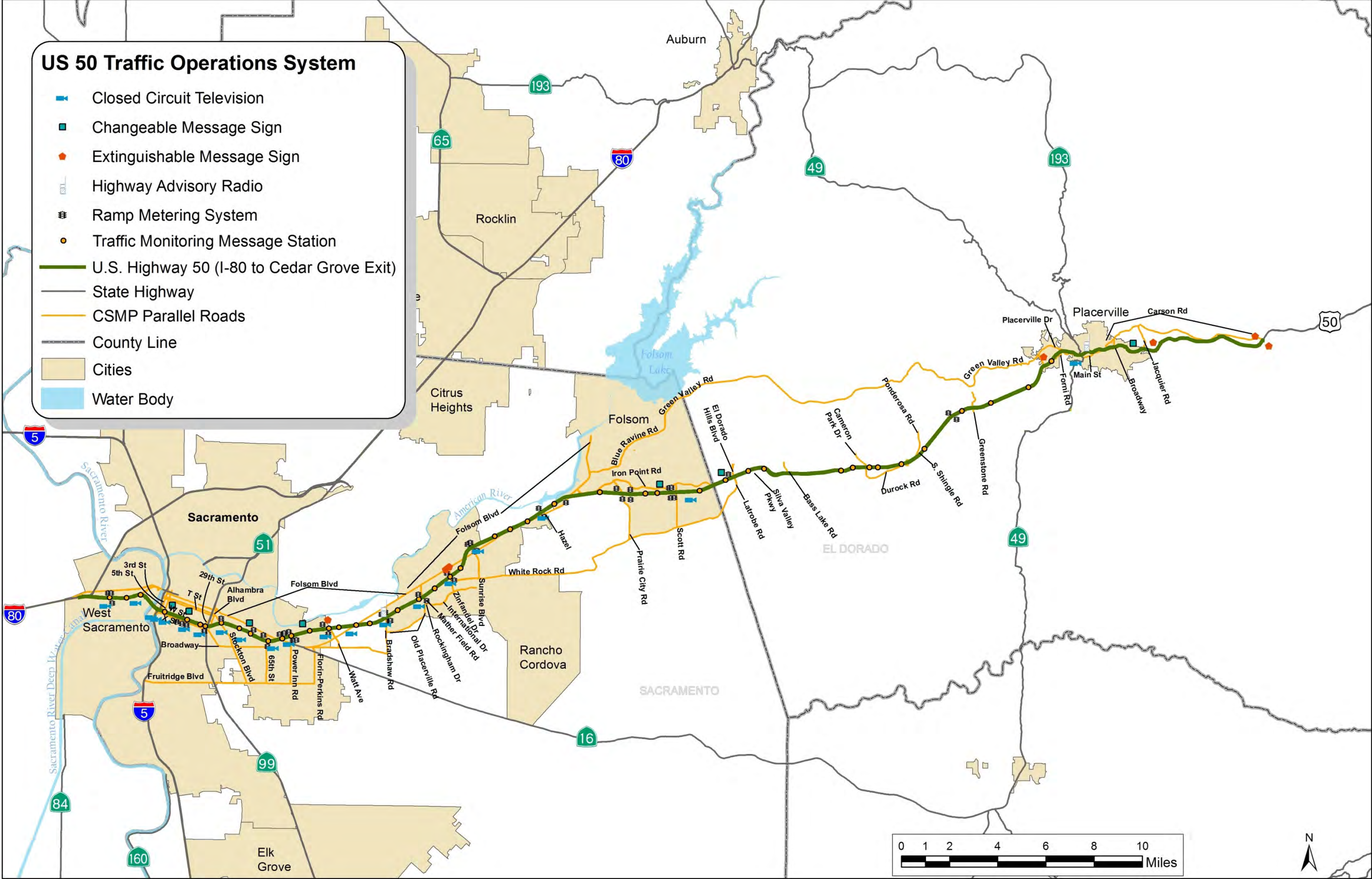


Figure 25: US 50 Traffic Operations System Map

ITEM 11.1.

PARALLEL AND CONNECTING ROADWAYS

Working with local agencies, Caltrans District 3 has identified several roads parallel to and connecting to US 50 in the CSMP portions of the facility, which are identified in Table 8 below and shown in Figure 2 on page 11 above. Together with transit and bicycle/pedestrian paths, the corridor functions as a whole to provide optimal system performance. It accomplishes this principally by offering alternatives to transportation along US 50 during times of peak commute or during an incident. Compared to 2009, the network of parallel and connecting roadways was expanded to include more roadways, creating a more complete system of urban streets. Major parallel and connecting roadways on the corridor are West Capitol Ave., Broadway, Stockton Blvd., Folsom Blvd., White Rock Rd., Sunrise Blvd., Iron Point Rd., Green Valley Rd., Cameron Park Dr., Mother Lode Dr., Placerville Dr., Broadway (in Placerville), and Main St.

A number of ITS elements utilized within the CSMP segments along the parallel and connecting roadways are as follows:

City of West Sacramento has one CCTV located on West Capitol Av. between Enterprise Blvd. and Capitol Mall.

City of Sacramento operates a TOC. Sensors in the street detect the passage of vehicles, vehicle speed, and the level of congestion. This information is received on a second-by-second (real-time) basis and is analyzed at the TOC.

Sacramento County also operates a TOC by gathering information through CCTV cameras, CMS, HAR, and a Fiber Optics (FO) network placed along major traffic corridors throughout the county.

City of Rancho Cordova installed CCTV cameras and a FO network on Folsom Blvd. in 2009. Currently, one CCTV exists on Sunrise Blvd. between US 50 and Folsom Blvd. Most major traffic corridors are on the network. The City contracts with the County of Sacramento to operate their systems through the County's TOC.

City of Folsom recently completed installing a FO system on all of the City's major corridors. Currently, the sole intersection that is monitored via camera is located on Iron Point Rd. and East Bidwell.

El Dorado County has three coordinated signals along Francisco Dr., at Green Valley Rd., the Market Place entrance (east side Safeway Center/west side Lake Forest Plaza), and Village Center Dr.

City of Placerville utilizes traditional control devices that includes traffic signals and stop signs. In addition, there is a CCTV at the intersection of US 50 and SR 49 (Spring St.).

ITEM 11.1.

TABLE 8: US 50 CSMP PARALLEL ROADWAY NETWORK							
Seg. #	Location		US 50		Parallel and Connector Roads		
	County	City	From	To	Roadway	From	To
1	YOL	West Sacramento	Interstate 80	YOL/ SAC County Line	West Capitol Ave.	Enterprise Blvd.	Capitol Mall
2	SAC	Sacramento	YOL/ SAC County Line	State Routes 99 and 51	W St.	5th St.	29th St.
					X St.	3rd St.	Alhambra Blvd.
					29th St.	W St.	T St.
					T St.	29th St.	Alhambra Blvd.
3			State Routes 99 and 51	Watt Ave.	Alhambra Blvd.	X St.	Folsom Blvd.
					Folsom Blvd.	Alhambra Blvd.	Watt Ave.
					Stockton Blvd.	Alhambra Blvd.	Fruitridge Rd.
					Broadway	5th St.	Alhambra Blvd.
					Broadway	Stockton Blvd.	65th St
					Fruitridge Rd./Seamas Ave	I-5	Florin Perkins Rd.
					65th St.	Fruitridge Rd.	US 50
					Power Inn Rd.	Fruitridge Rd.	US 50
Florin Perkins Rd.			Fruitridge Rd.	Folsom Blvd.			
4	SAC	Unincorp.	Watt Ave.	Zinfandel Dr.	Watt Ave.	Folsom Blvd.	US 50
		Rancho Cordova			Folsom Blvd.	Watt Ave.	Bradshaw Rd.
					Folsom Blvd.	Bradshaw Rd.	Sunrise Blvd.
					Bradshaw Rd.	Folsom Blvd.	Old Placerville Rd.
					Old Placerville Rd.	Bradshaw Rd.	Rockingham Dr.
					Rockingham Dr.	Old Placerville Rd.	Mather Field Rd.
					Mather Field Rd.	Rockingham Dr.	Folsom Blvd.
					International Dr.	Rockingham Dr.	Zinfandel Dr.
					Zinfandel Dr.	International Dr.	Folsom Blvd
5	SAC	Rancho Cordova	Zinfandel Dr.	Sunrise Blvd.	White Rock Rd.	Zinfandel Dr.	Sunrise Blvd
					Sunrise Blvd.	US 50	White Rock Rd.
					White Rock Rd.	Sunrise Blvd.	Rancho Cordova City limits
6	SAC	Rancho Cordova	Sunrise Blvd.	Folsom Blvd.	Folsom Blvd.	Sunrise Blvd.	Hazel Ave.
	SAC	Unincorp.	Sunrise Blvd.	Folsom Blvd.	White Rock Rd.	R. Cordova City limits	Prairie City
					Folsom Blvd.	Hazel Ave.	Iron Point Rd.
					Blue Ravine Rd.	Folsom Blvd.	Green Valley Rd.
					Prairie City Rd.	Iron Point Rd.	White Rock Rd.

ITEM 11.1.

TABLE 8: US 50 CSMP PARALLEL ROADWAY NETWORK

Seg. #	Location		US 50		Parallel and Connector Roads		
	County	City	From	To	Roadway	From	To
7	SAC	Folsom	Folsom Blvd.	Sacramento/ El Dorado County Line	Iron Point Rd.	Folsom Blvd.	Empire Ranch Rd.
					Folsom Blvd.	Iron Point Rd.	Blue Ravine Rd.
					Blue Ravine Rd.	Folsom Blvd.	Green Valley Rd.
					Prairie City Rd.	Iron Point Rd.	White Rock Rd.
					E. Bidwell/Scott Rd.	Iron Point Rd.	White Rock Rd.
		Unincorp.			White Rock Rd.	Grant Line Rd.	SAC/ELD Cty. Line
8	ELD	Unincorp.	Sacramento/ El Dorado County Line	El Dorado Hills Blvd.(Latrobe)	Green Valley Rd.	Blue Ravine Rd.	Cameron Park Dr.
					White Rock Rd.	SAC/ELD Cty. Line	Latrobe Rd.
					Latrobe Rd.	White Rock Rd.	US 50
					White Rock Rd.	Latrobe Rd.	Silva Valley Pkwy.
					Silva Valley Pkwy.	White Rock Rd.	Serrano Parkway
9	ELD	Unincorp.	Latrobe Road	Bass Lake Rd	Green Valley Rd.	Francisco Dr.	Deer Valley Rd.
					White Rock Rd.	Latrobe Rd.	Silva Valley Pkwy.
					Silva Valley Pkwy.	White Rock Rd.	Serrano Pkwy.
10	ELD	Unincorp.	Bass Lake Rd	Cameron Park Dr	Green Valley Rd.	Deer Valley Rd.	Cameron Park Dr.
					Cameron Park Dr.	Durock Rd.	US 50
11	ELD	Unincorp.	Cameron Park Dr.	So. Shingle Rd. (Ponderosa Rd)	Green Valley Rd.	Cameron Park Dr.	Ponderosa Rd.
					Durock Rd.	Cameron Park Dr.	South Shingle Rd.
12	ELD	Unincorp.	Ponderosa Rd.	Missouri Flat Rd.	Green Valley Rd.	Ponderosa Rd.	Missouri Flat Rd.
					South Shingle Rd.	Durock Rd.	US 50
					Mother Lode Dr.	South Shingle Rd.	Missouri Flat Rd.
13	ELD	Unincorp.	Missouri Flat Rd.	End of Freeway, Placerville	Green Valley Rd.	Missouri Flat Rd.	Placerville Dr.
					Forni Rd.	Placerville Dr.	Main St.
					Placerville Dr.	Forni Rd.	US 50
14	ELD	Placerville	End of Fwy., Placerville	Bedford Ave., fwy. start.	Main St.	Placerville Dr.	Bedford Ave.
15	ELD	Placerville	Bedford Ave., start of Fwy.	Cedar Grove Exit	Main St.	Bedford Ave.	Broadway
					Broadway	Main St.	Point View Dr.
					Jacquier Rd.	Point View Dr.	Carson Rd.
					Carson Rd.	Main St./ Broadway	US 50 at Cedar Grove Exit

ITEM 11.1.

TRANSIT AND RIDESHARE FACILITIES

Transit and rideshare services within the US 50 corridor are identified on Table 9 and delineated on the CSMP segments of this Plan in Figure 26 below. They are important alternatives to automobile travel that frees roadway capacity. In the urban segments of US 50, transit services are provided by Sacramento Regional Transit (SacRT), Yolo Bus, Folsom Stage Line, El Dorado Transit, and Amtrak. Yolo Bus offers services between West Sacramento in both traditional and commuter bus options. SacRT provides traditional bus service and light rail service on the Gold Line. Folsom Stage Line has traditional bus services to major points of interest in Folsom, and El Dorado Transit makes both Sacramento commuter and traditional bus services available in western El Dorado County. Folsom Stage Line provides service to the three light rail stations at the end of the Gold Line extension.

In addition to the bus and rail services within metropolitan Sacramento, there are intercity transit services available. Amtrak California offers intrastate rail connections within California on either the Capitol Corridor or the San Joaquin lines. There are also numerous connections through the train service with the Amtrak connector bus, Amtrak Thruway. These Amtrak buses have several destinations in California and Nevada that are not on the Amtrak California rail service lines, such as Yuba City, South Lake Tahoe, and Reno. In addition, interstate Amtrak services connect the US 50 corridor to Oregon and Washington on the Coast Starlight line and to the eastern United States on the California Zephyr line.

In the rural segments of US 50, transit services are limited. Available transit services are focused on the developed areas of the corridor. Camino and Pollock Pines have limited El Dorado Transit bus service from the center of Pollock Pines near the main grocery store to the Missouri Flat Transfer Center near Placerville. Tahoe Transportation District (TTD) also offers transit service through BlueGo. The main line for South Lake Tahoe runs from the SR 89 North junction to east of the state line. With one-hour headways, both transit systems are basic services and are not a viable alternative to automobile travel for many people. Funds are being sought to maintain and possibly expand transit service in the Lake Tahoe Basin.



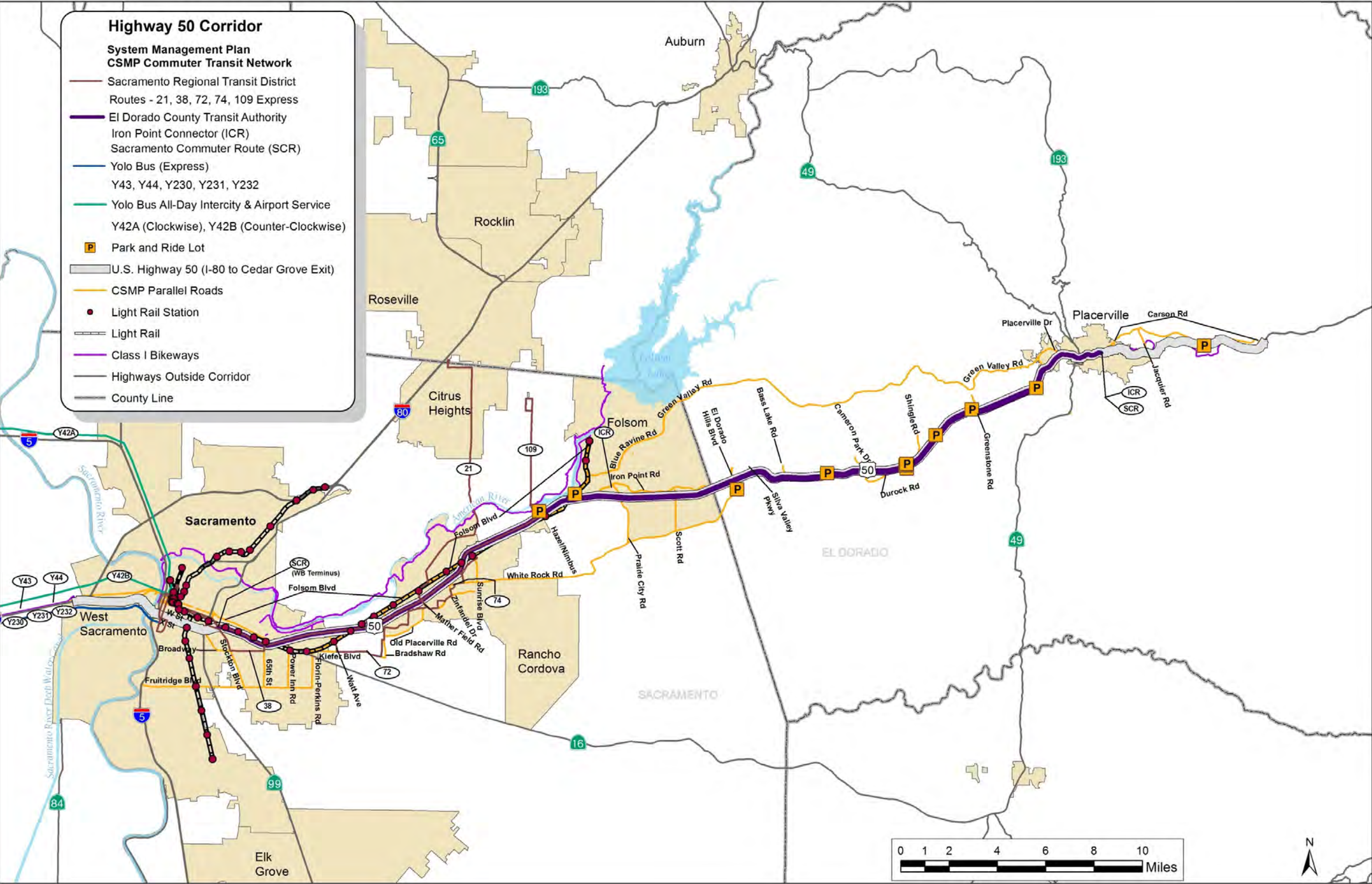


Figure 26: US 50 CSMP Network Transit Routes

ITEM 11.1.

Rideshare and park and ride facilities form a vital linkage in the transit system, allowing travelers to take transit when walking distances would otherwise limit its practicality. Park and ride lots can be operated by several different agencies, such as SacRT or local agencies. Caltrans has partnered with several local agencies to provide park and ride lots. These facilities are included in Table 9 below. Several of these lots also offer bicycle facilities such as lockers or stands. Additional Park and Ride lots information including specific location, capacity, and occupancy rates can be found at <http://www.dot.ca.gov/dist3/departments/planning/systemplanningPR.htm>.



ITEM 11.1.

TABLE 9: US 50 CORRIDOR TRANSIT SYSTEM				
Seg. #	Mode & Collateral Facility	Name	Route End Points	Headway
1	Traditional Bus	Yolo Bus	Downtown Sacramento; Davis; Woodland	Long
	Commuter Bus	Yolo Bus	Downtown Sacramento; Davis; Woodland	Long
	Amtrak Bus	Amtrak California	Major Cities in California	Long
	Amtrak Rail	Capital Corridor	Sacramento, Bay Area, Reno	Long
2	Traditional Bus	Sacramento Regional Transit (SacRT) and Yolo Bus	West Sacramento; Sacramento; Rancho Cordova	Short
	Commuter Bus	Yolo Bus	Yolo County; Folsom; El Dorado County;	Long
	Light Rail	SacRT Gold Line	Sacramento, Rancho Cordova, Folsom	Short
	Amtrak Bus	Amtrak California	Major Cities in California	Long
	Amtrak Rail	Capital Corridor	Sacramento, Bay Area, Reno	Long
3-6	Traditional Bus	Sacramento Regional Transit (SacRT)	Sacramento; Rancho Cordova; Fair Oaks	Short
	Commuter Bus	El Dorado County Transit Authority	Placerville, El Dorado Hills, Downtown Sacramento	Long
	Light Rail	SacRT Gold Line	Sacramento, Rancho Cordova, Folsom	Short
	Amtrak Bus	Amtrak California	Major Cities in California	Long
6	Park and Ride Lot	Hazel Park & Ride		
7	Traditional Bus	Folsom Stage Line	Places of Interest in Folsom	Short
	Traditional Bus	El Dorado County Transit Authority - Iron Point Connector	Placerville, Shingle Springs, Cameron Park, El Dorado Hills, Folsom	Long
	Light Rail	SacRT Gold Line	Sacramento, Rancho Cordova, Folsom	Short
	Park and Ride Lot	Folsom Iron Point Park & Ride		
8	Park and Ride Lot	El Dorado Hills Park & Ride		
		Cambridge Dr Park & Ride		
12	Park and Ride Lot	Ponderosa East and West Park & Ride Lots		
		Durock Park & Ride		
		Greenstone Park & Ride		
		Shingle Springs Park & Ride		
		Missouri Flat Park & Ride		

ITEM 11.1.

TABLE 9: US 50 CORRIDOR TRANSIT SYSTEM				
Seg. #	Mode & Collateral Facility	Name	Route End Points	Headway
8-15	Traditional Bus	El Dorado County Transit Authority	Cameron Park, Shingle Springs, Placerville	Short
	Traditional Bus	El Dorado County Transit Authority - Iron Point Connector	Placerville, Shingle Springs, Cameron Park, El Dorado Hills, Folsom	Long
	Commuter Bus	El Dorado County Transit Authority	Placerville, El Dorado Hills, Downtown Sacramento	Long
	Amtrak Bus	Amtrak California	Major Cities in California	Long
	Transit Station	Placerville Transit Station at Mosquito Rd.		
15	Park and Ride Lot	Camino Heights Park & Ride		
13-16	Traditional Bus	El Dorado County Transit Authority	Missouri Flat to Pollock Pines	Long
17-20	None			
21	Traditional Bus	BlueGo Bus Service	Jct. SR 89 North to State of Nevada	Long

A number of ITS elements utilized by Transit agencies along the corridor are as follows:

Yolo County Transit District (YCTD) uses a Global Positioning System (GPS) for locating buses in route, referred to as an Automatic Vehicle Location (AVL) system. The AVL System allows users to see where their bus is located within the last minute.

El Dorado County Transit Authority utilizes the GPS Zonar System for pre-trip inspections, maintenance, and real-time vehicle tracking.

Sacramento Regional Transit District (SacRT) has installed pre-emptive traffic signals at at-grade intersections along the Light Rail routes. SacRT has a GPS; however, it is only utilized for analysis purposes.

Computer-aided dispatch and Bus Rapid Transit are in the planning stages. In addition, SacRT has an online Trip Planning application to assist transit users. During special events such as the California State Fair, the Jazz Festival, the holiday seasons, and the Mather Field Air Show, SacRT operates additional service to connect events to light rail stations and offers free service to promote transit use during select events. The transit routes identified in the CSMP network are shown in Figure 5.

The Sacramento Valley Station in downtown Sacramento is the 7th busiest station in the national Amtrak system and serves as a multi-modal transfer facility. There are over 1.1 million passenger trips annually. Passengers can make connections with numerous local bus services as well as the SacRT light rail system.

Sacramento County installed pre-emptive traffic signals to give preferential signal timing to transit buses at selected locations that serve high priority transit corridors.

SACOG manages the 511 and rideshare programs that cost approximately \$1 million per year, region-wide, to foster carpooling, transit ridership, vanpooling, and bicycling in all areas and corridors. The Regional Rideshare Program covers Placer, El Dorado, Sacramento, Yolo, Yuba, and Sutter counties. It is part of a statewide network of rideshare agencies that encourage alternative transportation modes for traveling.

ITEM 11.1.

BICYCLE FACILITIES

Bicycling constitutes an active transportation alternative to automobile use that can help reduce congestion and improve corridor performance. Bicycle facilities, particularly on parallel roads, are important to encourage bicycling. These bicycle facilities are located on both local parallel roads and on dedicated pathways, such as the American River Parkway Trail. Table 10 below gives details about the bicycle facilities in the corridor. Figures 27 and 28 show the bicycle routes included in the CSMP segments of this plan.

Bicycles are prohibited on the freeway portion of US 50, but are generally permitted on the conventional highway portion. Bicyclists are expected to use an alternate parallel bicycle facility where US 50 prohibits it. Bicyclists can ride on US 50 where not prohibited. While bikeway expansion on US 50 would improve bicycling on the facility, the environmental constraints, the high cost, and low bicycle ridership currently prohibit construction of bicycle facilities in the rural sections of US 50, particularly through the Eldorado National Forest. In the developed portions of the facility there are several opportunities for collaboration with local agencies to construct the bicycle facilities appropriate to the context.

Caltrans District 3 recently completed the *State Highway Bicycle Facility Plan* (SHBFP). This plan establishes policies for bicycle planning across a variety of areas, such as maintenance, operations, planning, and project management. Further, the plan includes a table and maps with recommended improvements to the bicycle transportation system, such as Class II bike lanes and Class III bike routes. These improvements are to be incorporated as funds allow or the highway segment is improved.

Several policy recommendations were made as to what types of bicycle facilities would be constructed on the SHS. Priority is to be given to ensuring consistency with local bicycle plans, unless the local proposal is inappropriate to the context of the roadway. Bicycle facilities are generally not appropriate in areas with limited access and high vehicular speeds. In particular, urban freeways are not appropriate for bicycle facilities. In these cases, Caltrans consults with local governments to identify alternative routes to segments closed to bicycles. Further, Class II bicycle lanes are appropriate on the SHS passing through town centers and in developed areas where no local routes exist. Class III bicycle routes on the SHS may be appropriate for town centers, developed areas, and some rural locations.

The SHBFP established several District actions that help achieve the plan's vision. These actions by various District 3 divisions are intended to further coordination among divisions. These actions include several measures such as communication between divisions and maintenance agreements with local governments regarding bicycle facility planning. The SHBFP can be viewed at http://www.dot.ca.gov/dist3/departments/planning/bike/D3SHBFP_June2013.pdf.

As part of the Environmental Improvement Program (EIP) for Lake Tahoe, Caltrans has constructed 2.25 miles of bikeways on the state highways near the lake and has plans for nine more miles, six of which are on US 50. These bikeways form part of the bicycling network, which is intended to provide travel around Lake Tahoe. The plans now call for Class II bike lanes from Meyers to the State Line. Currently, there are bike lanes from Trout Creek to Wildwood. The rest of the bike lanes are slated to be constructed by 2020.

ITEM 11.1.



Bicycle facilities in the corridor are not actively managed in the same manner as motor vehicle facilities. However, there are traffic operation systems that serve bicyclists such as dedicated bicycle lanes, bicycle detection loops at signalized intersections, video detection, other non-loop type detection, and bicyclist-activated signal change buttons. The City of Sacramento is installing video detection at some locations.

SacRT buses and the new light rail trains are equipped with bicycle racks. There are over 150 weatherproof bicycle lockers at 19 light rail stations. YCTD has the Bikes on Buses Program that allows bicycles to travel on any YOLOBUS.

The Sacramento Area Bicycle Advocates maintain an on-line hazard reporting system to allow users to report hazardous locations for bicyclist such as potholes, inadequate signal timing, hazardous railroad crossings, insufficient shoulder, and inadequate bikeway markings. The reports are then sent to the applicable jurisdiction. SACOG is creating an on-line route planning system for bicyclists. In addition, SACOG maintains bicycle maps on their website, which are currently being updated. These maps are included in the *SACOG Bicycle, Pedestrian, and Trails Master Plan*, which can be found at

http://www.sacog.org/bikeinfo/download_bike_ped_trails_mp.cfm.

SACOG has also created an on-line route planning system for bicyclists, which can be found at <http://www.sacregion511.org/bicycling/trips/>.

ITEM 11.1.

TABLE 10: US 50 BICYCLE TRANSPORTATION NETWORK

Seg. #	County & City Location	Bicycle Access Prohibited	Bicycle Facility Type ¹	Parallel Bike Routes					
				Route	From	To	Facility Type		
1	YOL, West Sacramento	Yes	Alt. Route	West Capitol Ave.	Yolo Causeway	Tower Bridge	Class II		
2	SAC, Sacramento	Yes	Alt. Route	Tower Bridge	W. Capitol Ave.	Capitol Mall	C. I		
2/3				Capitol Mall	Tower Bridge	3rd/5th Sts.	None		
				3rd/5th Sts.	Capitol Mall	T St.	None		
3				T St.	3rd/5th Sts.	65th St.	C. II		
				65th St.	T St.	4th Ave.	None		
				4th Ave.	65th St.	Redding Ave.	None		
				Redding Ave.	4th Ave.	Folsom Blvd.	C. II		
				Folsom Blvd.	Redding Ave.	State Univ. Dr. East	C. II		
				State Univ. Dr. E.	Folsom Blvd.	Guy West Bridge	None		
				Guy West Bridge	State University Dr. East	Am. Riv. Pkwy. Bike Tr.	C. I		
				Alhambra Blvd.	2nd Ave.	Folsom Blvd.	C. II		
				Folsom Blvd.	Alhambra Blvd.	Watt Ave.	C. II		
				2nd Ave.	Riverside Blvd.	34th St.	C. II		
				Riverside/11th St.	T St.	2nd Ave.	C. II		
				18th/21st/34th Sts.	T St.	2nd Ave.	C. II		
				American River Parkway Bike Trail/Jedediah Smith Memorial Trail					
SAC, Unincorp.				Yes	Alt. Route	La Riviera Dr./ College Town Dr.	Folsom Blvd.	State University Dr. East	C. II
3/4	SAC, Rancho Cordova	Yes	Alt. Route	Watt Ave. Trail	Am. Riv. Bike Tr.	La Riviera Dr.	C. I		
4		Yes	Alt. Route	Folsom Blvd.	Watt Ave.	Bradshaw Rd.	C. III/None		
4-7				Folsom Blvd.	Bradshaw Rd.	Iron Point Rd.	C. II		
5				Folsom S. Canal Tr.	S. of Kiefer Blvd.	Am. Riv. Bike Tr.	C. I		
				American River Parkway Bike Trail/Jedediah Smith Memorial Trail					
5/6	SAC, Unincorp.	Yes	Alt. Route	Sunrise Blvd. Trail	Am. Riv. Bike Tr.	Folsom Blvd.	None		
6				Hazel Ave. Trail	Am. Riv. Bike Tr.	Folsom Blvd.	C. II		
	SAC, Folsom	Yes	Alt. Route	American River Parkway Bike Trail/Jedediah Smith Memorial Trail				C. I	
7	SAC, Folsom	Yes	Alt. Route	Iron Point Rd.	Folsom Blvd.	Empire Ranch Rd.	C. II		
				Blue Ravine Rd.	Folsom Blvd.	Green Valley Rd.	C. II		
				Humbug-Willow Creek Tr.	Folsom-Auburn Rd.	Natoma St.	C. I		
				Natoma St.	H.-W. Creek Trail	Green Valley Rd.	C. II		
10	ELD, Unincorp.	Yes	Alt. Route	Green Valley Rd.	SAC/ELD County Line	Cameron Park Dr.	C. II/None		
12/13				Green Valley Rd.	Cameron Park Dr.	Placerville Dr.	None		
13	ELD, Unincorp.	Yes	Alt. Route	Ray Lawyer Dr.	Placerville Dr.	Forni Rd.	C. II		
				Placerville Dr.	Ray Lawyer Dr.	Forni Rd.	C. II		
				ED Bike Trail	Ray Lawyer Dr.	Main St.	C. I		

ITEM 11.1.

TABLE 10: US 50 BICYCLE TRANSPORTATION NETWORK

Seg. #	County & City Location	Bicycle Access Prohibited	Bicycle Facility Type ¹	Parallel Bike Routes			
				Route	From	To	Facility Type
13 / 14	ELD, Unincorp.	Yes	Alt. Route	Main St.	Forni Rd.	Bedford Ave.	C. I/II/III
13				ED Bike Trail	Missouri Flat Rd.	Forni Rd.	C. I
12	ELD, Placerville	Yes/No	Alt. Route/Non - Designated	ED Bike Trail	Bedford Ave.	Clay St.	C. I
		No	Non-Designated	ED Bike Trail	Clay St.	Los Trampas Rd.	C. I
13	ELD, Unincorp.	Yes	Alt. Route	None	Cedar Grove Exit	Sly Park Undercrossing	None
		No	Non-Designated	None	Sly Park Undercrossing	0.67 mi east of Sly Park Rd	None
17	ELD	No	Non-Designated	None	East of Sly Park Rd	Ice House Rd	None
18					Ice House Rd	Echo Summit	None
19					Echo Summit	SR 89 South/Luther Pass Rd	None
20	ELD, South Lake Tahoe	No	Non-Designated	Pioneer Trail	SR 89/Luther Pass Rd	SR 89/Lake Tahoe Blvd	C. II
21			Non-Designated	Pioneer Trail	SR 89/Lake Tahoe Blvd	East End Trout Creek Bridge	C. II
			Class II		East End Trout Creek Bridge	Ski Run Blvd	C. II
			Non-Designated		Ski Run Blvd	State Line	C. II

¹ Bicycle Facility Type indicates the type of bicycle facility on that segment. Class I Bike paths are separate ROWs for bicycles and pedestrians. Class II bike lanes are separate lanes for bicyclists. Class III Bike routes are roadways with signs designating the roadway for shared bicycle use. Alternate route indicates that a designated local road is to be used when the facility is closed to bicyclists. Finally, non-designated means that while the facility is not prohibited to bicyclists, there is no designated bicycle facility on the corridor.

ITEM 11.1.

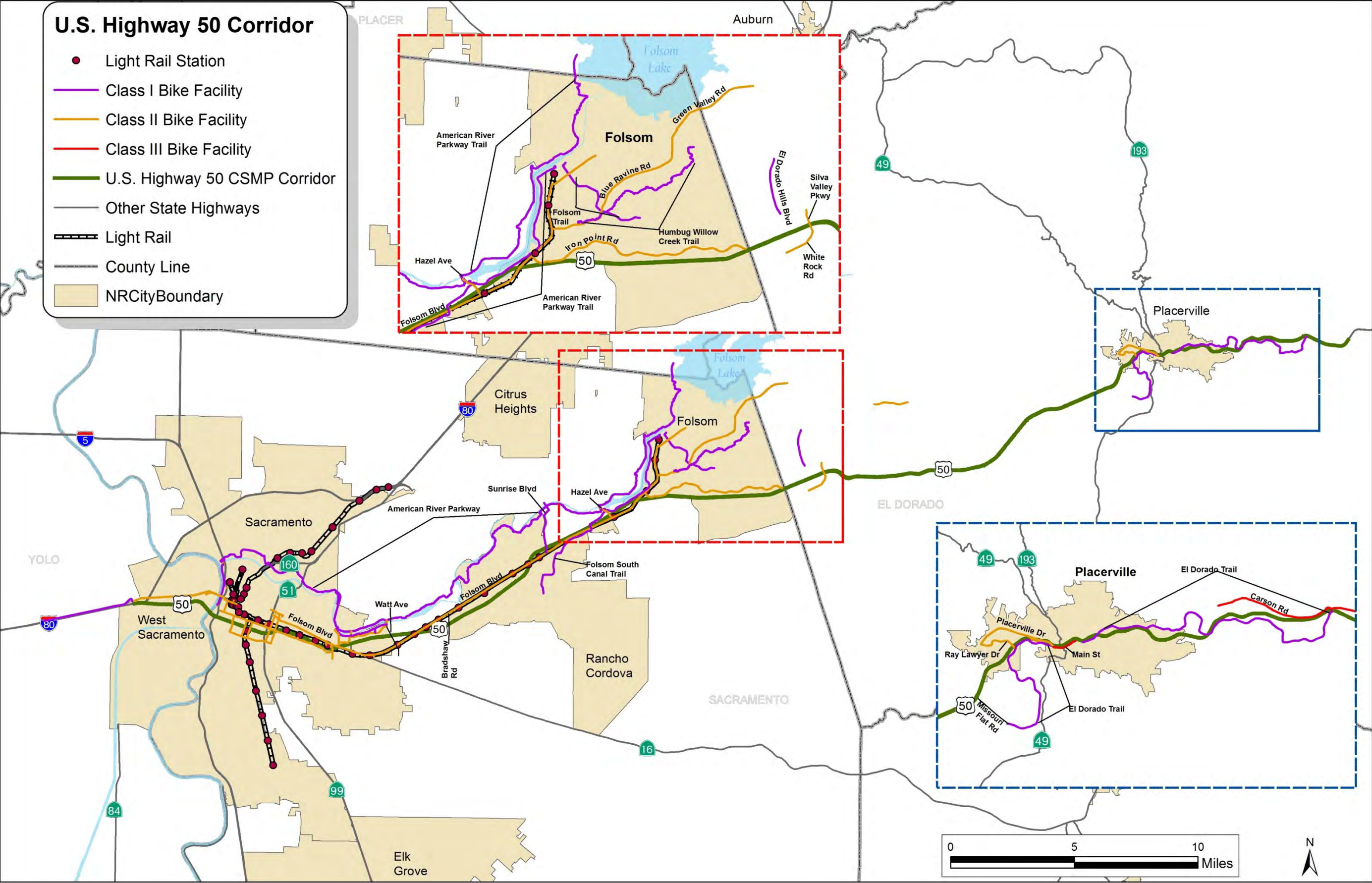


Figure 27: US 50 Corridor Bicycle Facilities Map

ITEM 11.1.

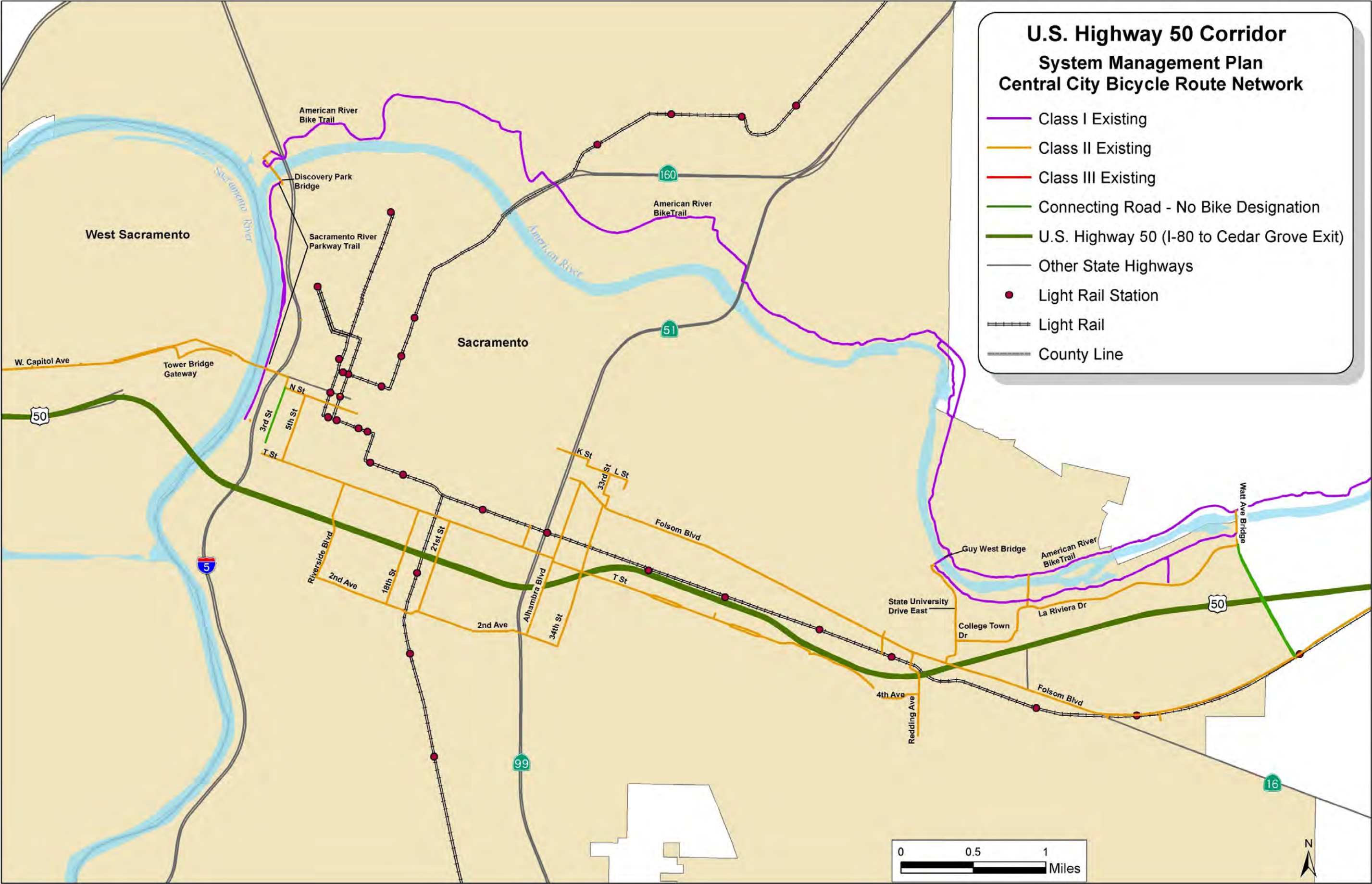


Figure 28: US 50 Corridor Bicycle Facilities Map (Inset)

ITEM 11.1.

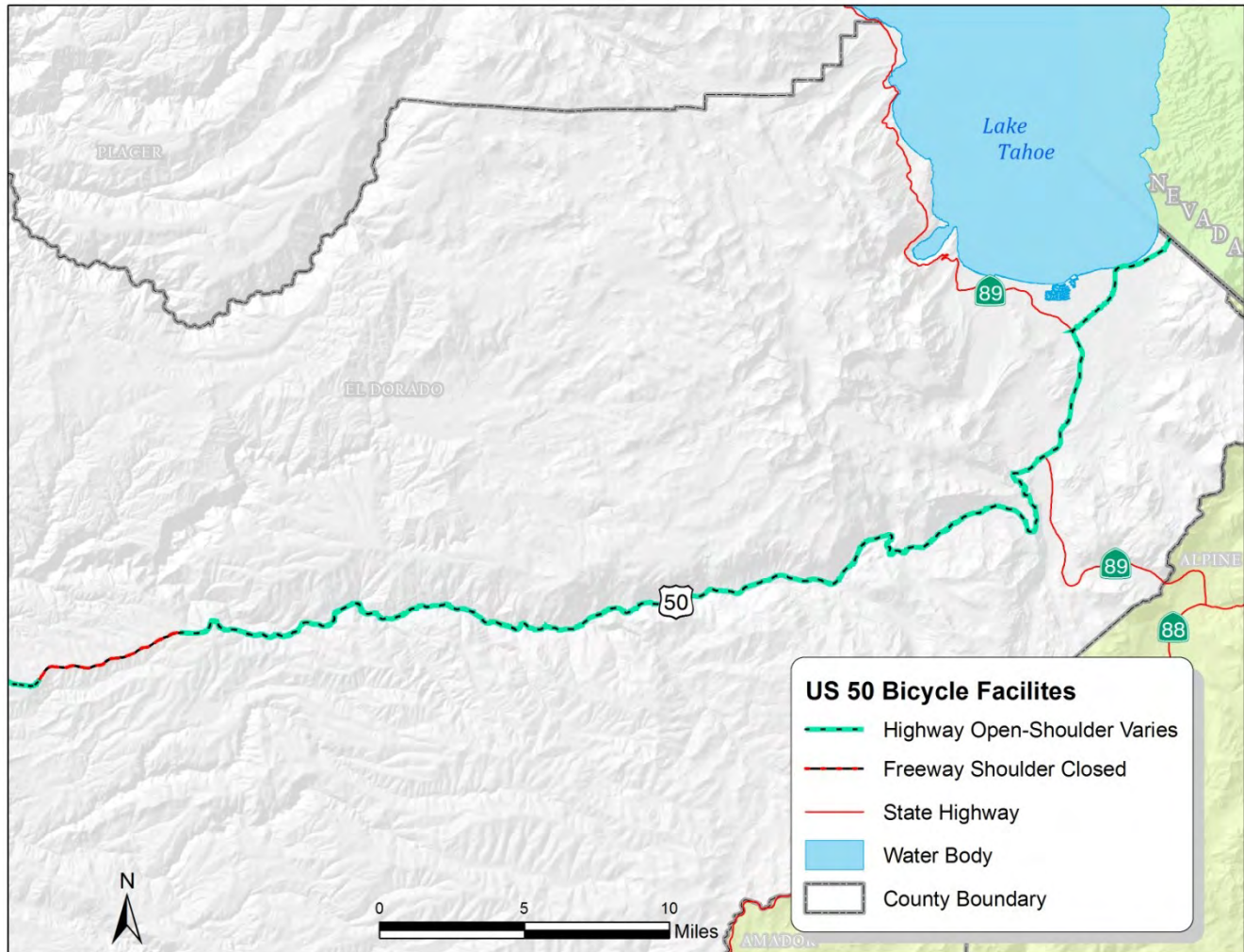


Figure 29: US 50 TCR Portion Bicycle Facilities

PEDESTRIAN FACILITIES

The pedestrian facilities on US 50 are identified in Table 11 below. In the Sacramento metropolitan area pedestrians are prohibited on US 50. For the rest of the corridor until near South Lake Tahoe, there are no pedestrian facilities due to the low pedestrian volumes. Pedestrian facilities can be very costly in areas with environmental or right-of-way constraints, especially in the Lake Tahoe area, so pedestrian sidewalks are not available in all areas. After the junction with SR 89 South near Lake Tahoe there are intermittent pedestrian facilities until the State line because US 50 functions as an urban street through the area.

As urban development takes place in the Sierra Nevada, it may become necessary to ensure pedestrian access in the conventional highway segments. For the Sacramento metropolitan areas, pedestrian bridges over US 50 could be needed. Parallel facilities could also provide a high level of service (LOS) for bicycle, pedestrian, and transit modes. In the South Lake Tahoe area, Caltrans has worked with local agencies through various agreements to develop pedestrian facilities on the state highway. Maintenance responsibilities for these and other pedestrian facilities are and will continue to be identified based on the physical and jurisdictional context of each facility. No plans are in the works for new pedestrian facilities on the urban segments or the segments within the Eldorado National Forest.

ITEM 11.1.

Caltrans District 3 is currently preparing the *Caltrans District 3 Complete Streets Plan* that will address the specific implementation of complete streets elements on the SHS within the District. A complete street is a transportation facility that is planned, designed, operated, and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit riders, and motorists appropriate to the function and context of the facility. Information regarding the addition of complete streets elements in the specific route or corridor will be included in each applicable TCR/CSMP. Caltrans will develop and implement the Plan in coordination with local and regional agencies.



ITEM 11.1.

TABLE 11: US 50 CORRIDOR PEDESTRIAN FACILITIES				
Seg. #	Post mile	Location Description	Pedestrian Access Prohibited	Sidewalk
1	0.00/3.16	I-80 to YOL/SAC County Line	Yes	No
2	L0.00/R0.00	YOL/SAC County Line to SR 99 and 51	Yes	No
3	R0.00/R5.34	SR 99 and 51 to Watt Ave.	Yes	No
4	R5.34/R10.92	Watt Ave. to Zinfandel Dr.	Yes	No
5	R10.92/12.50	Zinfandel Dr. to Sunrise Blvd.	Yes	No
6	12.50/17.01	Sunrise Blvd. to Folsom Blvd.	Yes	No
7	17.01/23.14	Folsom Blvd. to SAC/ED County Line	Yes	No
8	0.00/0.86	Sacramento/El Dorado County Line to Latrobe Rd.	Yes	No
9	0.86/R3.23	Latrobe Rd. to Bass Lake Rd.	Yes	No
10	R3.23/6.57	Bass Lake Rd. to Cameron Park Dr.	Yes	No
11	R6.57/R8.56	Cameron Park Dr. to Ponderosa Rd.	Yes	No
12	R8.56/R15.06	Ponderosa Rd. to Missouri Flat Rd.	Yes	No
13	R15.06/17.25	Missouri Flat Rd. to End of Freeway in Placerville	Yes	No
14	17.25/17.50	End of Freeway in Placerville to east of Canal St.	Yes	No
	17.50/17.70	East of Canal St. to Coloma Pedestrian OC (North side of US 50)	No	No
	17.70/18.11	Coloma Pedestrian OC to Bedford Ave.	Yes	No
15	18.11/20.741	Bedford Ave. to Newtown Rd. Overcrossing (OC)	Yes	No
	20.741/R25.95	Newtown Rd. OC to Cedar Grove Exit	No	No
16	R25.95 - R31.97	Cedar Grove Exit to 0.67 mi east of Sly Park Rd.	Yes	No
17	R31.97 - 39.77	0.67 miles east of Sly Park Rd. to Ice House Rd.	No	No
18	39.77 - 66.63	Ice House Rd. to Echo Summit	No	No
19	66.63 - 70.62	Echo Summit to State Route 89 South/Luther Pass Rd.	No	No
20	70.62 - 72.67	Junction with SR 89 South to Sawmill Rd.	No	Yes
	72.67 - 74.72	Sawmill Rd. to F St.	No	No
	74.72 - 75.45	F St. to SR 89 North/Lake Tahoe Blvd.	No	Yes
21	75.45 - 80.44	SR 89 North/Lake Tahoe Blvd. to State of Nevada	No	Yes

ITEM 11.1.

FREIGHT

There are three main types of freight facilities on the US 50 corridor as shown in Figure 29 and identified in Table 12. The first type of facility is the highway network. From the beginning of US 50 until Sly Park Rd, the facility is on the National Network, which allows trucks of Surface Transportation Assistance Act (STAA) dimensions to use the facility until that point. From Sly Park Rd until the junction with SR 89 South, US 50 is part of the California Legal network. This designation prohibits the longest truck lengths from using the facility. From SR 89 South until the state line, STAA trucks are allowed access only for terminal access, which is the permission to drive that route only to reach their destinations. Therefore, US 50 is only of limited use for goods movement. Most long distance haulers travel on I-5 and I-80.

Other important components of the highway network include the agriculture inspection station and the Riverton and Camino Commercial Vehicle Enforcement Facilities (weigh stations). The agriculture inspection station is located in Meyers and is intended to prevent invasive species from entering the State and causing serious damage to the State's agriculture industry. The commercial vehicle enforcement facilities protect the State's road infrastructure from commercial vehicles that are too heavy for facilities and could cause structural damage. Only commercial vehicles must stop at the enforcement facility.

The second type of freight facility is the Port of West Sacramento. This seaport is less than a mile south of US 50 and is easily accessible from Harbor Blvd. This Port primarily serves the import and export of agricultural goods and raw materials, in particular rice and cement. Further improvements of the surface transportation network and of the Sacramento River Deep Water Ship Canal will contribute to the attractiveness of the Port and increase freight volumes, making US 50 an even more important regional highway.

The third type of freight facility is represented by the airports in the corridor. Along US 50 there are two airports that impact goods movement: Mather Airport and the South Lake Tahoe Airport. Mather Airport has one of the longest runways in California and spacious warehousing on site from its time as an Air Force base. In 2011, Mather Airport handled 45,168 tons of cargo and plans to expand to accommodate future cargo deliveries. Caltrans is working with the airport and local agencies to ensure that development around the airport is compatible with airport operations.

The South Lake Tahoe Airport is owned by the City of South Lake Tahoe, but does not currently provide commercial scheduled air service. The airport provides another mode of access to southern Tahoe Basin communities and recreational venues. Air travelers using commercial airlines must currently reach South Lake Tahoe communities through the Reno and Sacramento International airports, and typically rent vehicles to drive to their destination into the basin. If commercial air service to the airport were restored, it could help reduce the number of vehicle trips and congestion on local roads. The City's Emergency Operations Center is located at the airport, and the airport also provides emergency air medical transport, County Search and Rescue, fire fighting, and law enforcement services to the region. The airport is served by several transit operators and private transit companies providing fixed routes, and on demand services that enhance regional connectivity and access for the Lake's residents and visitors. The City's only clean natural gas facility is located at the airport and fuels the City's clean fleet of vehicles. Lastly, the airport is used as a base of operations for Customs and Border Patrol drug interdiction, Fire Academy training, K-9 Hot Load training, and Fire Fest – a community fire education program.

Caltrans District 3 is preparing a district-wide Goods Movement Plan. The Plan will synthesize the findings of other goods movement related plans in the District and State, conduct a district-wide assessment of the District 3 Goods Movement network, propose a prioritization framework to identify and prioritize projects, and propose a list of prioritized projects for potential funding that will sustain or improve goods movement throughput. The plan will require significant outreach, collaboration, and consensus with stakeholders, including public agencies

ITEM 11.1.

such as the Sacramento Area Council of Governments (SACOG), and the private sector entities such as the California Trucking Association. Findings from the study will be included in the California Freight Mobility Plan, and will be transferrable to other Caltrans Districts statewide for implementation. The District 3 Goods Movement Plan is scheduled to be finished in 2015. More information can be found at: <https://sites.google.com/site/d03goodsmovement/>.

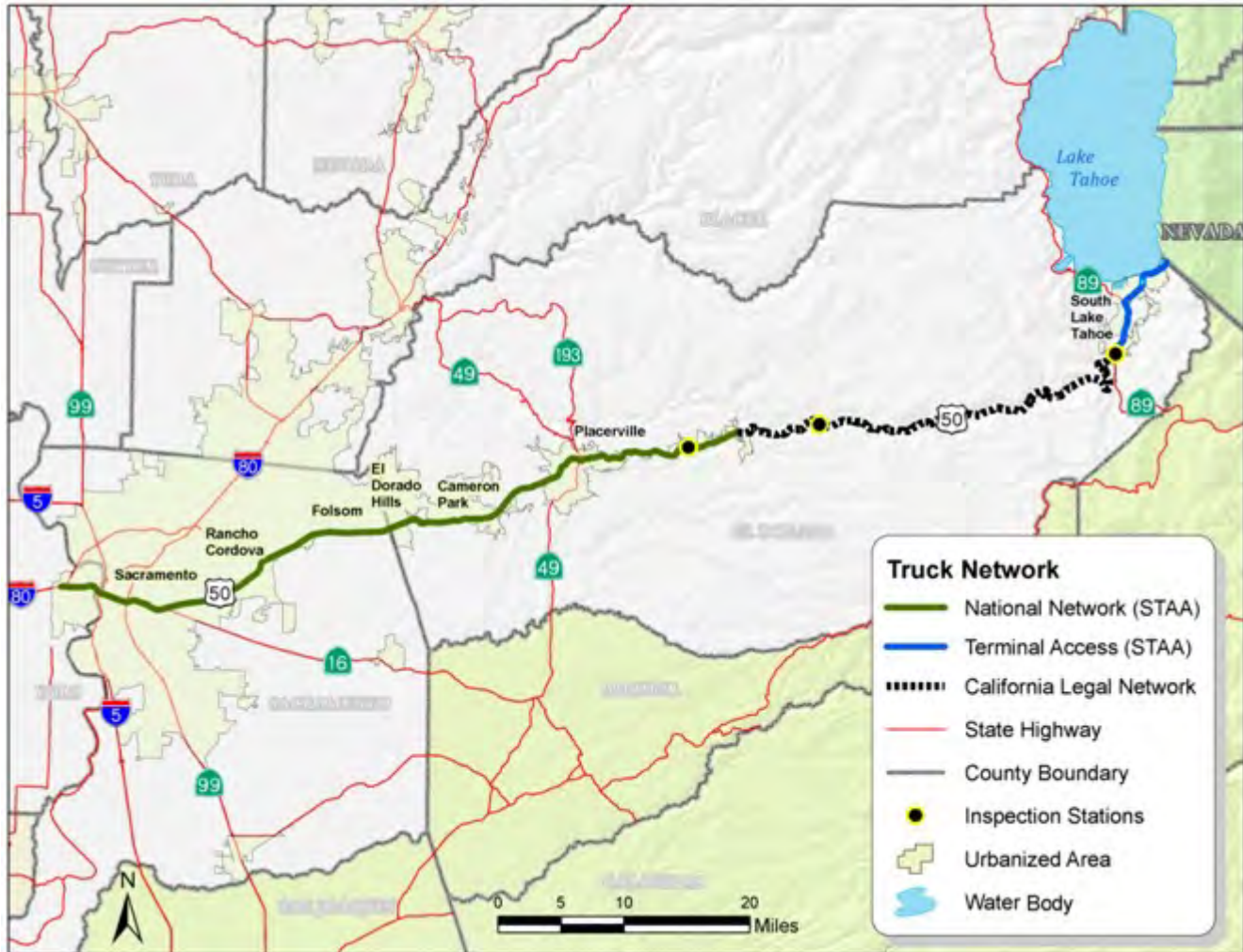


Figure 30: US 50 Truck Network Map

ITEM 11.1.

TABLE 12: US 50 FREIGHT FACILITIES			
Seg. #	Facility Type/Freight Generator	Location	Mode
1-21	Highway Network	National Network (STAA) to ED R31.297	Truck
		California Legal to ED PM 75.45	
		Terminal Access (STAA) to ED PM 80.44	
1-3	Industrial/Distribution Centers	YOL PM 1.209; SAC R3.682	Truck
1	Port of West Sacramento	YOL PM 1.094	Sea
4	Mather Airport	SAC PM R9.149	Air
20	Agriculture Inspection Station	ED PM 70.946	Automobile and Truck
17	Riverton Commercial Vehicle Enforcement Facility	ED PM 39.3	Truck
16	Camino Commercial Vehicle Enforcement Facility	ED PM R27.1	Truck

CORRIDOR PERFORMANCE MANAGEMENT

There are two major components of corridor performance management, which are performance measurement and performance monitoring.

PERFORMANCE MEASUREMENT

The use of performance measures with threshold standards is used to evaluate the degree of congestion along a highway segment or local parallel/connecting roadway, transit facility, and bicycle and pedestrian facility to determine the scope and schedule of system improvements needed to correct a performance deficiency. The performance measures used for the highway facility in this TCR/CSMP include Level of Service (LOS), Vehicle and Person Hours of Delay (VHD) at 60 MPH, Vehicle Miles Traveled (VMT), Peak Hour VMT, Peak Hour Volume over Capacity (V/C), and Peak Hour Average Speed. The tools used to determine the performance measures include Average Annual Daily Traffic (AADT), Truck AADT, Percent of Trucks, 5+ Axle Truck AADT, and 5 Axle Truck Percentage of AADT. The definitions, applicability, and sources of the baseline performance measures data used in this TCR/CSMP corridor are identified in Appendix C. This data is given for both the base (2012) and horizon (2035) years for all of US 50 where available. Basic system operation, truck traffic, and peak hour traffic performance data is summarized in Tables 13, 14, and 15 on the pages that follow.

LOS is a qualitative measure describing operational conditions within a traffic stream and perception of condition by users. Operational conditions are defined in terms of speed, travel time, freedom to maneuver, traffic interruption, comfort, and convenience. LOS is defined into six levels with letter designations from A to F. LOS A represents the best operating conditions wherein there is ample maneuverability, no speed restrictions and no delays, while LOS F represents the worst operating conditions with traffic congestions, significant delays and little maneuverability (please see Appendix A for more information including data sources). LOS is accepted as a performance measure by the Federal Highway Administration and California, as well as almost all 49 other states.

ITEM 11.1.

The “*Concept LOS*” is based on District 3 standards, which are from the Caltrans District 3 District System Management and Development Plan (DSMDP). Typical Concept LOS standards in District 3 are LOS “D” in rural areas and LOS “E” in urban areas. Performance variations and interchange deficiencies within a corridor segment may inadvertently increase or decrease the LOS calculations, which may warrant additional detailed operational analysis. A local agency may set a higher LOS threshold standard consistent with community wishes and other local concerns. Caltrans as the owner and operator of the facility establishes the Concept Level of Service as the **minimum acceptable level of service**. Any threshold standard LOS established by a local agency for the State Highway System (SHS) should not be lower than the Caltrans Concept LOS. For those parts of the SHS where LOS may not be an appropriate measure to describe performance such as in locations designated as a “Transit Priority” area where the Caltrans Performance Measurement System (PeMS) is available, the Caltrans District 3 DSMDP (page 34) suggests using other performance measures including, but not limited to, Vehicle Travel Time (minutes) and Vehicle Hours of Delay (VHD).

LOS is one performance measure utilized by Caltrans in the review of proposed projects during the Intergovernmental Review/CEQA development review process to determine if proposed projects might cause significant impacts to the operation of the SHS. In segments of the SHS main line where the existing LOS is at or below the Concept LOS, any land use development should not directly or cumulatively lower the existing LOS. Any impacts exceeding this threshold will be viewed by Caltrans as significant and warrant appropriate mitigation. Any CEQA lead agency should coordinate with Caltrans as early in the development review process as feasible to jointly determine the most appropriate threshold standards of significance.

Data collection for non-auto modes is not as robust as what is needed for active system management. AADT and LOS were used in the 2009 CSMPs as performance measures for the local parallel/connecting roadways. However, the availability and year date consistency of this data varied between local city and county jurisdictions, which resulted in the data not being valuable to measuring roadway performance across the corridor. Consequently, this TCR/CSMP update does not include performance measures for the roadways.

Available Average Daily and Peak Hour Capacity were used in the 2009 CSMPs as performance measures for transit. No performance measures were identified for bicycle and pedestrian facilities. Following consultation with key external stakeholders for both bicycling and transit after adoption of the 2009 CSMPs, the progress in implementing the infrastructure improvements to close system gaps by improving and facilitating bicycling, pedestrian, and mass transit, as included in the applicable regional transportation plans, was determined to replace the performance measures reported in the 2009 CSMPs for bicycling, pedestrian, and transit facilities, and to be reported in subsequent CSMPs for bicycling, pedestrian, and transit modes. It is realized that the bicycle and pedestrian transportation networks need to be completed prior to developing meaningful performance measures that quantify deficiencies.

PERFORMANCE MONITORING

The goal of performance monitoring is to continuously and dynamically examine corridor performance to identify operational problems caused by traffic congestion and implement immediate, efficient, and effective system operations and improvement actions and strategies along the corridor, including capital improvements to generate the desired results. Where available, PeMS is utilized to monitor highway performance. In other corridor segments where PeMS is not available, HCS 2010 analysis is performed using traffic counts or tachometer (tach) runs to assess performance.

ITEM 11.1.

TABLE 13: US 50 BASIC SYSTEM OPERATIONS

Seg. #	County	Post Miles	Distance (Miles)	Average Annual Daily Traffic			Level of Service (LOS)				Vehicle Miles Traveled (VMT)			Delay	
				Base Year (BY)*	No Build (Horizon Year (HY))*	Build (HY)	B Y	No Build (HY)	Build (HY)	Concept LOS	BY	No Build (HY)	Build (HY)	Daily Vehicle Hours of Delay	Daily Person Hours of Delay
1	YOL	0.00/3.16	3.16	176,000	206,000	210,000	E	F	F	E	337,274	394,000	402,000	228	310
2	SAC	L0.00/L2.48(R0.00)	2.48	246,000	279,000	300,000	F	F	F	E	452,373	513,000	552,000	1,697	2,309
3		R0.00/R5.34	5.34	206,000	249,000	265,000	F	F	F	E	959,231	1,158,000	1,235,000	1,708	2,323
4		R5.34/R10.92	5.58	171,000	226,000	234,000	F	F	F	E	660,438	873,000	905,000	509	692
5		R10.92/12.50	1.58	141,000	196,000	204,000	E	F	F	E	194,349	271,000	281,000	204	278
6		12.50/17.01	4.51	117,000	160,000	161,000	F	F	F	E	630,648	862,000	866,000	565	768
7		17.01/23.14	6.13	91,000	113,000	132,000	F	F	F	E	521,760	645,000	759,000	158	215
8	ELD	0.00/0.86	0.86	91,000	100,000	110,000	F	F	F	E	81,060	89,000	98,000	59	80
9		0.86/R3.23	2.37	70,000	94,000	105,000	E	F	F	E	127,860	171,000	191,000	10	13
10		R3.23/6.57	3.34	61,000	86,000	84,000	D	F	D	E	207,994	294,000	286,000	51	70
11		6.57/R8.56	1.99	61,000	73,000	77,000	D	E	D	E	170,099	203,000	216,000	15	20
12		R8.56/R15.06	6.5	52,000	67,000	71,000	C	D	C	E	307,233	396,000	420,000	16	21
13		R15.06/17.25	2.19	49,500	59,000	67,000	D	D	E	E	129,242	153,000	176,000	6	9
14		17.25/18.11	0.86	52,000	59,000	58,000	C	C	C	D	37,604	43,000	42,000	132	179
15		18.11/R25.95	7.84	30,000	35,000	35,000	C	C	C	E / D*	180,361	212,000	213,000	31	43
16		R25.95/R31.97	6.02	19,900	24,880	24,900	B	C	C	E	108,240	135,300	135,420	Not available for TCR corridor	
17		R31.97/39.77	7.65	12,700	15,880	15,890	B	C	C	D	97,160	121,450	121,560		
18		39.77/66.63	26.64	13,100	16,380	16,390	E	F	F	D	351,840	439,800	440,190		
19		66.63/70.62	3.99	10,900	13,630	13,640	E	E	E	D	36,270	45,340	45,380		
20		70.62/75.45	4.83	19,000	23,750	23,770	E	F	F	D	68,450	85,560	85,640		
21		75.45/80.44	4.99	33,000	42,900	42,940	E	F	F	E	159,040	206,750	206,930		

Note: Please see Appendix A: Glossary for explanation of these terms and performance measures.

*- Concept LOS on a segment that contains both urban and rural portions

ITEM 11.1.

TABLE 14: US 50 TRUCK TRAFFIC DATA							
Seg. #	County	Post Miles	Distance (Miles)	Average Annual Daily Truck Traffic (AADTT)	Total Trucks (% of AADT) (BY)	5+ Axle AADTT (BY)	5+ Axle Total Truck (% of AADT) (BY)
1	YOL	0.00/3.16	3.16	7,093	4.0%	3,120	1.8%
2	SAC	L0.00/L2.48(R0.00)	2.48	6,012	2.4%	2,515	1.0%
3		R0.00/R5.34	5.34	8,060	3.9%	2,137	1.0%
4		R5.34/R10.92	5.58	7,709	4.5%	1,964	1.1%
5		R10.92/12.50	1.58	7,811	5.5%	2,120	1.5%
6		12.50/17.01	4.51	7,488	6.4%	3,295	2.8%
7		17.01/23.14	6.13	5,824	6.4%	2,399	2.6%
8	ED	0.00/0.86	0.86	5,824	6.4%	2,399	2.6%
9		0.86/R3.23	2.37	4,200	6.0%	1,730	2.5%
10		R3.23/6.57	3.34	3,660	6.0%	1,508	2.5%
11		6.57/R8.56	1.99	3,660	6.0%	1,508	2.5%
12		R8.56/R15.06	6.5	3,120	6.0%	1,289	2.5%
13		R15.06/17.25	2.19	2,970	6.0%	1,227	2.5%
14		17.25/18.11	0.86	3,120	6.0%	1,376	2.6%
15		18.11/R25.95	7.84	1,860	6.2%	837	2.8%
16		R25.95/R31.97	6.02	1,393	7.0%	641	3.2%
17		R31.97/39.77	7.64	800	6.3%	384	3.0%
18		39.77/66.63	26.64	537	4.1%	200	1.5%
19		66.63/70.62	3.99	338	3.1%	141	1.3%
20		70.62/75.45	4.83	760	4.0%	228	1.2%
21		75.45/80.44	4.99	1,320	4.0%	139	0.4%

ITEM 11.1.

TABLE 15: US 50 PEAK HOUR TRAFFIC DATA

Seg. #	County	Post Miles	Volume			Directional Split			Volume/Capacity (V/C)			VMT		
			BY	No Build (HY)	Build (HY)	BY	No Build (HY)	Build (HY)	BY	No Build (HY)	Build (HY)	BY	No Build (HY)	Build (HY)
1	YOL	0.00/3.16	14,900	17,400	17,800	55%	52%	53%	0.93	1.02	1.06	25,041	29,300	29,800
2	SAC	L0.00/L2.48 (R0.00)	20,500	23,300	25,000	54%	52%	53%	1.14	1.26	1.37	33,921	38,500	41,400
3	SAC	R0.00/R5.34	20,100	24,300	25,900	56%	54%	52%	1.16	1.36	1.29	70,378	85,000	90,600
4	SAC	R5.34/R10.92	16,600	21,900	22,700	56%	54%	53%	1.05	1.21	1.25	75,883	100,300	103,900
5	SAC	R10.92/12.50	13,000	18,100	18,800	64%	58%	58%	0.89	1.06	1.01	15,716	21,900	22,700
6	SAC	12.50/17.01	11,300	15,400	15,500	64%	60%	60%	1.02	1.26	1.09	48,560	66,300	66,600
7	SAC	17.01/23.14	8,600	10,600	12,500	65%	63%	63%	1.04	1.27	1.33	39,119	48,400	56,900
8	ED	0.00/0.86	8,600	9,500	10,400	65%	66%	66%	1.08	1.24	1.14	6,640	7,310	8,070
9	ED	0.86/R3.23	7,000	9,400	10,500	65%	66%	66%	0.95	1.22	1.16	12,120	16,220	18,110
10	ED	R3.23/6.57	5,700	8,100	7,800	65%	66%	66%	0.75	1.02	0.74	17,060	24,130	23,440
11	ED	6.57/R8.56	5,600	6,700	7,100	65%	62%	64%	0.86	0.98	0.83	12,420	14,800	15,740
12	ED	R8.56/R15.06	4,150	5,300	5,700	65%	62%	64%	0.63	0.77	0.62	22,100	28,480	30,230
13	ED	R15.06/17.25	4,600	5,400	6,300	65%	63%	63%	0.73	0.84	0.96	9,750	11,500	13,200
14	ED	17.25/18.11	4,650	5,300	5,200	63%	60%	62%	0.00	0.00	0.00	3,535	4,000	4,000
15	ED	18.11/R25.95	3,250	3,800	3,800	63%	63%	65%	0.54	0.59	0.59	20,747	24,400	24,500
16	ED	R25.95/R31.97	2,650	3,310	3,320	67%	61%	63%	0.47	0.54	0.56	15,490	19,360	19,380
17	ED	R31.97/39.77	2,150	2,690	2,690	67%	63%	63%	0.41	0.47	0.48	16,450	20,560	20,580
18	ED	39.77/66.63	1,900	2,380	2,380	67%	61%	63%	0.88	1.00	1.03	51,030	63,790	63,840
19	ED	66.63/70.62	1,550	1,940	1,940	67%	61%	63%	0.71	0.81	0.84	5,820	7,280	7,280
20	ED	70.62/75.45	2,400	3,000	3,000	61%	55%	57%	0.99	1.13	1.17	9,260	11,580	11,590
21	ED	75.45/80.44	3,850	5,010	5,010	54%	50%	51%	0.66	0.80	0.80	15,910	20,680	20,700

ITEM 11.1.

BOTTLENECK AND CONGESTION ANALYSIS

The 2010 Highway Capacity Manual defines a bottleneck as “a road element on which demand exceeds capacity.”

The bottleneck analysis evaluates specific causes of existing recurrent traffic congestion in the corridor. Freeway bottleneck locations that create mobility constraints are identified and documented, and their relative contribution to corridor-wide congestion is reported. The bottleneck locations were determined based on a combination of the use of 2012 PeMS data, probe vehicle tach runs, and field observations. This analysis was only performed for the CSMP portion of the facility.

Traffic congestion can be categorized as either recurrent or non-recurrent.

Recurrent congestion occurs repeatedly at the same place and time of day in a predictable pattern. Recurrent congestion is often associated with facility capacity limitations, changes in capacity, conflicting vehicle movements such as lane merges, inadequate number of transit vehicles to handle passenger loads, or other persistent physical conditions of the transportation facility.

Non-recurrent congestion is usually attributed to collisions, equipment malfunction, community events, weather, construction projects and other occasional occurrences. When transportation systems are close to their maximum carrying capacity, non-recurrent congestion is more likely to occur as there is little excess capacity in the system.

Prior to analyzing the congestion and bottlenecks located within the corridor, a review of the District 3 *2012 Mobility Performance Report* (MPR) was conducted. The MPR is prepared by each Caltrans District where PeMS is utilized. Headquarters Traffic Operations Division requests and compiles these District reports annually and quarterly. The freeway congestion data is identified by freeway route and county but does not contain specific CSMP segment data. This data, which lists Vehicle Hours of Delay at 60 MPH, provides an overall perspective of the level of congestion for each route, which can be compared to prior year data so that performance can be monitored. The data presented in the MPR also identifies the top ten bottlenecks during the AM Peak Period and PM Peak Period by freeway route and county and identifies Total and Average Vehicle Hours of Delay and the Average Duration, which again can be compared to prior year data for performance monitoring purposes. The MPR data is useful in providing an overall perspective of the performance of the freeway at the county level that can be compared to the CSMP corridor segment-specific performance data. US 50 in Sacramento and El Dorado Counties is included in the District 3 MPR's top ten congested freeways and bottleneck locations. The ranking of the US 50 corridor is listed as follows:

Traffic Congestion:

- **Vehicle Hours of Delay (VHD):** Total VHD at 60 miles per hour in both directions increased in 2012 over 2011 in both Counties applicable to the CSMP corridor. The results are as follows:

Route	County	2011	2012
US 50	SAC	1,121,970 VHD	1,294,019 VHD
	ELD	247,159 VHD	254,511 VHD

- **Top 10 Congested Freeways:** Based on the VHD of all District 3 Freeway urban corridors in the Sacramento area, the congestion comparison of US 50 for 2011 and 2012 was ranked with the other corridors. As identified below, the US 50 corridor is becoming slightly more congested relative to other freeways in the District.

Route	County	2011 Rank	2012 Rank
US 50	SAC	3	2
	ELD	8	8

ITEM 11.1.

- **Top Bottleneck Locations:** The bottleneck comparisons of US 50 for 2011 when available and 2012 by locations and rankings listed below can change from year to year, and may be indicative of temporary bottlenecks (i.e. short-term construction activities or special events) rather than major geometric constraints that require major operational strategies or capital expansion. Rankings are in comparison to all state highways in the greater Sacramento area of District 3 during both the AM peak and PM peak time periods and by direction. As identified below, US 50 captures several bottlenecks in the District top ten worst bottlenecks. These bottlenecks come in two main groups. The first and more severe group is between I-5 and SR 99 downtown, where several highways converge. The second group is near Howe Ave, close to Sacramento State and a bridge across the American River.

County	Route	Location	Time of Day	2011 Av. Daily VHD	2012 Av. Daily VHD	2011Av. Duration (min)	2012 Av. Duration (min)	2011 Rank	2012 Rank
Eastbound									
SAC	50	16 th St.	PM	75	141	64	122	21	6
Westbound									
SAC	50	Occidental Dr.	AM	8	145	3	54	N/A	5
SAC	50	NB Howe Ave.	AM	55	126	18	49	5	8
SAC	50	15 th St.	PM	118	285	32	59	13	5

Along with the MPR information, additional PeMS data was compiled and analyzed so that congestion and bottleneck locations on the individual route segments within the CSMP corridor could be further refined and causality defined.

It should be noted that while both the MPR data and the data collected by District 3 Travel Forecasting and Modeling utilized PeMS, the data was collected for different time periods, and duration and delay thresholds between the two data sets vary. As such, while both data sets are generally consistent with each other, there may be some variation. Further work is being conducted to refine the identification and causality of bottlenecks within the corridor.

Table 16 shows a summary of the US 50 eastbound and westbound bottlenecks, while the analysis that follow the table discuss each bottleneck, including location and possible causality. Minor or hidden bottlenecks are those that are not as defined (or severe) as the major bottlenecks. Bottlenecks in the chart are listed in order of probability of formation. Please note that the graphics accompanying the bottlenecks are not to scale.

Bottlenecks in the eastbound direction during the PM peak period are at 16th St., 48th St., Folsom Blvd., 28th St., Howe/Power Inn, west of Scott Rd., and Sunrise Blvd. In the AM peak the sole bottleneck is at 16th St. Bottlenecks in the westbound direction during the PM peak period are at 25th St., 15th St., Stockton Blvd., and 59th St. In the AM peak the bottlenecks are at Watt Ave., Occidental Dr., El Dorado Hills Blvd., and Howe Ave.

Causalities for these bottlenecks range from high-traffic demand (congestion), heavy weaving/merging areas, or physical constraints such as lane drops, lack of ramp meters, incomplete HOV network, incomplete auxiliary lane network, poorly coordinated traffic signals and an off-ramp queue (Sunrise Blvd.).

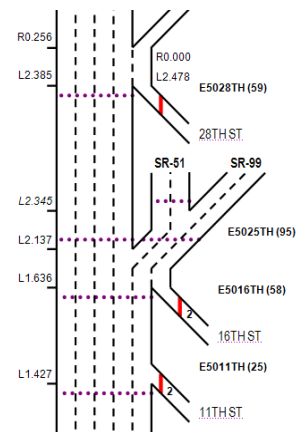
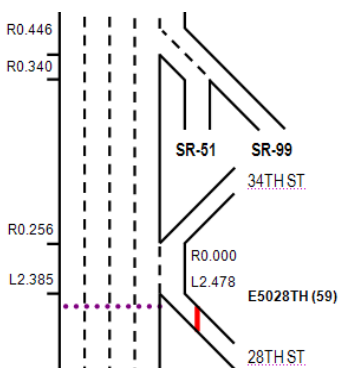
ITEM 11.1.

TABLE 16: US 50 BOTTLENECK ANALYSIS DATA								
Seg. #	Location	County	Time of Day	Post Miles	Probability of Bottleneck Forming	Avg Queue Length (Miles)	Avg Delay (Veh Hrs)	Avg Duration (Minutes)
Eastbound								
2	16th St.	SAC	PM	L1.567	97.4%	0.45	141	122
2	16th St.		AM	L1.567	46.8%	0.49	63	51
2	28th St		PM	L2.394	50.6%	1.52	283	58
3	48th St.		PM	R1.453	71.8%	1.11	193	79
3	NB Howe/Power Inn		PM	R3.88	41.7%	0.72	74	56
5	SB Sunrise Blvd.		PM	12.4	21.8%	0.89	57	45
6	Folsom Blvd.		PM	16.901	53.8%	1.72	93	54
7	West of Scott Rd.		PM	20.7	23.7%	1.95	93	54
Westbound								
8	El Dorado Hills	ELD	AM	0.5	30.1%	0.95	54	46
4	NB Watt Ave.	SAC	AM	R5.4	39.1%	1.14	71	36
3	Occidental Dr.		AM	R4.5	34.0%	1.31	145	54
3	NB Howe Ave.		AM	R3.8	24.4%	1.46	126	49
3	Stockton Blvd		PM	R.595	54.5%	1.26	129	43
3	59th St.		PM	R1.9	48.1%	1.52	156	52
2	25th St.		PM	L2.166	80.1%	1.05	108	53
2	15th St.		PM	L1.351	64.7%	2.25	285	59

Eastbound Bottleneck Analysis

A. 16th St. Bottleneck (Both AM and PM)

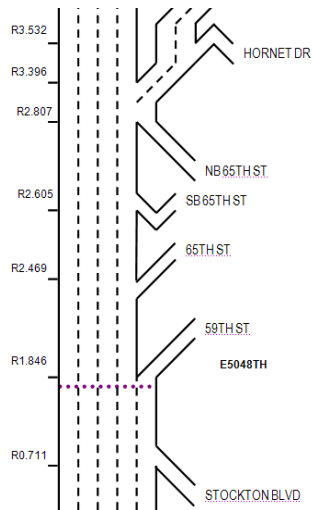
The bottleneck at 16th St. is caused by heavy volume of merging traffic, which causes weaving between vehicles merging onto US 50 and diverging vehicles for the SR 51 and SR 99 connectors. Merging traffic from the on-ramps has to cross 2+ lanes of traffic and diverge directly across diverging vehicles for SR 51 and SR 99 connectors. The combination of heavy volumes and diverging traffic approaching the SR 51 and SR 99 connectors creates bottlenecks that are exacerbated during peak hours.

B. 16th St. (See A Above)

C. 28th St. Bottleneck

The bottleneck at 28th St. is caused by heavy demand, the downstream lane drop, as well as diverging traffic at the 28th St. on-ramp. Past the on-ramp, there is a slight uphill grade and horizontal curve that contributes to the formation of a bottleneck.

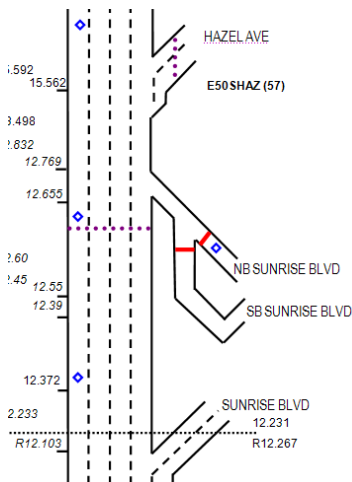
ITEM 11.1.

**D. 48th St. Bottleneck**

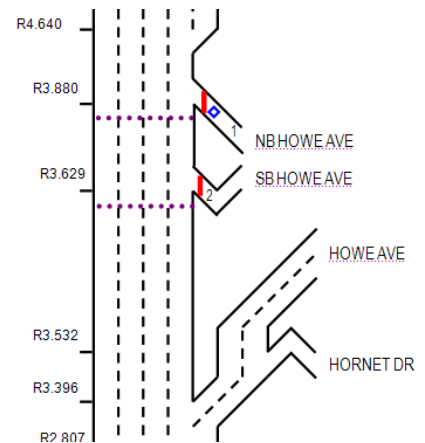
The bottleneck approximately located at 48th St. is due to the additional traffic merging from SR 51 and SR 99, combined with a lane drop at 59th St. This queue extends upstream past the off-ramp to SR 51 and SR 99. These off-ramps are bottlenecks in themselves, which spill back and choke the US 50 mainline.

E. Howe/Power Inn

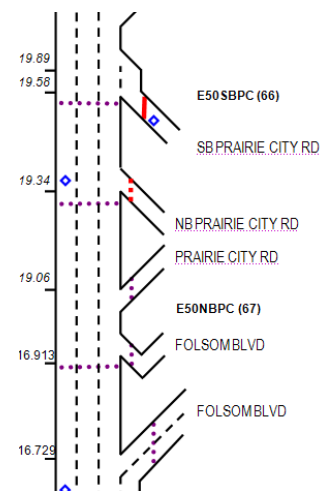
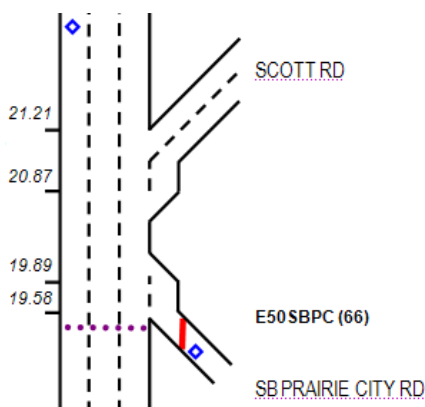
The bottleneck at Howe Ave. is due to the entering traffic from Howe Ave. Two Howe Ave. on-ramps feed into US 50 eastbound: southbound Howe Ave. loop on-ramp and northbound Howe Ave. direct ramp, approximately 300 feet apart. The Watt Ave. off-ramp is just downstream with heavy existing volumes; therefore the segment between Howe and Watt is characterized by heavy weaving.

**F. Sunrise Blvd Bottleneck**

At Sunrise Blvd., the right-most lane exits, and high volumes of automobiles enter the facility from the large employment centers in Rancho Cordova. As a result, there is a large volume of vehicles queued at Sunrise off-ramp which spills back and negatively affects the US 50 mainline.

**G. Folsom Blvd**

The right-most lane exits to Folsom Blvd., leaving one HOV lane and two regular lanes along the US 50. The bottleneck is caused by this lane drop as well as the quick merge at the Folsom on-ramp.

**H. West of Scott Road Bottleneck**

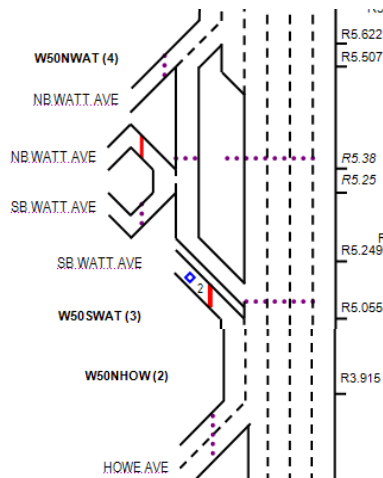
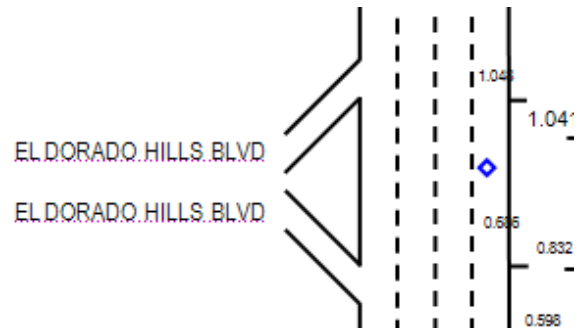
The bottleneck at Scotts Rd. is due to heavy demand and merging traffic from both southbound and northbound Prairie City on-ramps.

ITEM 11.1.

Westbound Bottleneck Analysis

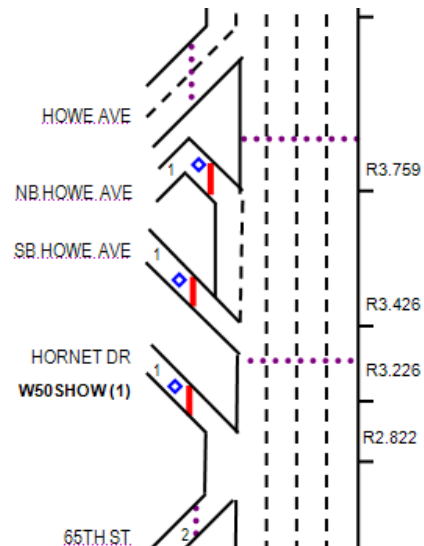
A. El Dorado Hills Blvd Bottleneck

The bottleneck at El Dorado Hills Blvd is caused by heavy demand on El Dorado Hills Blvd. and traffic from El Dorado Hills Blvd. merging with existing westbound US 50 traffic.



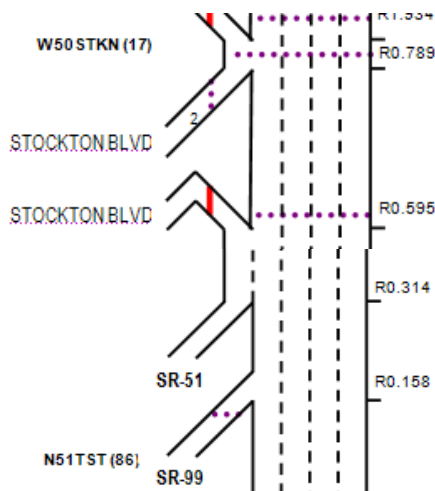
B. Occidental Dr. Bottleneck/Watt Ave. Bottleneck

The bottleneck at Watt Ave. is due to the lane drop at the Watt Ave. exit and merging traffic from the Watt Ave. on-ramp, which conflict with traffic on US 50. The auxiliary lane stretches all the way to the Howe Ave. exit. Last second weaving from vehicles merging along the auxiliary lane, before the Howe Ave. exit, creates a spill back effect on US 50 and contributes to the sections bottleneck.



C. Howe Ave Bottleneck

The Howe Ave. bottleneck is caused by a grade change and the merging traffic entering from northbound and southbound Howe Ave. on-ramps and Hornet Dr on-ramp.



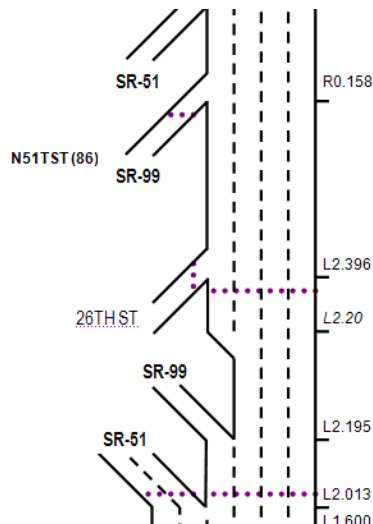
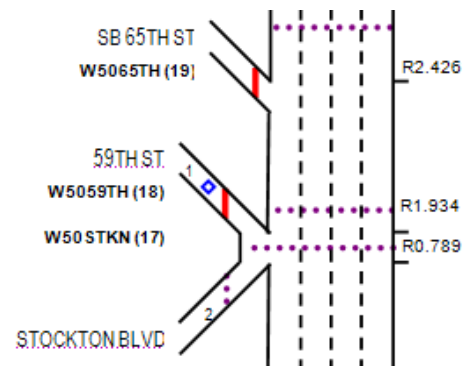
D. Stockton Blvd Bottleneck

Bottleneck at Stockton Blvd. is due to vehicles merging onto US 50 and diverging to SR 99 and SR 51 along the same auxiliary lane. High volume of weaving between entering and exiting vehicles on US 50 increases the likelihood of bottlenecks in this segment is increased during peak hours.

ITEM 11.1.

E. 59th St. Bottleneck

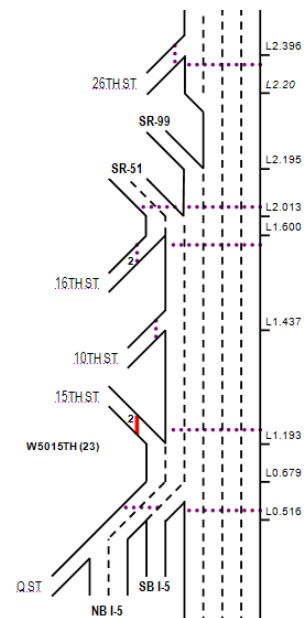
Vehicles merging onto US 50 from the 59th St. on-ramp, conflict with traffic on US 50 and weaving at the two most right lanes create a bottleneck. This bottleneck is exacerbated and/or worse from the spill back effect of the Stockton Blvd. bottleneck.

**F. 25th St. Bottleneck**

The bottleneck approximately at 25th St. is due to a lane drop and merging traffic from SR 99 and SR 51 connectors onto US 50. Vehicles on US 50 experience a slight horizontal curve and a lane drop approaching the SR 99 connector. A small stretch of US 50 is reduced to three lanes, but is widened back to four lanes after the SR 99 interchange. The high volume of weaving and diverging traffic, along with the downstream lane drop and slight horizontal curve, contribute to the overall sections bottleneck.

G. 15th St. Bottleneck

The bottleneck approximately at I-5 is caused by a conflict between entering SR 99 and SR 51 traffic and exiting I-5 traffic as well as the queues formed on the ramps to I-5, which spill back onto US 50. The number of lanes in this section reaches a maximum of 6 and then drops to 4 as two lanes exit at the I-5 freeway. This bottleneck is exacerbated during the peak periods when it stretches upstream to the lane drop before SR 99.



ITEM 11.1.

KEY CORRIDOR ISSUES

A number of significant issues provide challenges for the segments of US 50 discussed in this document, including the complicated physical, environmental, and commercial setting of the highway.

Roadway configuration is a critical issue for transportation on US 50. Lanes drop off at some specific locations, causing a bottleneck to be activated at times. Further, there is an incomplete set of auxiliary lanes on the facility, causing operational problems at those locations. Constructing auxiliary lanes would allow easier merging onto and exiting from the facility. Further the system of HOV lanes needs to be expanded to include the entire Sacramento urban area. The HOV lanes begin at Watt Ave. and run until the Cameron Park Area. Constructing HOV lanes in downtown Sacramento and West Sacramento would significantly improve traffic flow and reduce congestion.

Improvements to ITS on US 50 could also greatly improve traffic flow. Implementing ramp metering on all appropriate onramps would greatly increase throughput on the facility by reducing platooning and resulting bottlenecks. Another ITS implementation strategy is signal coordination on key arterials and freeway ramp intersections. Other ITS implementation strategies are forthcoming in the District 3 *ITS/Operational Improvement Plan* (ITS/Ops Plan).

Transit improvements have also been identified for the corridor to improve traffic. To increase transit ridership, more funding is necessary for capital and operations on expanded lines and enhanced service. For example, double tracking of the light rail Gold Line to Folsom is necessary to decrease headways at stations east of the Sunrise Blvd. station. At-grade rail crossings, in downtown Sacramento and along Folsom Blvd. going east, cause delay to motorists, bicyclists, and pedestrians. Coordination between local and regional agencies will be critical in making service improvements to transit along the corridor.

There are also deficiencies in the bicycle and pedestrian facilities on the corridor. Pavement deficiencies, maintenance issues, and gaps and barriers within the bicycle route network make active transportation modes less attractive to travelers and contribute to higher automobile usage. Keeping bicycle facilities in usable order will require the close cooperation of local agencies along the corridor. Bicyclist-activated signal change devices will also greatly improve transportation on the corridor. Finally, coordination between transit operators and bicyclists can make great improvements on transit access and bicycle storage to promote increased alternative transportation.

Recreational traffic is an important issue in US 50 transportation. This traffic is highly directional and heavily concentrated in certain times of year (ski season and summer recreation season). Traffic on this route is concentrated on weekends, particularly Fridays and Saturday mornings to Lake Tahoe and Sunday afternoons from Lake Tahoe, during the ski season and during the summer, and to the Apple Hill area during fall. Because of the difficulty of planning for these conditions, the El Dorado County Transportation Commission (EDCTC) applied for and received grants from the State to study the impact of tourism on travel and mobility issues associated with agritourism. The *Bay to Tahoe Basin Recreation and Tourism Travel Impact Study* is currently in development and will provide important information and recommendations regarding recreational travel within this corridor, covering several counties and transportation facilities and the *Sustainable Agritourism Mobility Study* will begin developing recommendations regarding agritourism mobility in the corridor in winter 2015.

Additionally, EDCTC has identified operational issues between the Smith Flat interchange and east of the Upper Carson Road/Camino intersection in the *Camino Area Parallel Capacity/Safety Study*. Transportation issues include at-grade access to US 50, left turn conflicts across US 50, increasing average daily local and interregional traffic, growth in the area, lack of alternate routes, seasonal traffic to and from Apple Hill and other local events,

ITEM 11.1.

and seasonal access to recreation in the Lake Tahoe Region. These operational issues were further explored in a PSR-PDS that EDCTC completed in December 2009.

Large rock slides have required closure of US 50 and the need for a detour for traffic crossing the Sierra. Caltrans has partnered with El Dorado County and the Eldorado National Forest to detour traffic at the US 50/Sly Park Road turn-off which connects with Mormon Emigrant Trail, which connects with SR 88.

Climate also is an issue that the US 50 corridor must confront. During most of the year, the weather is warm and travel to Lake Tahoe is unimpeded. During the winter, access to much of the facility is restricted to vehicles with four-wheel drive or chains, and chain control locations are conveniently located throughout the corridor. This chain requirement, the inclement weather, and use of traction material on the road have a detrimental impact on the road pavement, which deteriorates more rapidly than other facilities' pavements. Special attention must be paid to ensure that US 50 is maintained in good condition. In addition, snow removal in the area is not provided on bicycle facilities during the winter months.

Another key corridor issue is the lack of right of way for modification or enhancement of the facility in some locations. The urban facility from West Sacramento to Folsom is surrounded by urban development, and expansion would be prohibitively expensive. From Folsom until Placerville there is room to expand US 50 to accommodate new development in western El Dorado County, but careful corridor planning is essential in preserving ROW for future lane expansion. Through most of the Eldorado National Forest US 50 is a two-lane conventional highway, with protected forest, steep cliffs, or mountainside, thus making modification considerably more difficult. In developed areas, such as South Lake Tahoe, the facility serves built out areas, and modifying the facility would be prohibitively costly. There is some ability to expand capacity in Camino and Pollock Pines. In planning for future facility improvements coordination with local agencies will prove vital.

Bus/Carpool Lane Degradation

A recent report, the *2011 California HOV Lane Degradation Determination Report*, determined that US 50 bus/carpool lanes are degraded in the eastbound evening and the westbound morning periods. According to federal law, a bus/carpool lane is degraded when during the peak morning or evening period the average speed drops below 45 mph for at least 10% of the time in a 180-day period. The degraded segments are from Sunrise Blvd. (PM 12.5) to halfway between Hazel Av. and Folsom Blvd. (PM 16.311) in both directions. The segments are listed as slightly degraded, 14.5% of the time degraded for eastbound evening and 18.3% of the time degraded for westbound morning. This pattern roughly reflects commuting patterns to and from downtown Sacramento and Rancho Cordova employment opportunities. Because this report uses data from before the opening of the bus/carpool lanes from Watt Ave. to Sunrise Blvd. in 2012, the conditions may have changed on the ground.

As a result of this report and the degraded bus/carpool lane conditions, Caltrans must take action to improve bus/carpool lane performance. According to the federal transportation law, Moving Ahead for Progress in the 21st Century Act (MAP 21), Caltrans must enact measures to improve bus/carpool lane performance within 180 days of the determination of degradation, or Caltrans must otherwise face sanctions of withheld funds or withheld project approval.

CORRIDOR CONCEPT FACILITY

CONCEPT RATIONALE

"Concept LOS" and "Concept Facility" have traditionally been used in Caltrans TCRs and CSMPs to reflect the minimum level or quality of operations acceptable for each route segment and the highway facility needed in

ITEM 11.1.

the next 20 years and beyond. The “*Base Year*”, “*No Build*”, “*Build*”, and “*Concept*” LOS for US 50 are identified in Table 13 by segment. The *Concept* LOS is LOS D in rural areas and LOS E in urban areas. The “*20-Year Build Facility*” and “*Ultimate Facility Concept*” for US 50 are shown above in Table 6. The *20-Year Build Facility* includes all projects expected to be completed within the 20-year horizon (2031), while the *Ultimate Facility Concept* includes all projects with an expected completion year beyond the 20-year horizon. Projects have been identified below as *Projects and Strategies*.

Over one-half of US 50 segments are forecasted to operate under LOS “F” conditions in 20 years under the “*No Build*,” “*Build*,” and “*Concept*” scenarios. The No-Build scenario is the current facility with future traffic volumes. The Build scenario is the current facility plus planned and programmed SHS projects with future traffic volumes. The *Ultimate Facility Concept* is the facility needed to meet District performance standards for a particular segment. Many segments within the US 50 TCR/CSMP cannot be improved to perform at the District standard of E for urban areas due to financial, environmental, right of way, or political constraints. For these segments, targeted operational improvements, Intelligent Transportation Systems (ITS), and Integrated Corridor Management (ICM) including Transportation Demand Management (TDM) and active multimodal corridor management strategies will be needed to assist in achieving the Concept LOS, which are reflected in the programmed, planned, and conceptual project lists located in Tables 18 through 22. Planning and deployment of ITS and operational improvements within District 3 will be articulated in the *District 3 ITS/Operational Improvement Plan* and the *District 3 Concept of Operations Plan*, both in development.

Additionally, measures to reduce travel demand on the highway such as increased use of transit and development of parallel local road facilities may be explored as a means to prevent further LOS threshold degradation on the SHS and will be considered in the CEQA development process, provided that the reduction is quantified to the satisfaction of Caltrans. Moreover, the *District 3 Complete Streets Implementation Plan* as described previously in this document, and the *District 3 State Highway Bicycle Facility Plan* identify locations for construction of pedestrian and bicycle facilities that will further reduce local vehicular trips on state highway facilities.

PROJECTS AND STRATEGIES

Projects and strategies to achieve the LOS and facility concept have two categories of funding status: fiscally constrained and fiscally unconstrained.

Fiscally constrained projects and strategies are projects that can be implemented using committed, available, or reasonably available revenue sources.¹

Fiscally unconstrained projects and strategies are conceptual transportation improvements without an identified funding source and may be funded if reasonable additional resources become available.²

In addition to the funding status categories, there are three types of transportation improvements or actions: programmed, planned, and conceptual. Projects and strategies to achieve facility concept are grouped into (1) highway planned and programmed projects and strategies, (2) highway conceptual projects and strategies, and (3) off-highway corridor projects.

Planned and Programmed Projects and Strategies

A ***programmed improvement or action*** is a project listed in a near-term programming document identifying funding amounts by year, such as the State Transportation Improvement Program (STIP) or the State Highway Operations and Protection Program (SHOPP).

ITEM 11.1.

A ***planned improvement or action*** is a project listed in a fiscally constrained section of a long-term plan, such as an approved Regional or Metropolitan Transportation Plan (RTP or MTP), Capital Improvement Plan, or measure, including SHOPP plan projects.

Conceptual Projects and Strategies

Conceptual improvement or action is a project that is needed to maintain mobility or serve multimodal users, but is not currently included in a fiscally constrained plan and is not currently programmed. Conceptual projects are all fiscally unconstrained projects derived from documents such as local and regional General Plans, and Caltrans System Planning Documents.

Highway planned and programmed projects along the US 50 corridor are listed in Table 17, highway conceptual projects along the corridor are listed in Table 18, and off-highway corridor projects are listed in Tables 19 through 21.

To improve the bus/carpool lane segments with degraded performance, several projects have been proposed and are listed in this CSMP. Chief among these projects is the extension of bus/carpool lanes from Watt Ave. to the Oak Park Interchange, which will improve traffic flow on the entire facility. Several traffic operations projects will also improve the performance of the bus/carpool lanes. These projects include an auxiliary lane from Zinfandel Dr. to Sunrise Blvd., ramp metering, and a transition lane between the slip-on and off-ramps at Sunrise Blvd. Transit projects, such as shuttle service to light rail stations in Rancho Cordova, and bus stop and light rail station enhancements, will make transit a more attractive alternative to freeway travel. Finally, numerous bicycle and pedestrian improvements are planned for the corridor, creating a further alternative to travel on US 50. In the mean time, before these projects are built, increased enforcement by the California Highway Patrol (CHP) of minimum bus/carpool lane occupancies and more rapid Freeway Service Patrol response will yield improved bus/carpool lane performance. Further information on these actions can be found in the *2013 California High Occupancy Vehicle Lane Degradation Action Plan*.



ITEM 11.1.

TABLE 17: HIGHWAY PLANNED AND PROGRAMMED PROJECTS AND STRATEGIES							
Seg. #	Description	Programmed or Planned ¹⁾	Location, County, Lead Agency, Post Mile	Purpose	Source ²⁾	Total Cost Estimate (x \$1,000) ³⁾	Completion Year ³⁾
1	IC improvements	Programmed	Jefferson Blvd. YOL PM 2.495	System Management	2035 SACOG MTP/MTIP	26,450	2022
1	Install ramp meters; modify ramp design	Programmed	South River Rd. YOL PM 2.926	System Management	2035 SACOG MTP/MTIP	22,625	2020
1	Install Weigh-In-Motion (WIM) Station on SR 50 and I-80 Ramp	Planned	I-80 Junction. YOL PM 0.00	Weigh Stations and Weigh-in-Motion Stations	2014 SHOPP	2,000	2020
1-6; 20-21	Upgrade closed caption televisions (CCTV)	Programmed	80 locations in urban areas. Various PM.	Modify existing ITS elements	2014 SHOPP	2,640	2020
2	IC reconstruction including Bus/Carpool connectors	Planned	Oak Park IC. SAC PM L2.137	System Expansion	2035 SACOG MTP	300,000	2035
2/3/4	Construct Bus/Carpool lanes	Partially Programmed	Watt Ave. to Downtown Sacramento. SAC PM L0.00- R5.37	Priority Congestion Relief, System Expansion	2035 SACOG MTP	68,315	2020
3	Replace existing communication lines with fiber optics to improve performance	Planned	SR 99 and 51 to Watt Ave. SAC PM L0.00-R5.37	Modify existing ITS elements	2013 10 Year SHOPP Plan	952	2023
3-7	Upgrade Comm systems	Programmed	178 locations in urban areas. Various PM, routes and counties.	Modify existing ITS elements	2014 SHOPP	4600	2019
4	Construct aux lanes	Planned	NB Howe Ave. on ramp to SB Howe Ave. on ramp. SAC PM R3.68	Priority Congestion Relief, System Management	2035 SACOG MTP	3,746	2020
4	Construct aux lanes	Planned	Bradshaw Rd. overcrossing to Mather Field Rd. overcrossing. SAC PM R7.8-R9.5	Priority Congestion Relief, System Management	2035 SACOG MTP	3,700	2020
4	IC modification	Planned	Mather Field Rd. SAC PM R9.505	Interchange Modification	2035 SACOG MTP	5,647	2025
5	Bike/Ped OC of US 50 to connect Olson Dr to Prospect Dr	Planned	Olson Dr. to Prospect Park Dr. SAC PM R11.30	System Management	2035 SACOG MTP	8,500	2035
5	Construct aux lanes EB & WB	Planned	Sunrise Blvd. to Zinfandel Dr. SAC PM R10.92-12.5	System Management	2035 SACOG MTP	6,844	2035

ITEM 11.1.

TABLE 17: HIGHWAY PLANNED AND PROGRAMMED PROJECTS AND STRATEGIES							
Seg. #	Description	Programmed or Planned ¹⁾	Location, County, Lead Agency, Post Mile	Purpose	Source ²⁾	Total Cost Estimate (x \$1,000) ³⁾	Completion Year ³⁾
5/6	Construct transition lane WB	Planned	Sunrise Blvd. slip off ramp to Sunrise Blvd. slip on ramp. SAC PM 12.5	Priority Congestion Relief, System Management	2035 SACOG MTP	4,107	2035
6	Upgrade video wall at Regional Transportation Management Center (RTMC)	Planned	RTMC east of Sunrise Blvd. SAC PM 12.96	Modify existing ITS elements	2013 10 Year SHOPP Plan	2,000	2023
6	Multi-modal corridor improvements & IC improvements	Programmed	Hazel Ave. SAC PM 15.76	System Management	2035 SACOG MTP	85,000	2020
6/7	Natoma Overhead: widen EB US 50 and add HOV lane at on ramp, add ramp meter	Programmed	Folsom Blvd. and Natomas Overcrossing. SAC PM 16.90-17.40	Priority Congestion Relief, System Management	2013 10 Year SHOPP Plan	6,821	2015
6/7	Add aux lanes EB	Planned	Sunrise Blvd. to Scott Rd. SAC PM 12.5-21.5	System Management	2013 DSMDP	3,500	2025
6/7	Construct new IC at US 50/Rancho Cordova Pkwy. including aux lanes on US 50 btwn Hazel Ave. & Sunrise Blvd. and 4 lane arterial connection to US 50 off Rancho Cordova Pkwy. to White Rock Rd.	Partially Programmed	Rancho Cordova Pkwy. SAC PM 12.5-15.76	System Expansion	2035 SACOG MTP	100,000	2020
7	Construct new 4 lane IC	Programmed	Empire Ranch Rd. SAC PM 23	System Management	2035 SACOG MTP	38,552	2035
7	Construct new 4 lane IC	Planned	Oak Ave Pkwy. SAC PM 20.3	System Management	2035 SACOG MTP	84,646	2035
7	Ramp modifications & overpass widening	Planned	East Bidwell St./Scott Rd. IC. SAC PM 21.5	System Management	2035 SACOG MTP	3,740	2020
9	IC Phase 1	Programmed	Silva Valley Pkwy. IC ELD PM R1.65	System Management	2035 SACOG MTP/MTIP	52,375	2016
8	Construct Auxiliary Lanes - WB	Planned	WB, El Dorado Hills Blvd./Latrobe Rd. to future Empire Ranch Rd. IC. ELD PM 0.00-0.86	Priority Congestion Relief, System Management	2035 SACOG MTP	3,688	2035

ITEM 11.1.

TABLE 17: HIGHWAY PLANNED AND PROGRAMMED PROJECTS AND STRATEGIES							
Seg. #	Description	Programmed or Planned ¹⁾	Location, County, Lead Agency, Post Mile	Purpose	Source ²⁾	Total Cost Estimate (x \$1,000) ³⁾	Completion Year ³⁾
8	IC Improvements-EB Ramps	Planned	El Dorado Hills Blvd. ELD PM 0.86	System Management	2035 SACOG MTP/MTIP	5,904	2035
9	Construct Class 1 Ped/Bike overcrossing, El Dorado Hills Blvd	Programmed	El Dorado Hills Blvd. Area. ELD PM 1.183	System Management	2035 SACOG MTP/MTIP	6,783	2028
9	IC Improvements Ph 1, WB auxillary lane between Silva Valley Rd & Bass Lake Rd.	Planned	Bass Lake Rd. IC. ELD PM R1.65-R3.23	System Management	2035 SACOG MTP	20,829	2035
9	IC Phase 2	Planned	Silva Valley Parkway IC. ELD PM R1.65	System Management	2035 SACOG MTP	14,200	2035
10	Construct Aux. Lanes - WB	Planned	Bass Lake Rd. to Cambridge Rd. ELD PM R3.23-4.962	System Management	2035 SACOG MTP	23,640	2035
10	Construct Auxiliary Lanes - EB	Planned	Cambridge Rd. to Cameron Park ICs, WB Cameron Park to Bass Lake Rd. Ics. ELD PM R3.23-6.57	System Management	2035 SACOG MTP	15,500	2035
10	IC Improvements-Ph 1, EB/WB Ramps	Planned	Cambridge Rd IC. ELD PM 4.962	System Management	2035 SACOG MTP	10,645	2035
10-12	Construct Aux. Lanes - EB	Planned	Cambridge Rd. to Ponderosa Rd. ELD PM 4.962-R8.564	System Management	2035 SACOG MTP	14,550	2035
10/11	IC Improvements	Planned	Cameron Park Dr. ELD PM 6.57	System Management	2035 SACOG MTP	58,737	2035
12	IC; Realign WB Offramp with Wild Chaparral Dr and signalize intersection; Realign 0.25 Mile of North Shingle Rd at Ponderosa Rd	Programmed	Ponderosa Rd IC/ North Shingle Rd. ELD PM R8.564	System Management	2035 SACOG MTP/MTIP	5,020	2024
12	Bus/Carpool Lanes (Phase 3)	Planned	Ponderosa Rd. to Greenstone Rd. ELD PM R8.56-R12.19	System Expansion	2035 SACOG MTP	34,730	2035
12	Durock Rd Realignment; signalize new intersection	Planned	Ponderosa Rd. IC/ Durock Rd. ELD PM 8.564	System Management	2035 SACOG MTP/MTIP	7,152	2026
12	IC Improvements	Planned	South Shingle Rd. IC. ELD PM R8.564	System Management	2035 SACOG MTP	23,088	2035

ITEM 11.1.

TABLE 17: HIGHWAY PLANNED AND PROGRAMMED PROJECTS AND STRATEGIES							
Seg. #	Description	Programmed or Planned ¹⁾	Location, County, Lead Agency, Post Mile	Purpose	Source ²⁾	Total Cost Estimate (x \$1,000) ³⁾	Completion Year ³⁾
12	IC Improvements Ph 1 & 2	Planned	El Dorado Rd. ELD PM 14.011	System Management	2035 SACOG MTP	10,803	2035
13	IC Improvements Ph 2A & Ph 3	Planned	Western Placerville ICs, Ph 2A & Ph 3. ELD PM 15.83-16.503	System Management	2035 SACOG MTP/MTIP	23,374	2030
13	Local Road Improvements Ph 2B & 2C; improvements to Ray Lawyer Dr & Forni Rd	Programmed	Western Placerville ICs, Ph 2B & 2C. ELD PM 15.83-16.503	System Management	2035 SACOG MTP/MTIP	6,748	2018
13	Local Road Improvements Ph 1B-Realign Fair Lane to correct curve & construct Class II Bike Lanes, sidewalks & retaining walls	Programmed	Western Placerville ICs, Ph 1B, ELD PM 16.276	System Management	2035 SACOG MTP/MTIP	1,589	2014
14, 16, 18, 19, 21	Upgrade HAR systems	Planned	25 locations in rural areas. Various PM, routes and counties.	Modify existing ITS elements	2016 SHOPP	2670	2021
15	EB signalization and ramp lengthening	Planned	Broadway. ELD PM 18.517	System Management	2035 SACOG MTP	2,000	2035
15	Construct new IC	Planned	Mosquito Rd. ELD PM 18.52	System Management	2035 SACOG MTP	60,000	2035
15	Construct undercrossing, median barriers, modify local connectors, operational/ safety improvements	Planned	Camino Operational/ Safety Improvements. ELD PM 24.052	System Management	2035 SACOG MTP	33,900	2035
19	Upgrade RWIS systems	Planned	18 locations in rural areas. Various PM, routes and counties.	Modify existing ITS elements	2016 SHOPP	2300	2021
20	Construct roundabout or install signal at junction	Planned	Junction SR 89 in Meyers. ELD PM 70.64	System Management	2035 TMPO RTP	5,000	2020
20	Intersection improvements	Planned	Pioneer Trail in Myers. ELD PM 71.477	System Management	2035 TMPO RTP	2,000	2020
20/ 21	Signal synchronization - Install Adaptive Traffic Signal Control	Planned	19 locations in El Dorado County. Various PM.	System Management	ITS/OPS Project List	1,000	Long
21	Create new Loop Rd	Partially Programmed	Park Ave to Stateline. ELD PM 80.149-80.44	System Management	2035 TMPO RTP	75,000	2017

ITEM 11.1.

TABLE 17: HIGHWAY PLANNED AND PROGRAMMED PROJECTS AND STRATEGIES

Seg. #	Description	Programmed or Planned ¹⁾	Location, County, Lead Agency, Post Mile	Purpose	Source ²⁾	Total Cost Estimate (x \$1,000) ³⁾	Completion Year ³⁾
21	Signal improvements	Planned	SR 89 (the "Y") to Nevada State line. ELD PM 75.456-80.44	Priority Congestion Relief, System Management	2035 TMPO RTP	5,000	2015

¹⁾ Programmed include those projects that are partially and fully funded. Definitions of Programmed, Planned, and Conceptual projects can be found in Appendix A.

²⁾ Note, only SHOPP projects that improve Mobility and are Mandated for furthering Complete Streets are included. A complete listing of SHOPP projects can be viewed at <http://ctips.dot.ca.gov/citrix/metaframexp/default/reports.asp>.

³⁾ Total Cost and Completion Year Estimates are from listed Source. Additional project details and programming information can be found in the District 3 DSMDP at <http://www.dot.ca.gov/dist3/departments/planning/systemplanningDSMDP.htm>, 2012 SACOG MTP project list at <http://www.sacog.org/2035/files/MTP-SCS/appendices/A-1%20Project%20List.pdf>, 2012 SACOG MTIP Appendix 3 project list at <http://www.sacog.org/mtip/2013-2016/adoption/pdf/2013%20MTIP%20Transmittal%209-26-12.pdf>, 2012 TMPO RTP, Chapter 6 project list at http://tahoempo.org/rtp_final/TAHOE%20RTP%2006%20Funding%20and%20Impl.pdf, and CT Programming at <http://ctips.dot.ca.gov/citrix/metaframexp/default/reports.asp>.

There are several conceptual projects identified in Table 18 below that are proposed for construction on US 50 in the long term, beyond year 2025. These projects consist of HOV lanes, ITS/Operations projects, interchange improvements, and bicycle/pedestrian projects. Because these projects are of an undefined time frame, they are subject to revision.

TABLE 18: HIGHWAY CONCEPTUAL PROJECTS AND STRATEGIES

Seg. #	Description	Location, County, Lead Agency, Post Mile	Purpose	Source ¹⁾	Total Cost Estimate (x \$1,000) ²⁾	Completion Year ²⁾
1	Construct HOV lanes (Sections B)	Davis to downtown Sacramento (Sections B & C). YOL PM 0.0-3.156	Construct HOV lanes to relieve congestion	2035 SACOG MTP	(see section A)	2035
2	Construct HOV lanes (Section C)	Davis to downtown Sacramento (Section C). SAC PM L0.36-0.02	Construct HOV lanes to relieve congestion	2035 SACOG MTP	(see section A)	2035
3 - 6	Ramp meter improvements on both directions	Stockton Blvd. to Folsom Blvd. SAC PM 0.6-17.01	Improve facility performance through operational enhancements	ITS/OPS Project List	8,000	2016
12/13	Interchange Improvements Ph 2	Missouri Flat Interchange. ELD PM R15.06	Interchange improvements to accommodate local development	2013 DSMDP	20,000	2035
11	Bus/Carpool Lanes (Phase 2B)	Cameron Park Dr. to Ponderosa Rd. IC. ELD PM 6.57-R8.56	System Expansion	2035 SACOG MTP	22,637	2035

ITEM 11.1.

TABLE 18: HIGHWAY CONCEPTUAL PROJECTS AND STRATEGIES

Seg. #	Description	Location, County, Lead Agency, Post Mile	Purpose	Source ¹⁾	Total Cost Estimate (x \$1,000) ²⁾	Completion Year ²⁾
13 - 19	El Dorado 50 ITS	In El Dorado County from Missouri Flat Rd to Echo Sandhill. ELD PM R15.06-67.295	Improve facility performance through ITS enhancements	ITS/OPS Project List	2,600	Long
19 - 21	Construct Class II Bike Lane	S. Upper Truckee Rd. to Stateline Rd.	Accommodate bicyclists as part of the Environmental Improvement Program (EIP)	2013 D3 SHBFP	4,800	Long

¹⁾ Note, only SHOPP projects that improve Mobility and are Mandated for furthering Complete Streets are included. A complete listing of SHOPP projects can be viewed at <http://ctips.dot.ca.gov/citrix/metaframexp/default/reports.asp>.

²⁾ Total Cost and Completion Year Estimates are from listed Source. Additional project details and programming information can be found in the District 3 DSMDP at <http://www.dot.ca.gov/dist3/departments/planning/systemplanningDSMDP.htm>, 2012 SACOG MTP project list at <http://www.sacog.org/2035/files/MTP-SCS/appendices/A-1%20Project%20List.pdf>, 2012 SACOG MTIP Appendix 3 project list at <http://www.sacog.org/mtip/2013-2016/adoption/pdf/2013%20MTIP%20Transmittal%209-26-12.pdf>, 2012 TMPO RTP, Chapter 6 project list at http://tahoempo.org/rtp_final/TAHOE%20RTP%2006%20Funding%20and%20Impl.pdf, and CT Programming at <http://ctips.dot.ca.gov/citrix/metaframexp/default/reports.asp>.

Off-Highway US 50 Corridor Projects

The original US 50 CSMP from 2009 contained off-highway projects on parallel roads, bicycle routes, and transit systems. These projects, while not under Caltrans' direct purveyance, have an impact on freeway operations of US 50 by offering alternatives to travel on the highway. These alternatives reduce traffic on the freeway and improve overall functioning of the corridor. These off-highway projects as identified in Tables 20 through 22 below are either on parallel roads, cross US 50 ROW, are transit projects, or are bicycle and pedestrian projects.



ITEM 11.1.

TABLE 19: OFF-HIGHWAY PARALLEL AND CONNECTING ROADS PROJECTS				
Seg. #	Description	Planned or Programmed	Location, County	Source
1	Streetscape improvements, including wider sidewalks, flatter road cross-section, reconfigure lanes, roundabout, utility relocation, new lighting, and substantial planting and hardscape treatments.	Programmed	West Capitol Ave, Westacre Rd. to Harbor Blvd.	2035 SACOG MTP/MTIP
3	Widen to 5 lanes	Planned	65th St., US 50 to Broadway	2035 SACOG MTP
3	Widen to 6 lanes	Planned	Power Inn Rd., Fruitridge Rd. to 14th Ave.	2035 SACOG MTP
3	Streetscape project including pedestrian and bicycle improvements, a raised landscaped median, landscaped planters, improvements to signal operations, frontage landscaping, and enhanced connections to transit facilities.	Programmed	Folsom Blvd., Power Inn Rd. to Watt Ave.	2035 SACOG MTP/MTIP
4	Widen to 4 lanes	Planned	Mather Blvd., Rockingham Rd. to Zinfandel Dr.	2035 SACOG MTP
6	Widen to 6 lanes with special treatments. Intersection improvements at White Rock, Folsom Blvd., Coloma Rd., Zinfandel Dr., Gold Express, and Gold Country.	Planned	Sunrise Blvd., White Rock Rd. to American River	2035 SACOG MTP
6	On existing 6-lane White Rock Rd., from Sunrise Blvd. to Luyung Dr.: construct improvements. From Luyung Dr. to Grant Line Rd.: widen and reconstruct from 2 to 4 lanes.	Programmed	On White Rock Rd.: Sunrise Blvd. to Luyung Dr.; Luyung Dr. to Grant Line Rd.	2035 SACOG MTP/MTIP
6	Grant Line Expressway Phase I: Widen four lanes and complete remaining sections of four lane Expressway. Intersection improvements at Jaeger Road, Keifer Blvd, International Drive and Jackson Highway.	Planned	Grant Line Rd., Jackson Hwy. to White Rock Rd.	2035 SACOG MTP
6-7	Easton Valley Pkwy.: Construct New Road: 4 Lanes	Programmed	Hazel Ave. to Prairie City Rd.	2035 SACOG MTP
7	Widen from 2 to 4 lanes	Planned	Prairie City Rd., US 50 to White Rock Rd.	2035 SACOG MTP
7	Widen from 2 to 4 lanes	Planned	White Rock Rd., Prairie City Rd to El Dorado County Line	2035 SACOG MTP

ITEM 11.1.

TABLE 19: OFF-HIGHWAY PARALLEL AND CONNECTING ROADS PROJECTS				
Seg. #	Description	Planned or Programmed	Location, County	Source
7	Widen to 6 lanes	Planned	Iron Point Rd., Black Diamond Dr. to Prairie City Rd.; Outcropping Way to Broadstone Pkwy.	2035 SACOG MTP
7	Widen from 2 to 6 lanes	Planned	Scott Rd., US 50 to White Rock Rd.	2035 SACOG MTP
8	Widen from 2 to 4 lanes, divided	Planned	White Rock Rd., Sacramento County Line to Manchester Dr.	2035 SACOG MTP
8	Construct new 2 lane arterial road to extend Saratoga Way from its current terminus at Finders Way in El Dorado Hills to the Sacramento County Line / Iron Point Rd.	Planned	Saratoga Way, Iron Point Rd./Sacramento County Line to Finders Way	2013 El Dorado County CIP
8/9	Construct a second eastbound through lane from the commercial area near Sophia Parkway intersection to Francisco Drive with traffic signal installation at the Green Valley Road/Browns Ravine/Miller Road intersection. Also add a second westbound lane from Francisco Drive to the commercial area near the Sophia Parkway intersection.	Planned	On Green Valley Rd. from County line to Francisco Dr.	2035 SACOG MTP
9	Widen to 6 lanes, divided. Construct interchange.	Planned	White Rock Rd., Latrobe Rd. to Silva Valley Pkwy.	2035 SACOG MTP
9	Widen from 2 lanes undivided to 4 lanes divided, with interchange; includes curb, gutter, sidewalk and Class II bike lanes	Planned	White Rock Rd., Monte Verde Dr. to Silva Valley Pkwy.	2035 SACOG MTP
9	Widen to 4 lanes	Planned	Green Valley Rd., Francisco Dr. to Deer Valley Rd.	2035 SACOG MTP
10/11	Widen to 5-lanes: 2 NB through lanes (with right and left turn pockets) and 3 SB through lanes (with dual right turn lanes at Robin Ln.). Project includes median and signal modification at Coach Ln. intersection, realignment of Robin Ln. intersection for future extension to Rodeo Dr. and construction of a new traffic signal.	Planned	Cameron Park Dr., Cameron Park Dr. to Coach Ln.	2035 SACOG MTP
12	Intersection improvements	Planned	Green Valley Rd and Deer Valley Intersection	2035 SACOG MTP

ITEM 11.1.

TABLE 19: OFF-HIGHWAY PARALLEL AND CONNECTING ROADS PROJECTS				
Seg. #	Description	Planned or Programmed	Location, County	Source
12	Replace the existing 2 lane functionally obsolete bridge with a new 2 lane bridge	Programmed	Green Valley Rd. and Indian Creek	2035 SACOG MTP/MTIP
12	Widen Green Valley Rd. to two 12-ft lanes with paved shoulders. Project includes adding six left-turn pockets.	Planned	Deer Valley Rd to Lotus Rd	2035 SACOG MTP
13	Widen to 4 lanes of traffic, a dual left turn lane, sidewalks, and bike lanes on both sides.	Planned	Placerville Dr. from Fair Ln. to Ray Lawyer Dr.	2035 SACOG MTP
13	Widen to 4 lanes of traffic, a dual left turn lane, sidewalks, and bike lanes on both sides.	Planned	Placerville Dr. from Ray Lawyer Dr. to Cold Springs Rd.	2035 SACOG MTP
13	Widen bridge to 5 lanes, 2 through lanes in each direction and a median turn lane. Widening will include bike lanes and sidewalks.	Programmed	Bridge over Hangtown Creek Bridge, 0.3 mi west of Cold Springs Rd.	2035 SACOG MTP/MTIP
13	Widen to 4 lanes of traffic, a dual left turn lane, sidewalks, and bike lanes on both sides.	Planned	Placerville Dr. from Cold Springs Rd. to US 50	2035 SACOG MTP
13	Replace existing structurally deficient 2 lane bridge with new 2 lane bridge over Weber Creek, widen and realign Green Valley Rd. at bridge approaches, and drainage improvements.	Programmed	Green Valley Rd. and Weber Creek	2035 SACOG MTP/MTIP
15	Construct 700-foot of new 2-lane road. Includes sidewalks to City collector street standards between Broadway and Main St. New road will extend Main St. down Spanish Ravine Road.	Planned	Main St., Broadway, and Spanish Ravine Rd.	2035 SACOG MTP
15	Construct roundabout	Planned	Main St., Cedar Ravine Rd., and Clay St.	2035 SACOG MTP
15	Install traffic signals	Planned	Intersection with Broadway. and Blairs Ln.	2035 SACOG MTP

ITEM 11.1.

TABLE 20: OFF-HIGHWAY TRANSIT PROJECTS				
Seg. #	Description	Planned or Programmed	Location, County	Source
1 - 2	9 mile urban streetcar network connecting the Intermodal Terminal in downtown Sacramento to West Sacramento	Programmed	West Sacramento and downtown Sacramento	2035 SACOG MTP/MTIP
2	Light rail station improvements: Add 2 shelters, surveillance camera, pedestrian signage, 2 visible message signs	Programmed	29th St. Light Rail Station	2035 SACOG MTP/MTIP
2	North-south alignment, relocating bus berths, providing enhanced passenger connections, relocating passenger vehicle and bicycle parking.	Programmed	Sacramento Valley Station	2035 SACOG MTP/MTIP
2	Complete makeover and rehab. of the depot to make it fully usable. Accommodation of high speed trains, commuter rail, light rail, streetcars, transit bus lines, intercity buses.	Planned	Sacramento Valley Station	2035 SACOG MTP
2 - 7	Enhancement of bus stops and light rail stations	Programmed	Various bus stops and light rail stations	2035 SACOG MTP/MTIP
3	Streetscape project with pedestrian and bicycle improvements, a raised landscaped median, planters, improvements to signal operations, frontage landscaping, and connections to transit facilities.	Programmed	On Folsom Blvd, from Power Inn Rd to Watt Ave	2035 SACOG MTP/MTIP
3 - 4	Modify freeway interchange. Construct multi-modal improvements with a bicycle and pedestrian path.	Programmed	US 50/Watt Ave Interchange	2035 SACOG MTP/MTIP
4	Streetscape Project: On Folsom Blvd. Includes landscape and safety improvements for bicycle and pedestrian access to transit. Phase IV.	Planned	Bradshaw Rd to Sunrise Blvd	2035 SACOG MTP
4	Rail Crossing Projects: Plan and construct a rail grade separation for RT's Gold Line	Planned	Bradshaw Rd, Mather Field Rd, Routier Rd, and Zinfandel Dr.	2035 SACOG MTP
4 - 5	Phase 1 of Loop Streetcar (7.5 miles)	Planned	Rancho Cordova Town Center	2035 SACOG MTP
7 - 8	Construct a 250-space park-and-ride facility near Empire Ranch Interchange	Planned	South of US 50 near Empire Ranch Interchange	2035 SACOG MTP
7 - 8	Construct a regional fueling station for transit operators	Planned	Sacramento/El Dorado County Line	2035 SACOG MTP
13	Construct 150 space park and ride lot on south side of US 50 between proposed Ray Lawyer Dr eastbound off-ramp and realigned Forni Road	Programmed \$1.1 million CMAQ on March 6, 2014	South of US 50 near Ray Lawyer Dr	SACOG MTIP

ITEM 11.1.

TABLE 21: OFF-HIGHWAY BICYCLE AND PEDESTRIAN PROJECTS				
Seg. #	Description	Planned or Programmed	Location, County	Source
4	Bicycle facility improvements at light rail station	Planned	Watt Ave Light Rail Station	SACOG MTP/MTIP
4	Add sidewalks and enhance pedestrian and disabled access.	Programmed	West side of Mather Field Road, between Folsom Blvd and Rockingham Dr. Known as the Mather Railroad Spur Rails to Trails Project	SACOG MTP/MTIP
4	Class I bike path along the south bank of the American River	Conceptual	Watt Ave. to Gristmill Park	Conceptual Project
4	Overcrossing of US 50 at Railroad ROW	Conceptual	Between Routier Rd. and Mather Field Rd.	Conceptual Project
4 - 6	Develop plan for citywide bicycle system	Planned	City of Rancho Cordova	SACOG MTP/MTIP
4 - 6	Class I bike path	Planned	From Mosher Rd. to White Rock Rd.	2013 RBPTMP
5 - 6	Provide a bicycle/pedestrian connection	Planned	Douglas Rd to Folsom South Canal Bike Trail	SACOG MTP/MTIP
6 - 7	Bicycle overcrossing of US 50	Planned	Folsom Blvd.	SACOG 2013 Regional Bicycle, Pedestrian, and Trails Master Plan (2013 RBPTMP)
7	Construct Class I bicycle path - Humbug-Willow Creek Trail/Lake Natoma Bikeway	Planned	Blue Ravine Rd to Lake Natoma Trail	SACOG MTP/MTIP
7	Overcrossing of Folsom Blvd at Humbug-Willow Creek Pkwy	Planned	Folsom Blvd at Humbug-Willow Creek Pkwy	SACOG MTP/MTIP
7	Construction of a Class I bike path parallel to US 50	Planned	Empire Ranch Rd to Alder Creek	SACOG MTP/MTIP
7 - 8	Construct Class II bike lanes as part of Saratoga Way extension	Planned	On Saratoga Way, from Finders Way to County Line	SACOG MTP
8	Bicycle/pedestrian overcrossing of US 50	Planned	El Dorado Hills Blvd.	SACOG MTP
8/9	White Rock Rd. Class II bike lanes	Planned	El Dorado County Line to Silva Valley Pkwy	2013 RBPTMP

ITEM 11.1.

TABLE 21: OFF-HIGHWAY BICYCLE AND PEDESTRIAN PROJECTS				
Seg. #	Description	Planned or Programmed	Location, County	Source
9	Silva Valley Pkwy. Class II bike lanes	Planned	White Rock Rd to Harvard Wy.	2013 RBPTMP
9	Sliva Valley Pkwy. Class I bike path and Class II bike lanes	Programmed CMAQ March 6, 2014	Class I bike path Harvard Way to Appian Way; Class II bike lanes Appian Way to Green Valley Road	SACOG MTIP
10	Class II bike lanes	Planned	On Country Club Dr., from Bass Lake Rd. to Cambridge Rd.	2013 RBPTMP
10	Class II bike lanes	Planned	On Country Club Dr., from Cameron Park Dr. to Cambridge Rd.	2013 RBPTMP
9	Design and construct a Class I bike path within the powerline easement operated by the Sacramento Municipal Utility District (SMUD)	Programmed	El Dorado Hills Blvd to Silva Valley Pkwy (Phase 1 from Silva Valley Parkway to New York Creek was completed and Phase II was programmed CMAQ 3/6/14	SACOG MTP/MTIP
13	Class I bike path	Planned	Missouri Flat Rd. to Mother Lode Dr.	2013 RBPTMP
12	Class II bike lanes	Planned	On Mother Lode Rd., Lindberg Ave. to Missouri Flat Rd.	2013 RBPTMP
12/13	Bicycle/pedestrian overcrossing of US 50	Planned	Missouri Flat Rd.	2010 Placerville Non-Motorized Transportation Plan
13	Widen Placerville Dr and construct sidewalks and Class II bike lanes on both sides	Planned	Cold Springs Rd to US 50	SACOG MTP/MTIP
13	Widen Placerville Dr and construct sidewalks and Class II bike lanes on both sides	Planned	Fair Ln to Ray Lawyer Dr	SACOG MTP/MTIP
13	Widen Placerville Dr and construct sidewalks and Class II bike lanes on both sides	Planned	Ray Lawyer Dr to Cold Springs Rd	SACOG MTP/MTIP
15	Design and construct a Class I bike path along the El Dorado Trail. Bike and pedestrian overcrossing.	Programmed	Clay St to Bedford Ave	SACOG MTP/MTIP
15	Class I bike path parallel to US 50	Planned	Halcon Rd. to Snows Rd. near Camino	2013 RBPTMP
15	Extend El Dorado Trail Class I bike path	Programmed CMAQ 3/6/14	Los Trampas Dr to Halcon Rd in Camino	2013 RBPTMP

ITEM 11.1.

APPENDIX A: GLOSSARY OF TERMS AND ACRONYMS**Acronyms and Important Abbreviations**

AADT - Annual Average Daily Traffic
ADT - Average Daily Traffic
BY - Base Year
CALTRANS - California Department of Transportation
CEQA – California Environmental Quality Act
CHP – California Highway Patrol
CSMP - Corridor System Management Plan
CSUS – California State University, Sacramento
DSMP - District System Management Plan
DU - Density Unit
EDCTC - El Dorado County Transportation Commission
EIP - Environmental Improvement Program
FHWA - Federal Highway Administration
HCM - Highway Capacity Manual
HOV – High Occupancy Vehicle
HY - Horizon Year
I-5 – Interstate 5
I-80 – Interstate 80
ICM – Integrated Corridor Management
ITS - Intelligent Transportation System
ITSP - Interregional Transportation System Plan
LOS - Level of Service
MAP-21 – Moving Ahead for Progress in the 21st Century Act
MPO - Metropolitan Planning Organization
MPR – Mobility Performance Report
MTIP - Metropolitan Transportation Improvement Program
MTP - Metropolitan Transportation Plan
PeMS – Performance Measurement System
PM - Post Mile
ROW – Right of Way
RTIP – Regional Transportation Improvement Program
RTP – Regional Transportation Plan
RTPA - Regional Transportation Planning Agencies
SACOG - Sacramento Area Council of Governments
SHBFP – State Highway Bicycle Facilities Plan
SHOPP - State Highway Operation and Protection Program
SHS - State Highway System
SR - State Route
STAA - Surface Transportation Assistance Act
TCR - Transportation Concept Report
TDM – Transportation Demand Management
TMPO - Tahoe Metropolitan Planning Organization
TOC – Traffic Operations Center
TOS – Traffic Operations Systems
TRPA - Tahoe Regional Planning Agency
TTD - Tahoe Transportation District

ITEM 11.1.

V/C – Volume-to-Capacity Ratio

VHD – Vehicle Hours of Delay

VMT - Vehicle Miles Traveled

Definitions

AADT – Annual Average Daily Traffic is the total volume for the year divided by 365 days. The traffic count year is from October 1st through September 30th. Traffic Counting is generally performed by electronic counting instruments moved from locations throughout the State in a program of continuous traffic count sampling. The resulting counts are adjusted to an estimate of annual average daily traffic by compensating for seasonal influence, weekly variation and other variables which may be present. Annual ADT is necessary for presenting a statewide picture of traffic flow, evaluating traffic trends, computing accident rates, planning and designing highways and other purposes.

Base Year- The year that the most current data is available to the Districts.

Bikeway Class I (Bike Path) – Provides a completely separated right of way for the exclusive use of bicycles and pedestrians with cross flow by motorists minimized.

Bikeway Class II (Bike Lane) – Provides a striped lane for one-way bike travel on a street or highway.

Bikeway Class III (Bike Route) – Provides for shared use with pedestrians or motor vehicle traffic.

Capacity – The maximum sustainable hourly flow rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, environmental, traffic, and control conditions.

Capital Facility Concept – The 20-25 year vision of future development on the route to the capital facility. The capital facility can include capacity increasing, State Highway, bicycle facility, pedestrian facility, transit facility (Intercity Passenger rail, Mass Transit Guideway, etc.), grade separation, and new managed lanes.

Concept LOS – The minimum acceptable LOS over the next 20-25 years.

Conceptual Project – A conceptual improvement or action is a project that is needed to maintain mobility or serve roadway users, but is not currently included in a financially constrained plan and is not currently programmed. It could be included in a General Plan or in the unconstrained section of a long-term plan.

Corridor – A broad geographical band that follows a general directional flow connecting major sources of trips that may contain a number of streets, highways, bicycle, pedestrian, and transit route alignments. Off system facilities are included as information purposes and not analyzed in the TCR.

Facility Concept – Describes the facility and strategies that may be needed within 20-25 years. This can include capacity increasing, State Highway, bicycle facility, pedestrian facility, transit facility, non-capacity increasing operational improvements, new managed lanes, conversion of existing managed lanes to another managed lane type or characteristic, TMS field elements, transportation demand management and incident management.

Facility Type – The facility type describes the state highway facility type. The facility could be freeway, expressway, conventional, or one-way city street.

ITEM 11.1.

Freight Generator – Any facility, business, manufacturing plant, distribution center, industrial development, or other location (convergence of commodity and transportation system) that produces significant commodity flow, measured in tonnage, weight, carload, or truck volume.

Headway – The time between two successive vehicles as they pass a point on the roadway, measured from the same common feature of both vehicles.

Horizon Year – The year that the future (20-25 years) data is based on.

ITS – Intelligent Transportation System improves transportation safety and mobility and enhances productivity through the integration of advanced communications technologies into the transportation infrastructure and in vehicles. Intelligent transportation systems encompass a broad range of wireless and wire line communications-based information and electronics technologies to collect information, process it, and take appropriate actions.

LOS – Level of Services is a qualitative measure describing operational conditions within a traffic stream and their perception by motorists. A LOS definition generally describes these conditions in terms of speed, travel time, freedom to maneuver, traffic interruption, comfort, and convenience. Six levels of LOS can generally be categorized as follows:

LOS A describes free flowing conditions. The operation of vehicles is virtually unaffected by the presence of other vehicles, and operations are constrained only by the geometric features of the highway.

LOS B is also indicative of free-flowing conditions. Average travel speeds are the same as in LOS A, but drivers have slightly less freedom to maneuver.

LOS C represents a range in which the influence of traffic density on operations becomes marked. The ability to maneuver with the traffic stream is now clearly affected by the presence of other vehicles.

LOS D demonstrates a range in which the ability to maneuver is severely restricted because of the traffic congestion. Travel speed begins to be reduced as traffic volume increases.

LOS E reflects operations at or near capacity and is quite unstable. Because the limits of the level of service are approached, service disruptions cannot be damped or readily dissipated.

LOS F a stop and go, low speed conditions with little or poor maneuverability. Speed and traffic flow may drop to zero and considerable delays occur. For intersections, LOS F describes operations with delay in excess of 60 seconds per vehicle. This level, considered by most drivers unacceptable often occurs with oversaturation, that is, when arrival flow rates exceed the capacity of the intersection.

Multimodal – The availability of transportation options using different modes within a system or corridor, such as automobile, subway, bus, rail, or air.

System Operations and Management Concept – Describes the system operations and management elements that may be needed within 20-25 years. This can include non-capacity increasing operational improvements (auxiliary Lanes, channelizations, turnouts, etc.), conversion of existing managed lanes to another managed lane type or characteristics (e.g., High Occupancy Vehicle lane to High Occupancy Toll lane), TMS Field Elements, Transportation Demand Management, and Incident Management.

Peak Hour – The hour of the day in which the maximum volume occurs across a point on the highway.

Peak Hour Volume – The hourly volume during the highest hour traffic volume of the day traversing a point on a highway segment. It is generally between 6 percent and 10 percent of the ADT. The lower values are generally found on roadways with low volumes.

ITEM 11.1.

Planned Project – A planned improvement or action is a project in a financially constrained section of a long-term plan, such as an approved Regional or Metropolitan Transportation Plan (RTP or MTP), Capital Improvement Plan, or measure.

Post Mile – A post mile is an identified point on the State Highway System. The milepost values increase from the beginning of a route within a county to the next county line. The milepost values start over again at each county line. Milepost values usually increase from south to north or west to east depending upon the general direction the route follows within the state. The milepost at a given location will remain the same year after year. When a section of road is relocated, new milepost (usually noted by an alphabetical prefix such as “R” or “M”) are established for it. If relocation results in a change in length, “milepost equations” are introduced at the end of each relocated portion so that mileposts on the remainder of the route within the county will remain unchanged.

Programmed Project – A programmed improvement or action is a project in a near-term programming document identifying funding amounts by year, such as the State Transportation Improvement Program or the State Highways Operations and Protection Program.

Route Designation – A route’s designation is adopted through legislation and identifies what system the route is associated with on the State Highway System. A designation denotes what design standards should apply during project development and design. Typical designations include but not limited to National Highway System (NHS), Interregional Route System (IRRS), and Scenic Highway System.

Rural – Fewer than 2,500 in population designates a rural area. Limits are based upon population density as determined by the U.S. Census Bureau.

Segment – A portion of a facility between two points.

TDM – Transportation Demand Management programs designed to reduce or shift demand for transportation through various means, such as the use of public transportation, carpooling, telework, and alternative work hours. Transportation Demand Management strategies can be used to manage congestion during peak periods and mitigate environmental impacts.

TMS – Transportation Management System is the business processes and associated tools, field elements and communications systems that help maximize the productivity of the transportation system. TMS includes, but is not limited to, advanced operational hardware, software, communications systems and infrastructure, for integrated Advanced Transportation Management Systems and Information Systems, and for Electronic Toll Collection System.

Post-25 Year Concept – This dataset may be defined and re-titled at the District’s discretion. In general, the Post-25 Year concept could provide the maximum reasonable and foreseeable roadway needed beyond a 20-25 year horizon. The post-25 year concept can be used to identify potential widening, realignments, future facilities, and rights-of-way required to complete the development of each corridor.

Urban Cluster – 2,500 to 49,999 in population designates an urban cluster. Limits are based upon population density as determined by the U.S. Census Bureau.

Urbanized Area – Over 50,000 in population designates an urbanized area. Limits are based upon population density as determined by the U.S. Census Bureau.

VMT – Is the total number of miles traveled by motor vehicles on a road or highway segments.

ITEM 11.1.

APPENDIX B: RESOURCES

California Road System (CRS) Maps, http://www.dot.ca.gov/hq/tsip/hseb/crs_maps/

Camino CDP.

http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1

El Dorado Transit. <http://www.eldoradotransit.com/>

Interregional Transportation Strategic Plan (ITSP). <http://www.dot.ca.gov/hq/transprog/ocip/te/itsp.pdf>

Pollock Pines CDP, California. <http://quickfacts.census.gov/qfd/states/06/0658030.html>

South Lake Tahoe (city), California. <http://quickfacts.census.gov/qfd/states/06/0673108.html>

South Lake Tahoe Zoning Map. <http://www.cityofslt.us/DocumentCenter/Home/View/60>

Tahoe Transportation District. <http://www.tahoetransportation.org/southtahoe>

Truck Networks on California State Highways: District 3.

<http://www.dot.ca.gov/hq/traffops/trucks/truckmap/truckmap-d03.pdf>

Zoning Maps. http://www.edcgov.us/Government/Planning/Zoning_Maps.aspx

<http://quickfacts.census.gov/qfd/states/06/0659444.html>

<http://www.csus.edu/oir/Data%20Center/University%20Fact%20Book/University%20Fact%20Book.html>

ITEM 11.1.

APPENDIX C: DATA RESOURCES

Base Year ADT: 2011 Caltrans Traffic Volumes on California State Highways Book

LOS: Used HCS in conjunction with data from this table

Base Year VMT: 2011 Caltrans Traffic Volumes on California State Highways Book (Link Based)

Horizon Year Volumes and VMT based on SACSIM model growth and SHI growth factors

Truck Data: 2011 Annual Average Daily Traffic on California State Highways Book

Base Year Peak Hour Volumes and Directional Split: 2011 Caltrans Traffic Volumes on California State Highways Book

Peak Hour VMT: 2011 Caltrans Traffic Volumes on California State Highways Book (Link Based)

Horizon Year Directional Splits based on SACSIM model projections in conjunction with 2011 Caltrans Traffic Volumes on California State Highways Book

V/C: HCS used in conjunction with data from this table

ITEM 11.1.**APPENDIX D: MAPS OF BICYCLE IMPROVEMENTS**

The following reproduce the maps of bicycle improvements as given in the District 3 State Highway Bicycle Facility Plan.

ITEM 11.1.

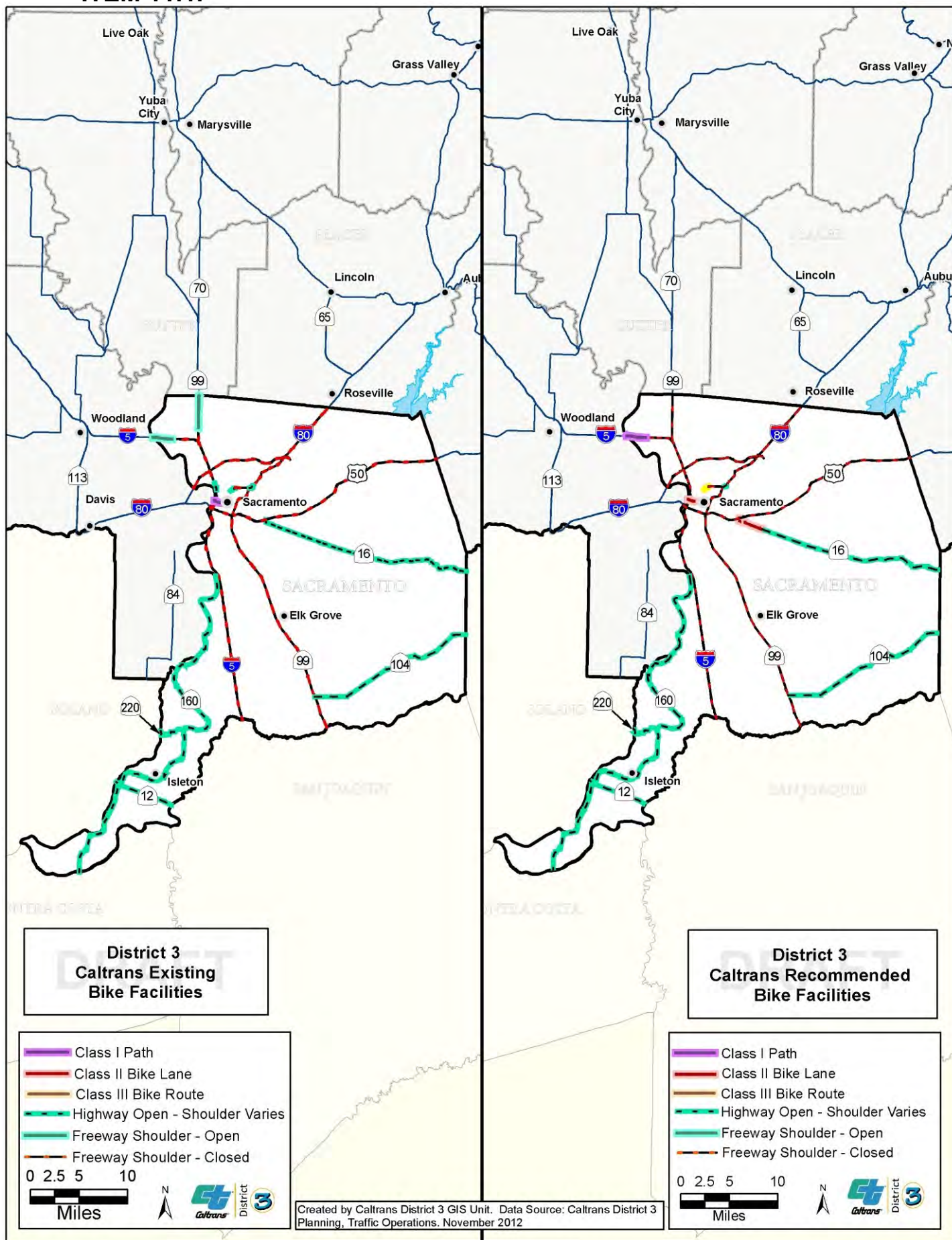


Figure 1: Sacramento County Facility Improvements

ITEM 11.1.

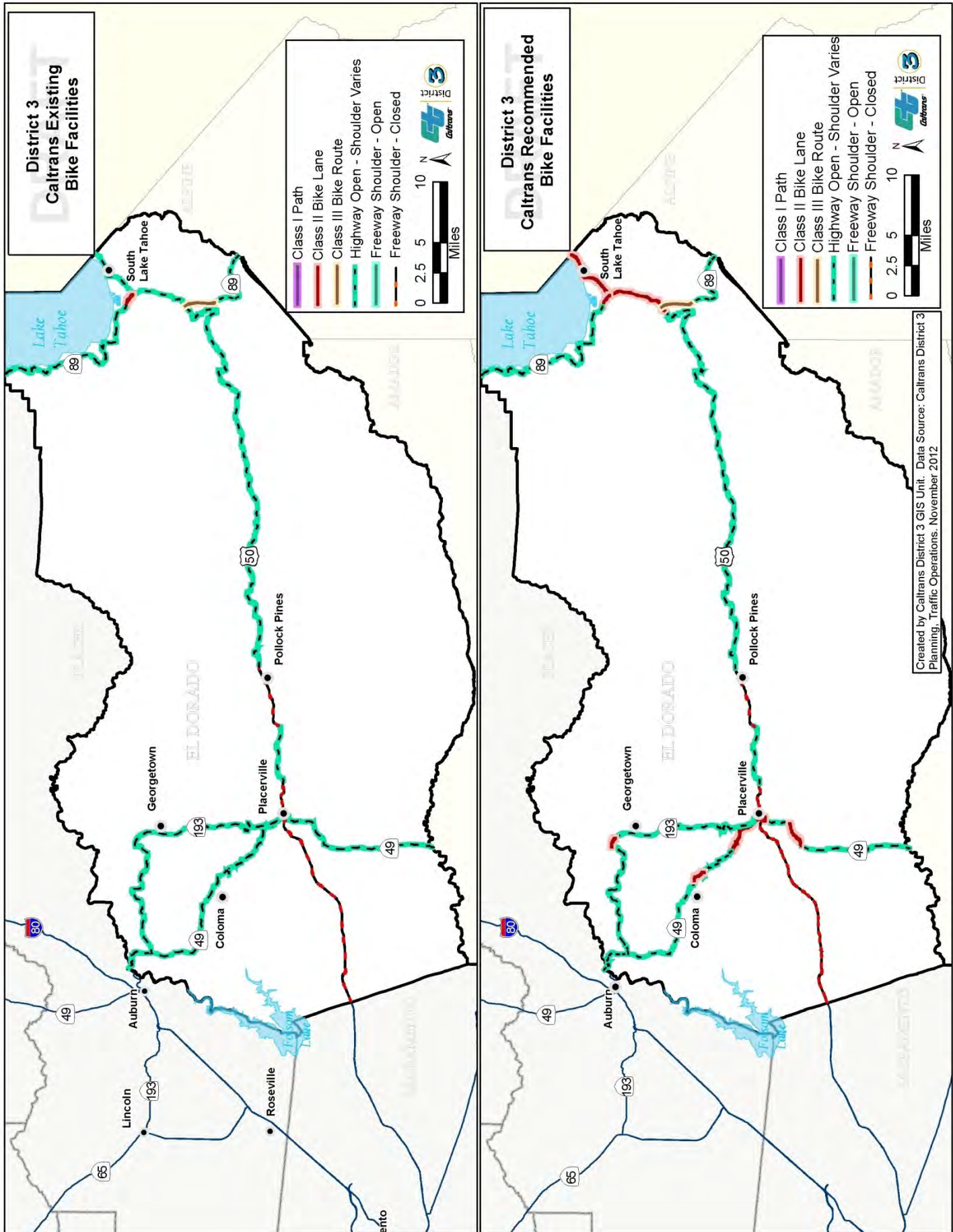


Figure 2: El Dorado County Bicycle Facility Improvements

ITEM 11.1.

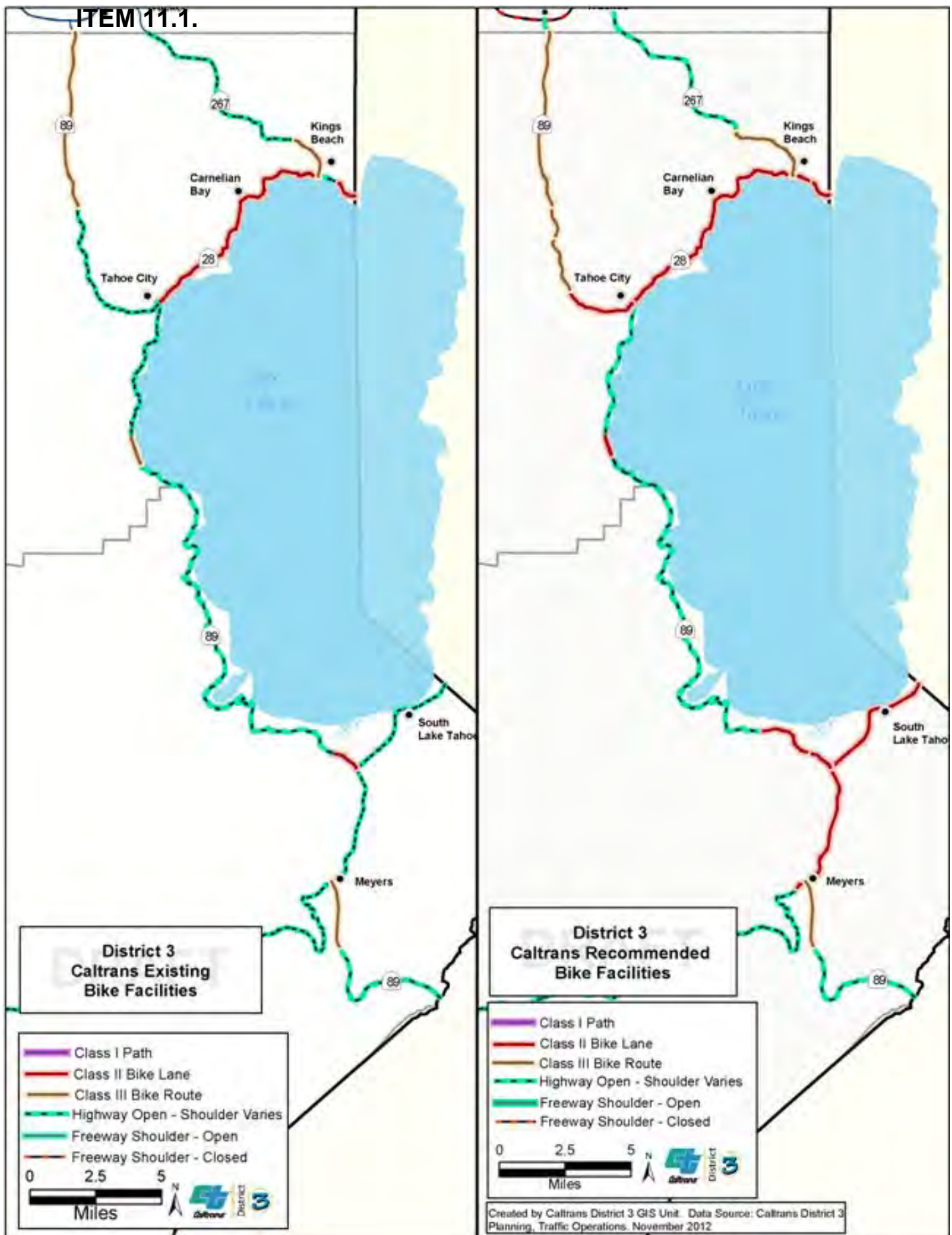


Figure 3: Lake Tahoe Area Bicycle Facility Improvements

ITEM 11.1.

EXHIBIT 8

ITEM 11.1.**Cardiovascular effects of environmental noise: Research in Austria****Review of studies in alpine valleys over 25 years – exposure response and effect modification**

P. Lercher¹, D. Botteldooren², U. Widmann³, U. Uhrner⁴, E. Kammeringer⁵

¹ Department of Hygiene, Microbiology and Social Medicine, Medical University Innsbruck, Sonnenburgstraße 16, A-6020 Innsbruck, Austria

² Acoustics group, Department of Information Technology, Gent University, Sint-Pietersnieuwstraat 41, B-9000 Gent, Belgium

³ AUDI AG, Abt. I/EK-5, D-85045 Ingolstadt. Germany

⁴ Technical University of Graz, Infeldgasse 21a, A-8010 Graz, Austria

⁵ University of Innsbruck, Technikerstrasse 13. A-6020 Innsbruck, Austria

ITEM 11.1.**Abstract**

Cardiovascular effects of noise rank second in terms of DALYs after annoyance. Although research during the past decade has consolidated the available data base the most recent meta-analysis still shows wide confidence intervals – indicating imprecise information for public health risk assessment. The alpine area of the Tyrol in the Austrian part of the Alps has experienced a massive increase in car and heavy goods traffic (road and rail) during the last 35 years. Over the past 25 years small, middle and large sized epidemiologic health surveys have been conducted – mostly within the framework of environmental health impact assessments. By design these studies have emphasized a contextually driven environmental stress perspective where the of adverse health effects by noise are studied in the broader framework of environmental health, susceptibility and coping. Furthermore, innovative exposure assessment strategies were implemented. This paper reviews existing knowledge from those studies over time, presents exposure-response curves with and without interaction assessment based on standardized re-analyses and discusses it in the light of past and current cardio-vascular noise effects research. The findings support relevant moderation by age, gender and family history in nearly all studies and suggest a strong need for consideration of non-linearity in exposure-response analyses. On the other hand, air pollution did not play a relevant role as moderator for the noise-hypertension or the noise-angina pectoris relationship. Finally, different noise modeling procedures can introduce variation in exposure response curves with substantive consequences for public health risk assessment of noise exposure.

ITEM 11.1.**Keywords**

Traffic noise, blood pressure, hypertension, angina pectoris, noise, exposure- response
relationship, effect modification

ITEM 11.1.**Introduction**

Through its geographical position in central Europe Austria has experienced transit-traffic since Roman times. Since the early seventies the Austrian part of the Alps has experienced a massive increase in car and especially in heavy goods traffic (road and rail). Currently, about 32 % of the population is exposed to road noise levels ≥ 60 dBA and 60% ≥ 55 dBA. While the increase occurred foremost on the road, first complaints were issued about highway traffic by the end of the seventies. In 1984 we started a first pilot study in a small community ("noise village") which was surrounded by a highway and an associated toll station (Lercher 1988, Lercher 1990) to explore the problem. Later, the intentions to move heavy goods transport from road to rail led to an increase of heavy rail traffic during the night resulting in higher noise levels than through the daytime (+3 dBA). Therefore, multi-community health surveys followed to study the supposed adverse effects of noise and air pollution in those alpine valleys where the transit-traffic was on the increase or where large rail infrastructure projects required environmental health impact assessment (EHIA) (Lercher 1992, Lercher et al. 1995, 1996a, 2000, Heimann et al., 2007). In these studies we emphasized a contextually driven environmental stress perspective (Cohen et al. 1996) and placed the study of noise related adverse health effects in the broader framework of environmental health, susceptibility and coping (Lercher 1994, Lercher 1996a, 1998b, 1998b, Lercher 2007).

Cardiovascular effects of noise rank second in terms of disability adjusted life years (DALYs) after annoyance. Although research during the past decade has consolidated the available data base the most recent meta-analysis - based on road traffic noise studies - reveals wide confidence intervals. It is not also sufficiently clear what the inconsistent results concerning standard potential effect modifiers such as sex, age and education mean. Furthermore, the quantitative role of psychological and physiological vulnerability factors that can promote adverse effects of noise such as noise sensitivity, health status or family history of hypertension has not yet been fully understood. Even the strong data base on the

ITEM 11.1.

cardiovascular effects of aircraft noise shows a substantial diversity in terms of exposure response shapes and slopes and in terms of observed effect modifiers. The conclusions about the effects of road traffic noise rest mainly on the Caerphilly & Speedwell and the Berlin studies. Insufficient data are available on the potential cardiovascular effects due to railway noise exposure.

In earlier papers we have suggested that the large variability of noise effects observed is partly due to the strong moderation and/or mediation by the context where the noise exposure occurs and partly due to the effectiveness of coping strategies (Lercher 1994, Lercher 1996b, Lercher et al 1998a, Lercher 2007). Related to this argument, factors such as regional differences in the underlying population morbidity structure (susceptibility and health status) and the overall exposure load (at work, environment, socio-economic)) may in addition be responsible for the often observed heterogeneous results. A specific argument is related to the potential difference in the experienced noise exposure in alpine areas. This may be either related to the perception of noise (perceived exposure contrast, signal to noise ratio) or to the inability of classical noise indicators to catch the difference in the meaning of noise exposure which is known to modify bodily responses. Eventually, since longitudinal studies are sparse and difficult to conduct in a continuously changing world with high mobility, the required latency time for the development of noise associated cardiovascular effects has not yet been established. Thus, the sampled population experience in the studies may differ in terms of the cumulative time to the effect and reflect only the different power to detect effects apart from the power provided by sample size.

This paper aims at sharing and integrating the existing knowledge from the Tyrol studies with a wider audience. Firstly, to make analyses available, which have not yet been published - or if so - not in English. Secondly, to summarize the main results observed over a 25 years time period. Thirdly, to add re-analyses based on the existing datasets which contribute to some of the still pertinent questions in cardio-vascular noise effects research. For this purpose

ITEM 11.1.

updated models were created to further evaluate interaction effects and to gain deeper insight into the meaning of effect modifiers over time.

Methods*Area, sample selection and recruitment*

Both areas of investigation, the Unterinntal and the Wipptal, are located along the most important European North-South-access route for heavy goods over the Brenner Pass. The heavy goods traffic over the Brenner has tripled within the last 25 years and the fraction of goods moved onto the road has substantially increased (up to 2/3). The areas consist of small towns and villages with a mix of industrial, small businesses, tourist and agricultural activities. The primary noise sources are highway and railway traffic. In addition, densely trafficked main roads are of importance. These road link the villages and towns and act as access roads to the highway.

Over the years sampling strategies have been refined. In the early studies all people of representative villages of a certain age range (25-65 yrs or 25-75 yrs) were approached by interviewers. In the later studies a basic phone survey (15-20 minutes) was conducted based on a stratified, random sampling strategy. The address base was typically stratified using GIS (Geographic information system) data, based on fixed distances to the major traffic sources (railway, highway, main road), leaving a common "background area" outside major traffic activities and an area with exposure to more than one traffic source ("mixed traffic area"). From these five areas, households were randomly selected and replaced in case of non-participation. Entry selection criteria were age range, sufficient hearing and language proficiency and residency of at least one year at the current address. The participation was higher in the earlier (around 60 %) and lower in the most recent surveys (around 40 %).

Noise exposure assessment

ITEM 11.1.

The earlier studies (Noise Village study, TRANSIT study) based the assessment of noise exposure on a short-term measurement network with a central long-term recording unit. Then, the individual noise exposure assignment was done in 5 dBA classes based on these measurements and local correction by noise expert judgments for each home (Lercher et al 1995). No distinction was made between the contributing sources. In the Noise Village study this was a main road and a highway with toll station. In the TRANSIT study in two of the five communities also rail exposure was of equal importance.

In the lower Inn valley EHIA-studies for the "Brenner Eisenbahn Gesellschaft" (BEG studies: UIT-1, UIT-2) noise exposure (dBA, Ldn) was assessed by modeling (utilizing "SoundplanTM" software) and a calibration by measurements from 31 sites according to Austrian guidelines (OAL Nr 28+30, ONORM S 5011). Based on both data sources approximate day-night levels (Ldn) were calculated for each respondent and noise source to facilitate comparison with typical dose-response data. Exposure and survey data were then linked via GIS.

In the latest study (ALPNAP study) railway noise emission was extracted from a typical day of noise immission measurements at close distance to the source. For highway traffic the yearly average load (light and heavy vehicles) was combined with an average diurnal traffic pattern. For main roads available traffic frequency data were supplemented with additional traffic counting. Noise emission by road traffic was calculated with the help of the Harmonoise source model (Jonasson 2007). In addition, micro-simulations of the traffic flow were conducted with Paramics (Quadstone[®], www.paramics-online.com) to obtain optimal individual vehicle characteristics (speed and acceleration). Within the ALPNAP study for the first time two noise calculation procedures were implemented. "Bass3", the propagation model developed by INTEC uses a three-dimensional object precise beam tracer gradually becoming a stochastic ray tracer at larger distance from the source to determine possible propagation paths. Sound propagation phenomena are included in an ISO9613-2 comparable way. The model includes up to four reflections and two sideways diffractions (de

ITEM 11.1.

Greve et al., 2005, de Greve et al., 2007). "Mithra-Sig" is the implementation of the French NMPB-Routes-96 procedure by the Centre Scientifique et Technique du Bâtiment, Lyon (CSTB), of the current interim engineering methods recommended by the Environmental Noise Directive (END). It uses 2.5 dimensional tracing for visibility check. An extensive noise monitoring campaign was available to check the validity of these simulations. At 38 locations sound levels were recorded for over one week during winter (October to January) and during summer (June to August). In addition, the predicted sound pressure levels resulting from parabolic equation (PE)-modeling have been evaluated against these long-term measurements (van Renterghem et al., 2007). Indicators of day, evening, night exposure and L_{den} were calculated for each source and the total exposure at several points on the building facade of the survey participants. In the present analyses, L_{den} at the façade most exposed was utilized.

Air pollution exposure assessment

In the BEG-studies exposure by air pollution was assessed by a Swiss expert group (OEKOSCIENCE AG, Quellenstrasse 31, CH-8005 Zürich) with long-term experience to monitor and calibrate air pollution exposure in alpine areas with special consideration of meteorological conditions. An adapted Gaussian propagation modeling procedure was used. In the ALPNAP study annual means for NO_x , NO_2 and PM_{10} were calculated for an area 27 km (W-E) × 23 km (N-S) east of Innsbruck). For these air quality assessment about 300 flow fields were calculated with the meteorological model GRAMM (Graz Mesoscale Model, Almbauer et al. 2000; Öttl et al. 2005) for each domain. The model system uses special algorithms to account for low wind or calm conditions (Öttl et al. 2001, Öttl et al. 2005). Traffic emissions were modeled using the network emission model NEMO (Rexeis & Hausberger 2005, Rexeis & Hausberger 2009). For each flow field a dispersion simulation with the Lagrangian particle model GRAL (Öttl et al. 2003a & 2003b; Öttl et al. 2007) was calculated on horizontal resolutions of 10 x 10 m² and in the vertical on 2m resolution. The model system uses special algorithms to account for low wind or calm conditions (Öttl et al.

ITEM 11.1.

2001; Öttl et al. 2005). Each run was weighted due to its meteorological classification and frequency. Thereafter, annual, summer and winter means were calculated by post processing and weighting the numerous dispersion calculations.

Within the ALPNAP study the simulation results were compared with 7 air quality stations located in the Inn Valley. The background values within this study were height corrected according to Seinfeld & Pandis (1997). Calculated NO₂ and PM₁₀ values for each of the participant's home were assigned by GIS.

Questionnaire information

The questionnaire covered socio-demographic data, housing, satisfaction with the environment, general noise annoyance, attitudes toward transportation, interference of activities, coping with noise, occupational exposures, lifestyle, reported sensitivities, health status, prevalent diseases and intake of medications. The telephone interview took about 15-20 minutes to complete. Education was measured in 5 grades (basic, skilled labour, vocational school, A-level, University degree). The last two grades were combined in the category "higher education". Noise sensitivity was asked with a 5-point Likert-type question. "High sensitivity" was defined by the two upper points on the scale (4 and 5). Health status was judged on a standard 5-grade scale (1 to 5). The three poorest grades were combined as "less than good" in the analysis. Active and emotional coping was assessed by a sum score based on 13 items (Botteldooren & Lercher, 2004). The area characteristic (urban, suburban and rural) was defined by residential pattern and community size.

Statistical analysis

The statistical analyses were carried out with "R" version 2.10.1 (R Development Core Team, 2009). Exposure-effect curves were calculated with extended logistic or ordinary least square regression methods using restricted cubic spline functions to accommodate for non-linear components in the fit if appropriate (Harrell, 2001). In the results section the p-values are reported for both the linear ("lin") and non-linear ("nlin") estimates. The non-parametric

ITEM 11.1.

regression estimate and its 95% confidence intervals (CI) are based on smoothing the binary or continuous responses – in the case of binary response taking the logit transformation of the smoothed estimates - using the contributed R packages "Design" and "Hmisc" (Harrell 2009). The criteria for the statistical consideration of interactions were relaxed since departure from additivity may be of relevance in a public health context when involved exposures and outcomes are prevalent (Greenland & Rothman 1998). It has also been demonstrated that selected studies can profit in terms of power by raising the Type I error rate from 5% to 20% to detect interactions that would otherwise remain uncovered (Marshall 2007). Selvin (1996) has advocated a Type I error rate of 20%. This error rate was applied to report *relevant effect modification*. Table 1 shows the major characteristics of the different studies.

Results*Exposure-response relationship without consideration of effect modification*

Statistically significant straight noise-effect relationships with basic adjustment of relevant confounders (no interactions) were observed only in selected analyses with cardiovascular endpoints. In most analyses the noise-effect relation was statistically significant only in subgroups or with a predefined combination of susceptibility factors (mainly gender, age, family history of disease, behavioral risk factors). To illustrate this point firstly only the exposure response relations of all studies are described which result from regression models with adjustment for standard factors without IA-terms. Note: The graphs show predicted probabilities based on modeled – not observed data.

In both, the Noise Village study and the TRANSIT study no relevant relationship (main effect =ME) between noise and systolic blood pressure (SBP) could be observed (Figure 1) The UIT-1 study showed a slight linear relationship of hypertension with sound level mainly in the

ITEM 11.1.

older group (Figure 2). The UIT-2 study exhibited a relationship of SBP with noise only in men at age 60 yrs. In the ALPNAP study in both hypertension and angina models without interaction terms a slight curve leveling off is visible around 60 dBA_{Lden} (Figure 3). Only in the UIT-1 study (basic hypertension model) the sound level increase between 50 and 60 dBA_{Lden} was significant (OR = 1.38, CI = 1.03-1.86). Furthermore, distance to the main road was a significant factor (p= 0.007). The companion models considering interactions are described below under the specific moderation heading. Interactions (IA) that were not significant in classical statistical terms were labeled as *relevant* effect modification. In some studies we also describe the relationship with distance to a relevant source. Note - the meaning of the air pollution models did not change when interaction terms were included.

Exposure-effect relationship with effect modification

a) Noise annoyance

It has been argued that subjective reports of actual perceived exposure may be a better exposure indicator than noise itself. Due to the established noise-stress-CVD hypothesis of action it would also seem reasonable to find noise-CVD associations particularly among those who showed a particular disturbance or interference by noise either during day (impairment of concentration or performance) or during nighttime (impairment of sleep). Only a few studies have tested these hypotheses (Babisch et al. 1995, Selander et al. 2009). Overall, our data did not reveal any significant support to the simple hypothesis that higher noise annoyance is associated with a higher cardiovascular disease outcome. To the contrary, from our early work on in the Noise Village study we consistently observed the opposite in our SBP or hypertension relationships with traffic noise. Reporting higher annoyance (very much versus not at all) was significantly linked with lower SBP (-5.83, CI = -8.99 to -2.68) mmHg, adjusting age, sex, bmi, education, cholesterol, family history, window behavior) in the TRANSIT study (Lercher et al. 1993). Likewise in the Noise Village study, the prevalence of hypertension was higher (Figure 4) in those reporting less interference by noise in their daily life (IA noise*interference p=0.06).

ITEM 11.1.

We explained this finding - which was unexpected at a first glance - with the much higher adaptive efforts that higher annoyed subjects invested to reduce noise exposure compared with less annoyed subjects (Lercher et al. 1996a). This supports a protective effect of certain active behavioral coping strategies – induced by higher annoyance. In the later studies, however, these associations of both coping activities and annoyance with blood pressure were weaker or no longer statistically significant. It remains to speculate whether the health gains of active coping fade away over time when the troubling noise exposure situation persists. Alternatively, it may be that annoyance reporting habits changed over time or coping became more common. Thus, the power to detect health gains of protective behavior diminished over time.

b) Bedroom location

In the Tyrol studies we did not consistently observe improved exposure effect relationships by either introducing bedroom location or an indicator of sleep disturbance as independent factors into the regression models. However, some models did improve. E.g. participants with bedrooms facing towards a quiet yard (Figure 5) did show a clear trend towards a reduction in hypertension diagnoses in the ALPNAP-study (OR=0.78, CI = 0.59-1.05). In the UIT-2 study a relevant interaction (IA) with bedroom location (IA: $p=0.18$, ME_{bedroom} : OR=2.01(1.09, 3.78)) was observed when the distance to the main road was considered as a additional source parameter (ME_{distance} : $p=0.02$) in a non-significant rail noise model. The interaction of bedroom location in the highway model was similar but statistically not relevant (IA: $p=0.31$) and also the single main effect (ME) of bedroom location was less precise (ME_{bedroom} : OR=1.77, CI = 0.72, 4.39), ME_{distance} : $p=0.08$, Figure 6). In addition, the presence of night disturbance by rail did exhibit a further main effect in both the rail (OR= 2.24, CI = 1.21-4.17) and the highway model (OR=1.98, CI = 1.08-3.62).

ITEM 11.1.

c) Length of exposure

Duration of living at the current home may be another candidate variable representing a more homogeneous group with longer latency times for potential health effects. Bluhm et al. (2007) observed a stronger association between noise and hypertension in subjects with a longer period of residence (>10 yrs). We found no significant effect of longer duration on the overall noise-disease association in the ALPNAP-study in the regression model. Duration of living is, however, tightly associated with older age (IA: $p=0.12$) and house type (≥ 20 yrs in single homes 52% versus 21% in apartment blocks). Thus it is difficult to disentangle, especially when a large proportion of the sample has such a record of longer living (66 %) or single housing (56 %). However, when an extreme comparison was made with a strong family history of hypertension in the model adjustments, duration of living for ≥ 30 years at the present address was significantly associated with hypertension (OR=1.68, CI = 1.07-2.66) against <8 years of living. The comparison of living for ≥ 30 years versus < 30 years in the UIT-1 study revealed quite clear results supporting that length of exposure was an important variable (Figure 7). In these analyses distance to the road was considered as exposure and heart problems as an outcome. When distance was replaced by the overall sound level, duration of living at the current home was significant ($p= 0.04$). However no sign of effect modification by noise level was evident.

d) Age

Hypertension: The re-analyses of the Tyrol health studies revealed substantial evidence for effect modification by age and gender on the relationship between noise and indicators of hypertension. Already in the small noise village study we observed supporting evidence for a noise effect only in those at a higher age compared with participants at a lower age with both dichotomous and continuous blood pressure outcomes. The interaction with noise level was statistically significant (IA: $p=0.01$ lin, $p=0.02$ nonlin). In the TRANSIT study, the age-noise level interaction on treated hypertension was significant only in men (IA_{treat}: $p=0.03$) (Figure 8). In the UIT-1 study (IA: $p=0.02$ lin, $p=0.03$ nonlin) and the ALPNAP-study (IA_{diagnosis}:

ITEM 11.1.

$p=0.003$ lin, $p=0.005$ nonlin, IA_{treat} : $p=0.013$ lin, $p=0.006$ nonlin) also the overall effect modification by age was highly significant with respect to any measurement of hypertension.

Heart disease: In the Transit-study we found a non-significant but relevant age-noise level interaction on the prevalence of angina pectoris indicating that the relationship with noise showed up only in elderly people at higher noise levels (Figure 9). This view was also supported in the results of the UIT-1 study when distance to the road was considered as exposure (IA : $p=0.26$ lin). The analyses from the ALPNAP-study did not support these earlier findings. Rather, it was found that age was less important when other risk factors (e.g. hypertension) were considered that are accompanied with older age.

e) Gender

Blood pressure and hypertension: In the Noise Village study the effect of the interaction of noise with age on systolic blood pressure was more pronounced in men (Figure 10). In the TRANSIT study this kind of effect modification could be replicated with respect to the prevalence of hypertension ($p=0.22$ lin). Also with a separate gender sub-regression the pattern was confirmed (IA_{age} : men: $p=0.06$, women: n.s). Likewise, a separate age sub-regression (three categories) on continuous blood pressure mimicked this pattern without reaching significance ($IA_{\text{sex-age}}$: $p=0.33$). Also in the UIT-2 study interaction patterns due to gender (IA_{sex} : $p = 0.18$ lin, 0.398 nonlin) occurred when adjustment for known hypertension was included. In the ALPNAP-study the effect modification due to age was stronger - the noise-sex interaction, however, was of minor importance. In summary, we observed a stronger not always significant effect of the noise level in men compared to women. In addition effect modification due to age was present and enhanced often the overall effect.

Heart disease: Neither in the Transit nor the ALPNAP study we found an indication of a relevant effect modification due to gender on the relationship between the noise level and

ITEM 11.1.

heart disease (IA: $p=0.6$). In both studies the prevalence of angina pectoris was slightly higher among men across noise levels.

f) Education

Education was associated with both dichotomous and continuous blood pressure outcomes in the Noise Village study. The interaction of education with the noise level was evident in both sexes – but only relevant in the older age group (>45 yrs) (IA: $p=0.20$). The power ($N=174$) was limited to test interactions. In the Transit and the UIT-1 studies education was not significant overall due to social differences between the studied communities. In the UIT-2 study there was a significant main effect of education on systolic blood pressure (lower SBP in subjects with higher education compared to lower education: mean adjusted difference: -3.90 , CI = -7.79 to -0.01 mmHg) – but no relevant signs of interaction with noise level were found. In the ALPNAP study, this trend was reversed – but there hypertension diagnosis or treatment was the outcome. This may be due to differences in the detection and treatment of hypertension in general practice.

g) Family history

The TRANSIT study revealed some interaction of family history with noise level on SBP (IA: $p=0.11$) in men, also in the presence of an additional effect modification by age (IA: $p=0.06$ lin $p=0.14$ nonlin). A similar non-significant result was obtained in the UIT 2 study with respect to systolic blood pressure. In fact the effect modification due to family history was caused by the interaction of sex with noise level. In the ALPNAP study we could test for possible interactions of family history with noise level by a more detailed question (no=0, one parent=1, two parents=2). Two noise propagation models were tested. With the MITHRA propagation model the interaction with noise level was relevantly moderated by the degree of family history (IA: $p=0.11$ lin) with an additional non-linear component (Figure 11). Sex did not modify the associations any further but age did to a highly significant extent (IA: $p=0.013$ lin, $p=0.006$ nlin). Similar results were obtained when the ISO-implementation by INTEC was

ITEM 11.1.

used for noise propagation. The effect modification due to family history (IA: $p=0.16$ lin) was obvious but not accompanied by a relevant effect modification due to age. Further strong indications of interaction with family history were found with respect to other CV-outcomes when keeping age and sex constant or when including further risk factors.

h) Hypertension

In the TRANSIT study (Figure 12) we observed a highly significant impact of known hypertension on the prevalence of angina pectoris ($p<.0001$). However, no relevant interaction with noise level was evident. Similar results were obtained in the ALPNAP study (Heimann et al. 2007) with respect to angina pectoris. Subjects with preexisting hypertension did exhibit a steeper increase in prevalence between noise levels of 50 and 60 dBA (OR=2.23, CI = 1.10-4.52) but no statistically relevant effect modification of hypertension on the relationship between noise and angina pectoris was observed.

i) Depression

In the TRANSIT study a borderline significant association between the prevalence of depression and the prevalence of angina pectoris was found. No interaction with noise level was present. While there was no association with blood pressure or hypertension in the ALPNAP study we also found a significant difference between people who suffered from depression and the probability of an angina pectoris diagnosis (OR=2.06, CI = 1.08 - 3.94). There was, likewise, no relevant interaction with the noise level.

j) Air pollution:

Hypertension. Support comes neither from the BEG studies nor from the ALPNAP study (not shown) for a significant positive effect of NO_2 or PM_{10} on blood pressure or hypertension. Rather opposite trends were observed. In addition no relevant signs of interaction could be found.

ITEM 11.1.

Angina pectoris: Like in the case of hypertension air pollution did also not affect the noise angina pectoris relation in the ALPNAP study. The observed inverse association is fully determined by the noise level.

k) Health status

From a prospective study Babisch et al., (2003) reported a stronger relation between annoyance and IHD in middle aged men with no prior disease at entry point. A similar effect modification ($p=0.16$) was observed in the presence of a strong noise*age interaction ($p=0.02$) in the UIT-1 study with respect to hypertension (Figure 13). Only in those subjects with good or very good health status a significant exposure effect relation was observed regarding hypertension diagnosis or treatment. Also with respect to three health status categories in the ALPNAP study only for those with very good health status a relation with noise level was found in men (IA: $p=0.18$) but not in women. The ALPNAP study could not confirm such an effect modification of health status on the association between noise level and angina pectoris – although health status was a relevant predictor of disease when persons with excellent versus poor health status were compared ($OR=0.50$, $CI = 0.24-1.01$).

l) Combination of risk factors

Hypertension: Using the final model (adjusted for the other factors) of the ALPNAP study simulations were carried out to demonstrate the relevant effect modification of the most important risk factors (age, family history, health status) on the relationship between the noise level and hypertension when the factors are varied in terms of extreme group comparisons (Figure 14).

Heart disease: Likewise we calculated the effect of two significant risk factors in the ALPNAP-study, namely, hypertension and depression on the probability of angina pectoris due to the noise exposure (highway) for subjects aged 40 and 60 yrs, respectively (Figure 15). A strong effect modifying impact of the prevalence of these two diseases on the

ITEM 11.1.

association between the noise level and the probability of developing angina pectoris is evident. However, the wide confidence intervals indicate the limitation when combinations with small subgroups are investigated.

m) Noise sensitivity

Hypertension: With respect to hypertension in none of the studies carried out in Tyrol positive relations with noise sensitivity were observed. To the contrary, consistently noise sensitivity was non-significantly or even inversely associated with blood pressure readings or self reported hypertension or treatment. On the other hand weather sensitivity (a general indicator of vegetative reactions) was a stronger predictor ($p=0.01$) in the UIT-1 study – but also no relevant interaction with noise level was evident (Figure 16). The finding of higher weather sensitivity related to hypertension could not be fully replicated with systolic blood pressure as an outcome in the UIT-2 study. Instead, an underlying relevant sex-noise interaction ($p=0.17$) was evident, showing a noise effect only in men. Noise sensitivity was again not a relevant parameter. However, vibration sensitivity also exhibited an inverse relation with blood pressure - but there was no effect modification of vibration sensitivity on the relationship between the noise level and blood pressure in the UIT-2 study. The smaller sample size in this study ($N=514$) was the reason why only borderline significance was achieved (weather: $p=0.09$, vibration: $p=0.05$).

Heart disease: Different results were obtained for heart disease. In the TRANSIT study, angina pectoris showed a non-significant association with noise sensitivity ($p=0.11$) but there was neither any interaction with sex (IA: $p=0.98$) nor with the noise level (IA: $p=0.72$). In the UIT-1 study noise sensitivity was not a significant predictor either. Instead weather sensitivity exhibited a strong effect modifying impact (IA: $p=0.11$) on the relationship between distance to the highway and the prevalence of angina pectoris (Figure 17). In the ALPNAP study a different pattern was found (Figure 18). There a strong interaction of sensitivity with sex (IA: $p=0.01$) was found on the non-linear relationship between the sound level (highway) and the

ITEM 11.1.

prevalence of angina pectoris (IA: $p=0.16$). The sex-sensitivity-interaction showed a deviating pattern: although sensitive males showed consistently the highest disease rates with varying noise level, sensitive females exhibited the lowest rates of angina pectoris. Note – the confidence intervals are wide.

Discussion*Exposure modifiers*

The results from literature and the results of our studies over time suggest that there are important modifiers that may partly be responsible for the large variations found in the noise health effects research. Bluhm et al. (2007) suggested exposure misclassification as a main culprit. Specifically, their findings of stronger associations in persons with a longer length of exposure (years of residence) at the same address, having triple-glazed windows, bedroom windows not directly facing a road or living in single houses do support this suggestion of potential over- and underestimation of true exposure. Caution is warranted, since the effect modification due to the length of exposure may be actually caused by older age which is typically confounded with it.

On the other hand a longer duration of time spent living at the same address may also indicate a certain time of exposure required to exert an effect (Bluhm et al. 2007). Therefore, studies with an insufficient proportion of people living longer at the same address (>10 yrs) may lack the power to detect noise effects. In the Bluhm et al. study this proportion was high (44.5%). In the ALPNAP-study 50 % lived at least 16 yrs and 25% at least 30 yrs at the same address. From meta-analysis of annoyance studies (Fields 1993) we know that confounding with age is a serious problem. In the Bluhm et al. study the age range went up to 80 yrs, which is an unusually high age range with inclusion of a large proportion of elderly people very likely to have lived longer at the same address.

ITEM 11.1.

We have seen protective effects (closing windows during night) as an additional modifier of exposure over and above the fact of having tightly fitted windows (Lercher 1996). Tightly fitted windows or closing windows during daytime alone did not show up as significant variables.

Selander et al. (2009) found an elevated association between road traffic noise and myocardial infarction in participants reporting noise annoyance mostly in their bedrooms. These findings can be interpreted in different causal pathway directions. First, bedroom exposure is a better exposure indicator in general by reducing exposure misclassification, since most participants (nightshift workers as an exception) are actually in bed while daytime exposure can vary substantially due to activity pattern and work exposure. Second, bedroom exposure is a causally relevant exposure since sleep is affected and impaired sleep is a known risk factor for myocardial infarction in men and women (Schwartz et al., 1999; Greenland et al.; 2003, Leineweber et al., 2003; Meisinger et al 2007).

Our studies support bedroom location or night disturbance as a potential moderator especially when additional noise sources contribute to the overall noise exposure. The effect seems, however, to depend also on the kind of source combination (rail-highway-main road). Therefore, bedroom location should be considered in the analysis design - but high variation is possible due to the actual feature of the specific source combinations.

Effect modification: Socio-demographic factors

a) Gender and age

Several studies observed differences in the effect of noise on cardiovascular outcomes by gender (Herbold et al., 1989; Belojevic et al., 2002; Babisch et al 2005; Willich et al., 2005; Bjork et al., 2006; Bluhm et al., 2007; Jarup et al., 2008; Barregard et al., 2009).

Unfortunately, the found associations are not uniform – thus casting doubt on their reliability and validity. Similar to what has been argued in air pollution studies - that effects only found

ITEM 11.1.

in women may be related to their longer duration of exposure at daytime – thus asserting this issue is related to exposure assessment rather than implying a different vulnerability.

However, there is evidence of a gender difference of psycho-physiological reactions towards stress. Generally, males are more susceptible to cardiovascular disease (Stoney et al. 1987) and women show greater resistance to stress between puberty and menopause (Kajantie & Phillips 2006; Kajantie 2008).

In accordance with these findings the Tyrol studies do not provide support for a stronger effect in women. Instead, more often men did exhibit stronger effects in interactions with noise exposure and older age. When no effect modification by gender was observed, disparities in health care may be at work, like in hypertension treatment or angina pectoris diagnosis (Vaccarino 2006; Johnstone et al., 2007; Gu et al., 2008; Bittner 2008; Hemingway et al., 2008). The extra-large studies of de Kluizenaar et al. 2007 and Bodin et al. 2009 used their power to test whether certain age ranges do exhibit stronger associations between noise and cardiovascular outcomes. The findings of these studies suggested the middle age ranges (40-60 yrs) to be associated with hypertension but not to other ages. Because the findings reported so far concerned middle-aged people the explanations were targeted to explain this finding. In view of the results from the Tyrol studies, where the elderly consistently were more affected, other explanations are necessary and equally plausible. Since noise is viewed as subtle but a chronic stressor, longer latency periods may be necessary to observe effects. In a recent, large semi-ecological medication study in the same study area we reported most significant findings for the age group above seventy years (Rüdisser et al., 2008).

The observed moderating effects of age or gender should be reviewed with caution, especially, when only category specific effects are reported and no exposure-effect relation is presented. Opposite to the argument of Bodin et al. (2009) it can be stated that cohort analyses have shown that some classical cardiovascular risk factors loose their importance

ITEM 11.1.

to predict cardiovascular mortality due to the survivor effect and age itself gains in importance (Grundy et al., 2001). It may therefore be that stress related risks gain importance the longer they can exhibit their subtle chronic effect. Eventually, the support for a positive association between noise annoyance and cardiovascular health is weak. At least in the Tyrol studies more often the opposite effect was observed.

b) Education

The results show that when measured blood pressure was considered, lower education was consistently associated with higher blood pressure and higher prevalence of hypertension based on standard cut-off points. When reported hypertension was used, persons with a higher education exhibited a higher prevalence. This suggests a differential effect of health care on education. However, no significant effect modification with noise level was observed in any of the studies.

*Effect modification: vulnerability factors***a) Family history**

Family history of hypertension is an established major risk factor for the development of hypertension (Stamler et al., 1979; Burke et al., 1998; Wang et al., 2008). In all studies (not available in UIT-1) family history was a significant contributor to either continuous or dichotomized blood pressure outcomes or treatment. Significant or public health relevant effect modification was observed with age and also with noise level. This supports the idea of higher vulnerability of people with a family history to noise exposure with a certain latency time. Since more than one third of the adult population in the ALPNAP study (41%) showed some degree of family history (one parent) effect modification should be evaluated in all noise - hypertension studies.

b) Hypertension

High blood pressure is a proven risk factor for cardiovascular diseases (Yusuf et al., 2001).

ITEM 11.1.

Selander et al. (2009) found a stronger association between road traffic noise and myocardial infarction in those with hypertension. Earlier or recent hypertension was also a significant contributor to angina pectoris in the ALPNAP and the TERW-89 study. The moderation with noise level did not become significant.

c) Depression

Depression is a known risk marker for cardiovascular diseases (Yusuf et al., 2001). Most studies have found depression to be significantly associated with mortality and/or cardiac morbidity– although the mechanisms underlying this relationship remain unclear (Suls & Bunde 2005; Carney et al., 2005). Since dysregulation of the autonomic nervous system is a plausible pathway to disease (Carney et al., 2002) chronic exposure to noise is a possible candidate for effect modification. Both in the TRANSIT and the ALPNAP study depressive symptoms or depression diagnosis were significant contributors in an angina pectoris regression model. Although some interaction between the noise level and the state of depression was visible in the figures the power was too low to gain significance. However, presence of both depression and hypertension showed a higher prevalence of angina at higher noise levels. We are not aware of other studies having evaluated depression as possible moderator of the noise angina relationship.

d) Health status

Health status is a general and reliable predictor of future morbidity and mortality (Idler et al., 1997; Lekander et al., 2004; Chen et al., 2007; Singh-Mantoux et al., 2007). In all studies (not available in Noise village and TERW-89) health status made a significant contribution to the cardiovascular outcomes studied. Consistently, persons with a poor health status showed higher starting levels of morbidity but typically also stronger slopes in the exposure response analysis. However, due to the generally lower disease levels sometimes only people with an excellent or good health status exhibited a significant increase of either hypertension or angina pectoris with increasing noise level in a dose response fashion. Therefore, effect

ITEM 11.1.

modification was not always significant at classical error rates ($p < 0.05$) but still relevant in terms of potential public health significance ($p < 0.20$). We are only aware of one study (Babisch et al., 2003) having applied a similar approach by using disease status as possible moderator of the noise exposure disease relationship.

e) Noise sensitivity

Noise sensitivity is known to be associated with higher symptom rates and medication consumption (Stansfeld 1992; Lercher et al., 1996a) and is also a predictor of noise annoyance. Recently, work based on data from the Finnish Twin Cohort study reported an association of noise sensitivity with hypertension after adjustment for noise exposure and other factors in a multivariate model (Heinonen-Guzejev et al., 2004). In a further study a relation between self-reported noise exposure and cardiovascular mortality was observed in noise sensitive women – but not among men (Heinonen-Guzejev et al., 2007). On the other hand, we observed consistently a negative relationship between noise sensitivity and hypertension as a health endpoint. This is fully in contrast to the results of the Finnish studies (overview in Heinonen 2009) showing several associations of noise sensitivity with hypertension and heart disease (morbidity and mortality) in noise exposed female subjects. Overall, there was a non-significant trend in noise sensitive subjects to show a higher prevalence of angina pectoris at higher noise exposure – but due to a significant interaction (sex*sensitivity, $p=0.01$) this was not true in women. Thus there is no good evidence for a relation of noise sensitivity in women from this study. The power to detect weaker associations was low in the ALPNAP study. But also the pooled Caerphilly and Speedwell analyses (only men) did not observe a significant association ($OR=0.9$) with noise sensitivity in a larger sample (Babisch et al., 1999). Note, the Finnish studies differ methodologically since both noise exposure and noise sensitivity was obtained subjectively. Such a procedure is vulnerable to the known subjective bias from stress research (Kasl 1984, Lazarus 1993).

ITEM 11.1.*Measures of hypertension*

In the noise literature the clear diagnosis of hypertension (from medical sources or patient remembered doctor diagnoses) is used in the analyses. Women are expected to show a lower prevalence of hypertension till the end of the fifth decade (Hajjar & Kotchen 2003). Since medication use or type was not confirmed in our studies misclassification may be introduced by missing other medications that may lower blood pressure. Furthermore, true awareness and control rates cannot be determined with the kind of data available. The literature reports awareness rate around 70%. Treatment and control rates are found around 60% and 30%, respectively, with lower rates in the elderly (Hajjar & Kotchen 2003; Cutler et al., 2008). The experience with other surrogate measures of hypertension in our studies showed following characteristics:

- Blood pressure readings were less often significantly related to noise levels
- Dichotomizing blood pressure readings at higher cut-off levels (160/95mmHg) were more likely significantly associated with noise exposure
- Treated hypertension was not a better indicator than doctor diagnosis or known hypertension.
- When using treated hypertension we did not observe a gender difference in prevalence. This gender difference was consistently present using remembered diagnosis or personal readings of blood pressure – indicating a lower prevalence of treatment among men than women. These findings are confirmed by large population surveys – but it seems that the male population is catching up (Cutler et al., 2008).

Time effects and latency to the effect

Since these are series of cross-sectional studies over time it is difficult to comment on time factors. However, there are some findings which contribute to the current scarce knowledge:

1. In the studies where we had two timeframes in the retrospective question available (e.g. “hypertension diagnosis ever” and “hypertension diagnosis during past 12 months”) the

ITEM 11.1.

precise time framing “past 12 months” did exhibit a stronger relation with noise than the more loose time framing “ever”. This finding may be explained by the concurrent measurement of exposure and outcome and thus reflect higher precision in both. Alternatively, it could also give hints for time windows where a certain proportion of the study population may exhibit noise related effects.

2. Consistently, we found persons at a higher age (>60 yrs) showed a firmer relation with noise than at a lower age (~ 40 yrs). This relation was typically enhanced in the presence of an additional risk factor for the outcome under investigation (especially family history of hypertension). These findings suggest longer latency times and the need of other risk factors to be present in order to develop noise related effects. The findings from our semi-ecological study, where significant relations with noise (antihypertensive prescriptions) were only found at an older age (>70 yrs), indirectly support longer latency times in general (Rüdiger et al. 2008).

3. Duration of living may not be a good approximation of the length of exposure since it was strongly associated with age, housing factors and education in our studies. From the social science literature it is long known and recently confirmed that people moving around less are better off in the light of various health outcomes and health related behaviour (Metzner et al 1982; Larson et al. 2005; Norman et al. 2005; Jelleyman & Spencer 2008). At least in our studies we observed no significant difference in subset analyses with 10, 20 or 30 years of living at the same address. Although utilizing length of residence as a continuous variable with adjustments of age, housing, education and health status did show a weak increase in the odds for hypertension development when the contrast in duration was stretched (<8 yrs versus >30 yrs). Although, it is not clear whether this indeed represents an independent finding – it supports also longer latency times similar to the conclusions from the Speedwell and Caerphilly studies (>15 yrs).

ITEM 11.1.*Air pollution*

Both noise and air pollution is often emitted by the same source, namely motorized traffic and depending on propagation conditions a wide range of correlations is reported (Allen et al., 2009). Such conditions open the possibility of confounding and make it difficult to disentangle associated effects statistically (Schwela et al., 2005). A large number of studies have shown stable associations of ambient air pollution with morbidity and mortality of cardio-pulmonary disease (Pope & Dockery 2006, Krewski & Rainham 2007, Brook 2008). A smaller number of studies have reported associations with blood pressure or hypertension (Ibald-Mulli et al., 2001; Zanobetti et al., 2004). Since noise exposure is also associated with CHD and hypertension (Babisch 2008) and only a few recent studies have actually considered both pollutants in the regression models (Heiman et al., 2007; de Kluizenaar 2007; Beelen et al., 2008; Selander et al., 2009) it remains an open question what contribution is made by which pollutant to which health outcome.

In both the UIT studies and the ALPNAP study high quality air and noise pollution propagation data were available for individual assignment. In none of the investigated health endpoints (angina, blood pressure/hypertension) a relevant or consistent relation with the studied range of air pollutants (NO_2 , PM_{10}) nor relevant moderation could be established. The large population based Oslo Health Study ($N=18,770$) was also unable to find a relation between indicators of air pollution exposure and blood pressure (Madsen & Nafstad 2006). Since we had two noise assignments options in the ALPNAP study of which the ISO-assignments showed very low correlations with NO_2 ($r=0.12$) and PM_{10} ($r=0.09$) confounding is highly unlikely to be of importance in this study. Although the MITHRA-assignments showed higher correlations (NO_2 : $r=0.48$ and PM_{10} : $r=0.39$) the statistical importance of both the air pollutants and the noise variables did not change. In the BEG studies the highway noise to air correlations were stronger (NO_2 : $r=0.63$ and PM_{10} : $r=0.61$).

ITEM 11.1.*Methodological issues***a) Interaction assessment and non-linearity**

The investigation of moderation of the noise health relationship by public health relevant factors is a necessary requirement for the better understanding of the processes that determine the person-environment-health relationship (Lercher 1996b, Evans & Lepore 1997, Evans 2001, Bodin et al., 2009). The single reporting of average risk effects or associations from an entire population can often conceal the substantial variation that may occur in important subgroups (the elderly, women, persons with positive family history of cardiovascular diseases including high blood pressure). This deviation from average risk can be even more pronounced when risk combinations are considered (see Figure 53). If significant interactions are present the meaning of main effects becomes questionable. Unfortunately, most studies do not have the power to evaluate effect modification and interaction tests in general lack power (Greenland 1993, Marshall 2007). The relaxation of the significance criteria can sometimes help (Selvin 1994, Marshall 2007). The use of p-values as sole criterion is discouraged (Matthews & Altman 1996). However, caution is needed since additional mediation or residual confounding may distort the results or make it hard to interpret (Pearce & Greenland 2004). Therefore, only biological plausible effect modification (based on prior knowledge) should be tested and a step by step procedure is advised - followed by detailed sensitivity analyses to safeguard the conclusions. Eventually, there is a strong need to examine non-linear components in the exposure-response analyses. Substantial over- and underestimations may result without consideration.

b) Noise propagation modeling

Typically, engineering methods and the resulting noise maps are validated against long-term noise measurements in “simple” open area propagation conditions and not in complex residential settings where most people actually live. The availability of having two (in the case of highway noise three) noise propagation methods in the ALPNAP study opened the unique opportunity to evaluate the modeling in the framework of the actual noise – health

ITEM 11.1.

relations. Thus the effects of noise modeling techniques on the estimation of noise associated health impacts could be directly assessed. While sometimes only marginal differences were noted even with complex effect modification, in other cases (e.g. angina pectoris) only with one method a significant exposure-response relationship was established but not with the second method. This leaves behind a substantial amount of uncertainty. Therefore, a move from mere exposure modeling to exposure effect modeling is required to minimize bias in public health risk assessment of the effects of sound on humans.

Conclusions

Because noise is not a strong risk factor per se the specific context of the exposure, health predispositions and the adaptability to this person-environment configuration determines whether effects occur. Specifically, the coping opportunities are of importance. If active coping (closing windows, bedroom on quiet site) is not feasible noise persists as a chronic stressor and with advancing age the effects may surface. Since the effects of age and gender observed in noise effects research can only be prevented by reducing the intensity and the duration of exposure overall - residential areas should be considered as sensitive areas and noise should not exceed 55 dBA. This is in accordance with the results of the most recent studies (Bluhm et al. 2007, Barregard et al. 2009, Selander et al. 2009). Finally, from the reported studies we could not find support for a relevant role of air pollution. Both neither with diagnoses of hypertension nor with heart disease statistical significance did come in reach and no signs for a relevant moderation of the noise health relation by air pollution could be observed in the Tyrol studies.

Acknowledgements

The ALPNAP project received European Regional Development Funding through the INTERREG III Community Initiative. In the context of this study we received data and

ITEM 11.1.

supporting information from various governmental, private and public institutions. Special thanks to the GEO-information system TIRIS and the traffic administration of the Tyrolean Government and the Brenner railway company (BEG). The phone surveys were conducted in all studies by the CAT-Lab of IMAD, an experienced opinion research Institute in Innsbruck. We thank the study participants and greatly acknowledge the field work done in the interview studies by various students, doctoral students from the medical and psychology curricula and supervising MDs and PhDs. The work was partly supported over time by the Department/Division of Social Medicine, Medical University Innsbruck, formerly The University of Innsbruck.

ITEM 11.1.**References**

Allen RW, Davies H, Cohen MA, Mallach G, Kaufman JD, Adar SD. The spatial relationship between traffic-generated air pollution and noise in 2 US cities. *Environ Res* 2009; 109, 334-342.

Babisch W, Gallacher J, Ising et al. Schallpegel oder subjektive Störung.

Lärmexpositionsmaße in Wirkungsstudien am Beispiel einer Kohortenstudie.

Bundesgesundheitsblatt 1995; 4: 137–145.

Babisch W, Ising H, Gallacher JE, Sweetnam PM, Elwood PC. Traffic noise and cardiovascular risk: The Caerphilly and Speedwell studies, third phase - 10 years follow-up. *Arch Environmental Health* 1999;54:210-6.

Babisch W, Ising H, Gallacher JE. Health status as a potential effect modifier of the relation between noise annoyance and incidence of ischaemic heart disease. *Occup Environ Med* 2003; 60:739-45.

Babisch W, Beule B, Schust M, Kersten N, Ising H. Traffic noise and risk of myocardial infarction. *Epidemiology* 2005; 16: 33-40.

Babisch W. Road traffic noise and cardiovascular risk. *Noise Health* 2008; 10: 27-33.

Barker SM, Tarnopolsky A. Assessing bias in surveys of symptoms attributed to noise. *J Sound Vib* 1978; 59: 349-354.

Barregard L, Bonde E, Öhrström E. Risk of hypertension from exposure to road traffic noise in a population-based sample. *Occup Environ Med* 2009; 66: 410–415.

Beelen R, Hoek G, Houthuijs D, van den Brandt PA, Goldbohm RA, Fischer P, Schouten LJ, Armstrong B, Brunekreef B. The joint association of air pollution and noise from road traffic with cardiovascular mortality in a cohort study. *Occup Environ Med* 2009; 66: 243-250.

Belojevic G, Saric-Tanaskovic M. Prevalence of arterial hypertension and myocardial infarction in relation to subjective ratings of traffic noise exposure. *Noise Health* 2002; 4: 33-7.

ITEM 11.1.

- Belojevic GA, Jakovljevic BD, Stojanov VJ, Slepcevic VZ, Paunovic KZ. Nighttime road-traffic noise and arterial hypertension in an urban population. *Hypertens Res* 2008; 31(4):775-781.
- Bittner V. Angina Pectoris. Reversal of the Gender Gap. *Circulation* 2008; 117: 1505-1507.
- Bjork J, Ardo J, Stroh E, Lovkvist H, Ostergren PO, Albin M: Road traffic noise in southern Sweden and its relation to annoyance, disturbance of daily activities and health. *Scand J Work Environ Health* 2006, 32(5):392-401.
- Bluhm GL, Berglind N, Nordling E, Rosenlund M. Road traffic noise and hypertension. *Occup Environ Med* 2007; 64:122-126.
- Bodin T, Albin M, Ardö J et al. Road traffic noise and hypertension: results from a cross-sectional public health survey in southern Sweden. *Environmental Health* 2009, 8:38
doi:10.1186/1476-069X-8-38.
- Botteldooren D, Lercher P. Soft-computing base analyses of the relationship between annoyance and coping with noise and odor. *J Acoust Soc Am* 2004; 115(6): 2974-2985.
- Brook RD. Cardiovascular effects of air pollution. *Clin Sci* 2008; 115: 175–87.
- Burke V, Gracey MP, Beilin LJ, Milligan RA. Family history as a predictor of blood pressure in a longitudinal study of Australian children. *J Hypertens* 1998;16(3):269-276.
- Carney RM, Freedland KE, Miller GE, Jaffe AS. Depression as a risk factor for cardiac mortality and morbidity: a review of potential mechanisms. *J Psychosom Res* 2002; 53: 897–902.
- Carney RM, Freedland KE, Veith RC. Depression, the autonomic nervous system, and coronary heart disease. *Psychosomatic Medicine* 2005; 67, Supplement 1: S29–S33.
- Chen H, Cohen P, Kasen S. Cohort Differences in Self-Rated Health: Evidence from a Three-Decade, Community-Based, Longitudinal Study of Women. *Am J Epidemiol* 2007; 166: 439-446.
- Cohen S, Evans GW, Stokols D, Krantz, DS. Behavior, health and environmental stress. New York, London: Plenum Press, 1986.

ITEM 11.1.

- Cutler JA, Sorlie PD, Wolz M, Thom T, Fields LE, Roccella EJ. Trends in Hypertension Prevalence, Awareness, Treatment, and Control Rates in United States Adults Between 1988 1994 and 1999 2004. *Hypertension* 2008; 52: 818-827.
- de Greve B, de Muer T, Botteldooren D. Outdoor beam tracing over undulating terrain, *Proceedings of Forum Acusticum* 2005, Budapest, Hungary; 2005.
- de Greve B, van Renterghem T, Botteldooren D. Outdoor sound propagation in mountainous areas: comparison of reference and engineering models. In: *Proceedings of ICA* on CD-ROM. Madrid, Spain; 2007.
- de Kluizenaar Y, Gansevoort RT, Miedema HM, de Jong PE: Hypertension and road traffic noise exposure. *J Occup Environ Med* 2007, 49(5):484-492.
- Eriksson C, Rosenlund M, Pershagen G, Hilding A, Östenson C-G, Bluhm G. Aircraft noise and incidence of hypertension. *Epidemiology* 2007; 18: 716-21.
- Evans GW. Environmental stress and health. In: Baum A, Revenson T, Singer JE, eds. *Handbook of health psychology*. Mahwah, NJ: Erlbaum, 2001:365-85.
- Evans GW, Lepore SJ. Moderating and mediating processes in environment-behavior research. In: Moore GT, Morons RW, eds. *Advances in environment, behavior, and design*. Vol 4. New York: Plenum Press, 1997:255-85.
- Fields JM. Effect of personal and situational variables on noise annoyance in residential areas. *J Acoust Soc Am* 1993; 93: 2753-2763.
- Greenland S. Modeling and variable selection in epidemiological analysis. *Am J Public Health* 1989;79:340-9.
- Greenland S. Basic problems in interaction assessment. *Environ Health Perspect* 1993; 101 (suppl 4):59-66.
- Greenland P, Knoll MD, Stamler J, et al. Major risk factors as antecedents of fatal and nonfatal coronary heart disease events. *JAMA* (2003) 290(7):891–897.
- Greenland S, Rothman KJ. Chapter 18: Concepts of Interaction. In *Modern Epidemiology* 2nd edition. Edited by: Rothman KJ, Greenland S. New York NY: Lippincott-Raven; 1998:329-342.

ITEM 11.1.

Hajjar I, Kotchen TA. Trends Hajjar I, Kotchen TA. Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988-2000. JAMA 2003; 290: 199-206.

Harrell FE Jr. Regression modeling strategies. New York: Springer; 2001.

Harrell FE Jr. R-Hmisc and R-Design library. URL: <http://cran.r-project.org/web/packages/Hmisc/> and <http://cran.r-project.org/web/packages/Design/>

Heimann D, de Franceschi M, Emeis S, Lercher P, Seibert P (eds) Air Pollution, Traffic Noise and Related Health Effects in the Alpine Space - A Guide for Authorities and Consultants.

ALPNAP comprehensive report. Università degli Studi di Trento, Trento, Italy, Dipartimento di Ingegneria Civile e Ambientale; 2007. Online available at:

http://www.alpnap.org/alpnap.org_ge.html

Heinonen-Guzejev M, Vuorinen HS, Kaprio J, Heikkilä K, Mussalo-Rauhamaa H, Koskenvuo M. Transportation noise exposure, annoyance and noise sensitivity in relation to noise map information, J Sound Vibration 2004; 234: 191–206.

Heinonen-Guzejev M, Vuorinen HS, Mussalo-Rauhamaa H, Heikkilä K, Koskenvuo M, Kaprio J. The association of noise sensitivity with coronary heart and cardiovascular mortality among Finnish adults, Sci Tot Environ 2007; 372: 406–412.

Heinonen-Guzejev M, Vuorinen HS, Mussalo-Rauhamaa H, Heikkilä K, Koskenvuo M, Kaprio J. Medical, psychological and genetic aspects of noise sensitivity. Proceedings Euronoise on CD-Rom, Institute of Acoustics on behalf of the EEA, Edinburgh 2009.

Hemingway H, Langenberg C, Damant J, Frost C, Pyörälä K, Barrett-Connor E. Prevalence of Angina in Women Versus Men: A Systematic Review and Meta-Analysis of International Variations Across 31 Countries. Circulation 2008; 117: 1526-1536.

Herbold M, Hense HW, Keil U. Effects of road traffic noise on prevalence of hypertension in men: Results of the Lübeck blood pressure study. Soz Praeventiv Med 1989; 34: 19-23.

Ibald-Mulli A, Stieber J, Wichmann HE, Koenig W, Peters A. Effects of air pollution on blood pressure: A population-based approach. Am J Public Health 2001; 91(4): 571–577.

ITEM 11.1.

Idler EL, Benyamini Y. Self-assessed health and mortality: a review of twenty seven community studies. *J Health Soc Behav* 1997; 38: 21–37.

Jarup L, Babisch W, Houthuijs D, Pershagen G, Katsouyanni K, Cadum E, et al. Hypertension and exposure to noise near airports – the HYENA study. *Environmental Health Perspectives* 2008; 116: 329-33.

Jelleyman T, Spencer N. Residential mobility in childhood and health outcomes: a systematic review. *J Epidemiol Community Health* 2008; 62: 584-592.

Jonasson HG. Acoustical Source Modeling of Road Vehicles, *Acta Acustica united with Acustica* 2007; 93: 174-183.

Crilly M, Bundred P, Hu X, Leckey L, Johnstone F. Gender differences in the clinical management of patients with angina pectoris: a cross-sectional survey in primary care. *BMC Health Services Research* 2007; 7:142 doi:10.1186/1472-6963-7-142.

Kajantie E, Phillips DIW. The effects of sex and hormonal status on the physiological response to acute psychosocial stress. *Psychoneuroendocrinology* 2006; 31(2): 151-178.

Kajantie E. Physiological stress response, estrogen, and the male-female mortality gap. *Current Directions in Psychological Science* 2008; 17: 348-352.

Kasl SV. Stress and health. *Ann Rev Publ Health* 1984; 5:319–341.

Krewski D, Rainham D. Ambient air pollution and population health: overview. *Journal of Toxicology and Environmental Health, Part A*, 2007; 70: 275–283.

Larson A, Bell M, Young A. Clarifying the relationships between health and residential mobility. *Social Science & Medicine* 2004; 59(10): 2149-2160.

Lazarus RS. Coping theory and research: past, present, and future. *Psychosom Med* 1993; 55:234–247.

Lekander M, Elofsson S, Neve IM, Hansson LO, Undén AL. Self-rated health is related to levels of circulating cytokines. *Psychosom Med* 2004; 66: 559-563.

Leineweber C, Kecklund G, Janszky I, Akerstedt T, Orth-Gomer K. Poor sleep increases the prospective risk for recurrent events in middle-aged women with coronary disease. The Stockholm female coronary risk study. *J Psychosom Res* 2003; 54:121–127.

ITEM 11.1.

Lercher P: Straßenverkehr und Gesundheit. Das Beispiel "Lärmdorf". In: Veröffentlichungen der Universität Innsbruck Nr. 166. Innsbruck, 1988: 27-48.

Lercher P. Community exposure to highway noise, behavioral adaptation and blood pressure. Master's Thesis. University of North Carolina at Chapel Hill, July 1990.

Lercher P. Auswirkungen des Straßenverkehrs auf Lebensqualität und Gesundheit.

Transitstudie - Sozialmedizinischer Teilbericht. Innsbruck: Amt der Tiroler Landesregierung, 1992.

Lercher P. Non-auditory health effects research: A conceptual analysis of recent results and research needs. In: Kuwano S, Ed. Proceedings Internoise 94. Yokohama, 1994: 1053-1058.

Lercher P, Schmitzberger R, Kofler W. Perceived traffic air pollution, associated behaviour and health in an alpine area. Sci Tot Environ 1995; 169: 71-74.

Lercher P, Kofler WW. Behavioral and health responses associated with road traffic noise along alpine through-traffic routes. Sci Total Environ. 1996a; 189/190: 85-89.

Lercher P. Environmental noise and health: An integrated research perspective. Environ Intern 1996b; 22: 117-129.

Lercher P, Stansfeld SA, Thompson SJ. Non-auditory health effects of noise: review of the 1993-8 period. In: Carter NL, Job RFS, eds. Noise as a public health problem. Sydney, Australia: Noise Effects, 1998;1: 213-20.

Lercher P. Context and coping as moderators of potential health effects in noise-exposed persons. In: Prasher D, Luxon L, eds. Advances in noise series. Vol I: biological effects. London: Whurr, 1998:328-35.

Lercher P. Environmental noise: A contextual public health perspective. In: Luxon L, Prasher D (eds) Noise and its effects: pp 345-377. London: Wiley, London 2007.

Lett HS, Blumenthal JA, Babyak MA, et al. Depression as a risk factor for coronary artery disease: evidence, mechanisms, and treatment. Psychosom Med 2004; 66(3):305-315.

Lundberg U. Stress hormones in health and illness: The roles of work and gender.

Psychoneuroendocrinology 2005; 30: 1017-1021.

ITEM 11.1.

Madsen C, Nafstad P. Associations between environmental exposure and blood pressure among participants in the Oslo Health Study (HUBRO). *Eur J Epidemiol* 2006; 21: 485-491.

Marshall SW. Power for tests of interaction: effect of raising the Type I error rate.

Epidemiologic Perspectives & Innovations 2007, 4:4 doi:10.1186/1742-5573-4-4.

Matthews JNS, Altman DG. Education and debate Statistics Notes: Interaction 2: compare effect sizes not P values. *BMJ* 1996; 313: 808.

Meisinger C, Heier M, Löwel H, et al. Sleep duration and sleep complaints and risk of myocardial infarction in middle-aged men and women from the general population: the MONICA/KORA Augsburg cohort study. *Sleep* 2007; 30(9): 1121–1127.

Metzner, HL, Harburg E, Lamphiear DE. Residential mobility and urban-rural residence within life stages related to health risk and chronic disease in Tecumseh, Michigan. *Journal of Chronic Diseases* 1982; 35(5): 359-374.

Norman P, Boyle P, Rees P, Selective migration, health and deprivation: a longitudinal analysis, *Social Science & Medicine* 2005; 60: 2755–2771.

Opatril S, Miller AP. Gender and blood pressure. *J Clin Hypertens* 2005; 7: 300-309.

Öttl D, Almbauer R, Sturm PJ. A new method to estimate diffusion in low wind, stable conditions. *Journal of Applied Meteorology* 2001; 40: 259-268.

Öttl D, Sturm P, Pretterhofer G, Bacher M, Rodler J, Almbauer R. Lagrangian dispersion modeling of vehicular emissions from a highway in complex terrain. *J of the Air and Waste Management Association* 2003a; 53: 1233-1240.

Öttl D, Almbauer RA, Sturm PJ, Pretterhofer G. Dispersion modelling of air pollution caused by road traffic using a Markov Chain - Monte Carlo model. *Stochastic Environmental Research and Risk Assessment* 2003b; 17: 58-75.

Öttl D, Goulart A, Degrazia G, Anfossi. A new hypothesis on meandering atmospheric flows in low wind speed conditions. *Atmos Environ* 2005; 39: 1739 - 1748.

Öttl D, Sturm P, Anfossi D, Trini Castelli S, Lercher P, Tinarelli G, Pittini T. Lagrangian particle model simulation to assess air quality along the Brenner transit corridor through the

ITEM 11.1.

Alps; Air Pollution Modelling and its Applications XVIII; Developments in Environmental Science, 6, 689-697, New York: Elsevier, 2007.

Pearce N, Greenland S. Confounding and interaction. In: Ahrens W, Krickeberg K, Pigeot I, eds. Handbook of epidemiology. Heidelberg: Springer-Verlag, 2004:375–401.

Pope CA, Dockery DW. Health effects of fine particulate air pollution: lines that connect. J Air Waste Manag Assoc 2006; 56: 709–742.

R Development Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria; 2009. ISBN 3-900051-07-0.

URL <http://www.R-project.org>.

Rexeis M, Hausberger S. Calculation of Vehicle Emissions in Road Networks with the Model "NEMO". Conference Proceedings of the 14th Symposium on Transport and Air Pollution, ISBN 3-902465, 1-3 June 2005, Graz: 118-128.

Rexeis M, Hausberger S. Trend of vehicle emission levels until 2020, prognosis based on current vehicle measurements and future emission legislation. Atmos Environ 2009; 43: 4689–4698.

Rüdisser J, Lercher P, A Heller. Traffic exposure and medication - a GIS based study on prescription of medicines in the Tyrolean Wipptal. Italian Journal of Public Health 2008; 5(4): 261-267.

Schwartz S, McDowell Anderson W, Cole SR, Cornoni-Huntley J, Hays JC, Blazer D. Insomnia and heart disease: a review of epidemiologic studies. J Psychosom Res 1999; 47: 313–333.

Schwela D, Kephelopoulou S, Prasher D. Confounding or aggravating factors in noise-induced health effects: air pollutants and other stressors. Noise Health 2005; 7, 41-50.

Seinfeld JH, Pandis SN. Atmospheric chemistry and physics: From air pollution to climate change. ISBN 0-471-17815-2, New York: Wiley-Interscience, 1997.

Selander J, Nilsson ME, Bluhm G, Rosenlund M, Lindqvist M, Nise G, Pershagen G: Long-term exposure to road traffic noise and myocardial infarction. Epidemiology 2009, 20(2): 272-279.

ITEM 11.1.

Selvin S. Statistical Analysis of Epidemiologic Data New York: NY: Oxford University Press; 1996: 213-214.

Singh-Manoux A, Guéguen A, Martikainen P, Ferrie J, Marmot M, Shipley M. . Self-rated health and mortality: Short- and long-term associations in the Whitehall II study. *Psychosom Med* 2007; 69: 138-143.

Stamler R, Stamler J, Riedlinger WF, Algera G, Roberts RH. Family (parental) history and prevalence of hypertension. *JAMA* 1979; 241(1):43-46.

Stansfeld SA. Noise, noise sensitivity and psychiatric disorder: epidemiological and psychological studies. *Psychological medicine. Monograph Suppl* 22. Cambridge: Cambridge University Press, 1992.

Stoney CM, Davis MC, Matthews KA. Sex differences in physiological responses to stress and in coronary heart disease: A causal link? *Psychophysiology* 1987; 24: 127–131.

Suls J, Bunde J. Anger, anxiety, and depression as risk factors for cardiovascular disease: the problems and implications of overlapping affective dispositions. *Psychol Bull* 2005; 131: 260–300.

Vaccarino V. Angina and cardiac care: are there gender differences, and if so, why? *Circulation* 2006, 113:467-469.

Van Renterghem T, Botteldooren D, Lercher P. Comparison of measurements and predictions of sound propagation in a valley-slope configuration in an inhomogeneous atmosphere. *J Acoust Soc Am* 2007; 121: 2522-2533.

Wang NY, Young JH, Meoni LA, Ford DE, Erlinger TP, Klag MJ. Blood Pressure Change and Risk of Hypertension Associated With Parental Hypertension: The Johns Hopkins Precursors Study. *Arch Intern Med* 2008; 168: 643-648.

Willich SN, Wegscheider K, Stallmann M, et al. Noise burden and the risk of myocardial infarction. *Eur Heart J* 2006; 27: 276 –282.

Wolf-Maier K, Cooper RS, Banegas JR, Giampaoli S, Hense HW, Joffres M, Katarinen M, Poulter N, Primatesta P, Rodriguez-Artalejo F, et al.: Hypertension prevalence and blood

ITEM 11.1.

pressure levels in 6 European countries, Canada, and the United States. JAMA 2003; 289(18):2363-2369.

Yusuf S, Reddy KS, Ôunpuu S, Anand S. Global Burden of Cardiovascular Diseases Part I: General Considerations, the Epidemiologic Transition, Risk Factors, and Impact of Urbanization. Circulation 2001; 104: 2746-2753.

Zanobetti A, Canner MJ, Stone PH, et al. Ambient pollution and blood pressure in cardiac rehabilitation patients. Circulation 2004; 110(15): 2184–2189.

ITEM 11.1.

Table 1: Study characteristics

Study	Year/season	Areas	Traffic sources	Age range	N	Methods	Participation	Design/Sampling
<i>"Noise Village" study</i>								
Schönberg-I	1984/summer	1 full community	highway main road	25-64 yrs	197	interview	77%	cross-section of the whole
					174	anthropometry	67%	community
Schönberg-II	1989/fall	1 full community	highway main road	25-69 yrs	218	interview	62%	cross-sectional cohort
							51%	(Schönberg I-II)
<i>Tyrol "TRANSIT" study</i>								
	1989/fall	5 communities Wipptal (2) Inntal (1) B 312 (2)	highway main road railway	25-64 yrs	1989	interview: environment, coping, behaviour health, medications anthropometry	62%	cross-sectional
<i>"BEG" study</i>								
UIT-I	1998/fall	32 communities Inntal	highway main road railway	18-74 yrs	1503	phone: environment, coping, behaviour health, medications	81%	random (based on visibility)
					701		83%	random stratified (based on distance to source)
UIT-II	1998/fall	Inntal	highway main road railway	18-74 yrs	840	interview: environment, coping, anthropometry	51%	cluster sampling: 500 m
					806			samplingradius around measurement point
					572	4 blood pressure readings		
<i>"BBT" study</i>								
	2004/spring	Wipptal-Nord (at) Wipptal-Süd (it) and sidevalleys	highway main road railway	20-74 yrs	2007	phone: environment, coping, behaviour, health, medications	80%	Stratified random sampling Strata=distance to source
	2004/summer	Wipptal-Nord (at) Wipptal-Süd (it)	highway main road railway	20-74 yrs	2070	interview: environment, coping, behaviour, QoL health, medications anthropometry	62%	
<i>"ALPNAP" study</i>								
Interreg IIIB-project	2006/spring	Inntal	highway	20-74 yrs	1653	phone: environment,	35%	Stratified random sampling

ITEM 11.1.

2006/fall	Inntal	main road railway highway main road railway	20-74 yrs	252	coping, behaviour, health, medications intensive questionnaire diary: annoyance+sleep anthropometry, FEV1 urine samples	41%	Strata=distance to source Subsample of volunteers based on stratified invitations
-----------	--------	---	-----------	-----	--	-----	--

ITEM 11.1.

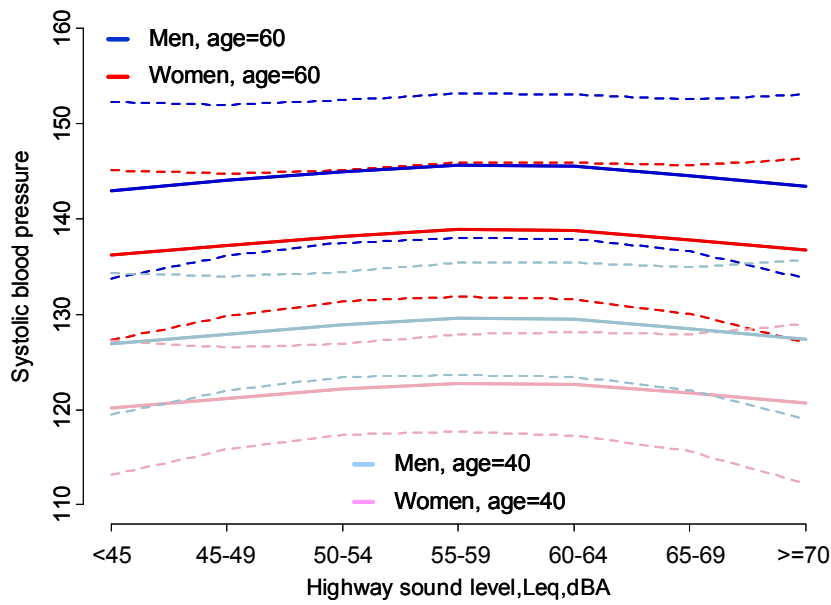


Figure 1: Systolic blood pressure: Exposure-response for highway sound exposure by age and sex. Adjusted for bmi, education, smoking, alcohol, sleep problems, window behaviour, work satisfaction [Noise Village study, 1984]

ITEM 11.1.

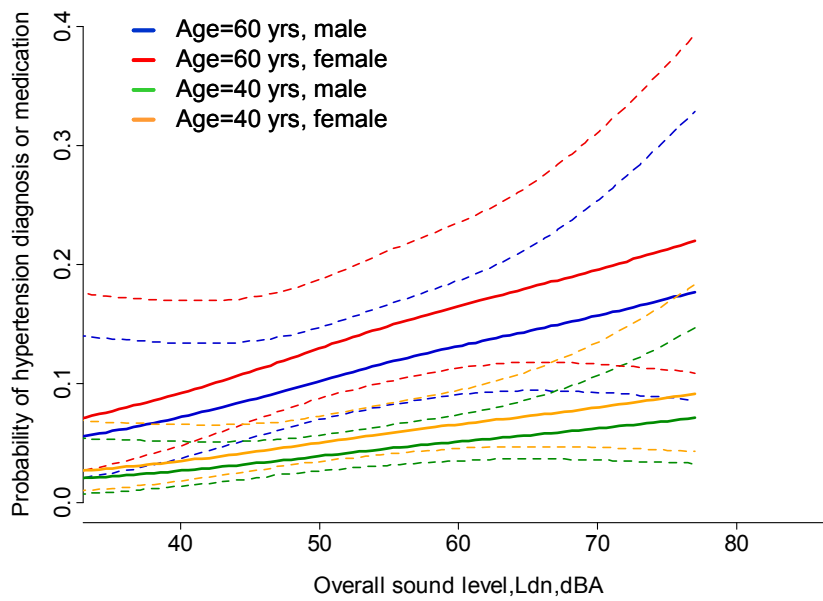


Figure 2: Hypertension diagnosis/treatment: Exposure-response for overall sound exposure (road & rail traffic) by age and sex. Adjusted for health status, weather and noise sensitivity, work noise and vibration, distance to highway and rail – [UIT-1 study, 1998]

ITEM 11.1.

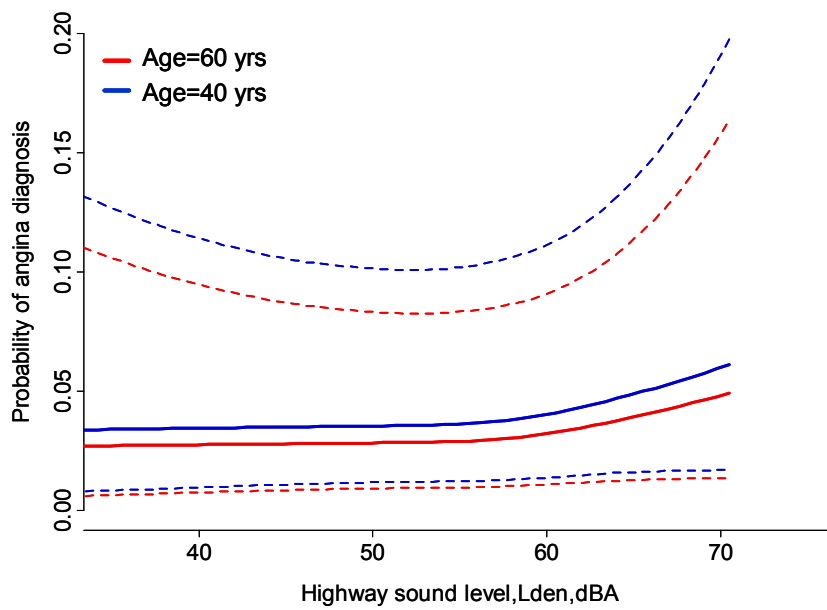


Figure 3: Angina pectoris: Exposure-response for highway sound exposure by age. Adjusted for bmi, family history, known hypertension, education, health status, depression, smoking, occupation, coping, anger, PM10 - [ALPNAP study, 2006 (MITHRA)]

ITEM 11.1.

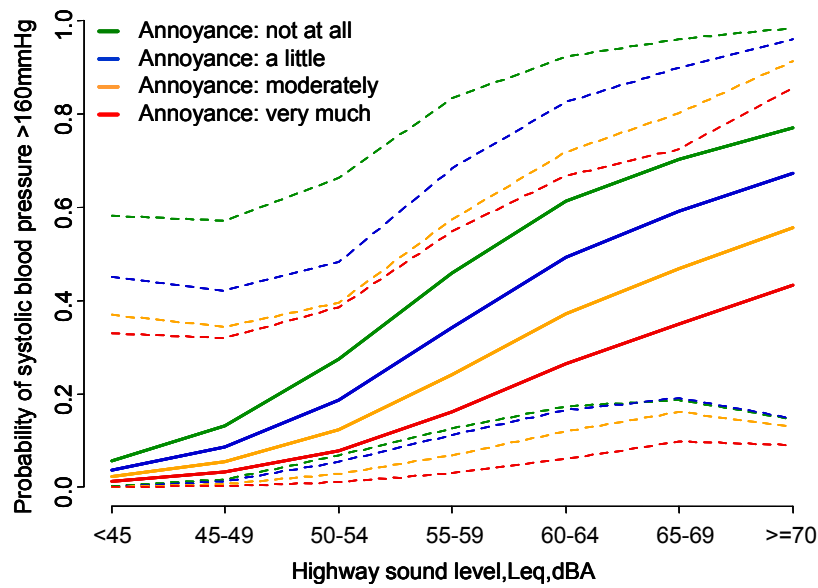


Figure 4: Systolic blood pressure > 160 mmHg: Exposure-response for highway sound exposure by annoyance rating. Adjusted for age, sex, bmi, education, occupational noise, window behaviour - [Noise Village study, 1984]

ITEM 11.1.

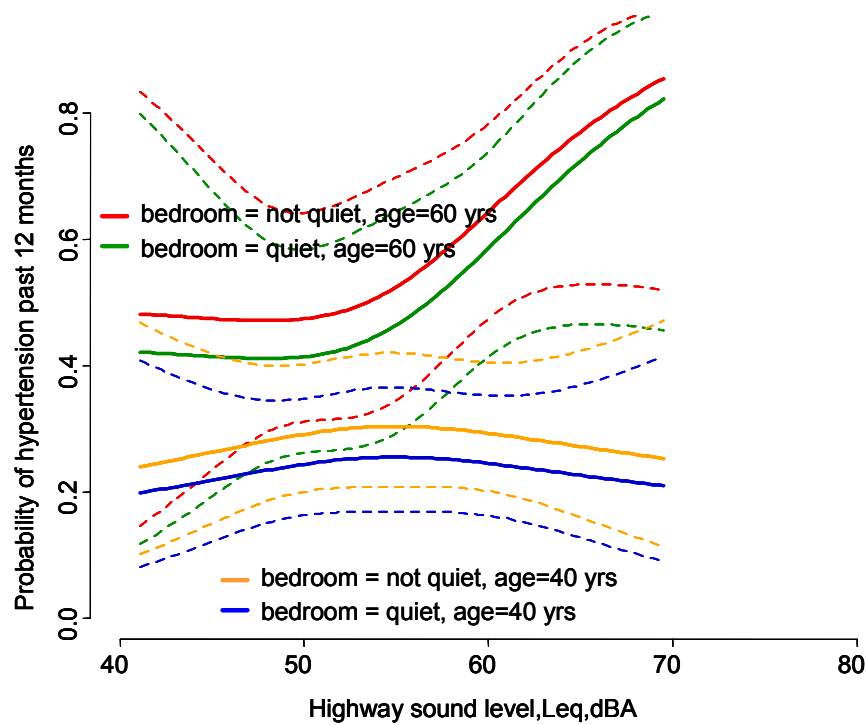


Figure 5: Hypertension: Exposure-response for highway sound exposure by bedroom location. Adjusted for age, sex, bmi, family history, education, health status, duration of living, IA level*age, level*history, level*health status – [ALPNAP study, 2006]

ITEM 11.1.

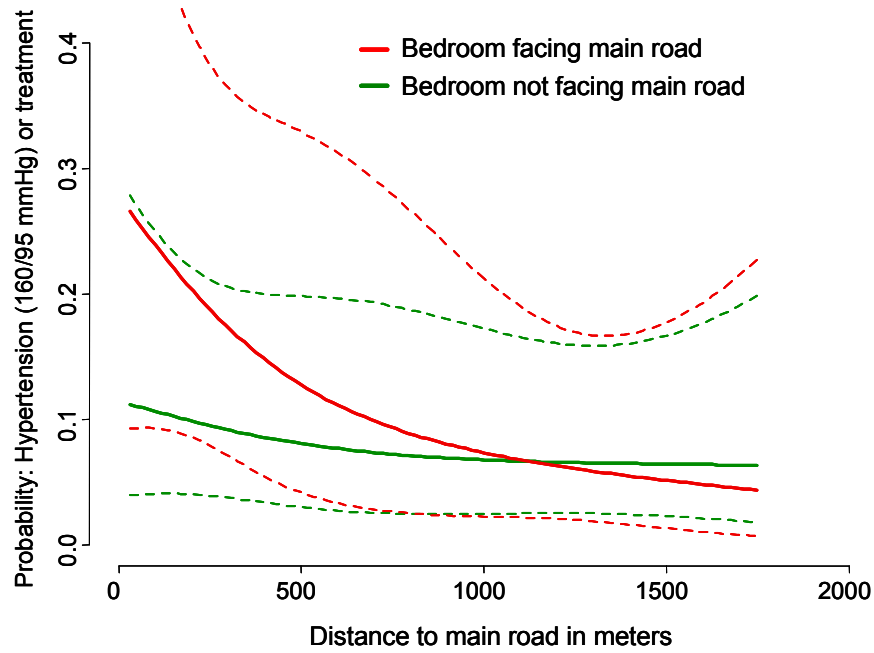


Figure 6: Hypertension/treatment: Exposure-response with distance to main road (highway model) by bedroom location. Adjusted for age, sex, bmi, family history, health, health worry, education, weather sensitivity, work noise, nightshift, heart medication, heart rate, night disturbance rail, level highway – [UIT-2 study, 1998]

ITEM 11.1.

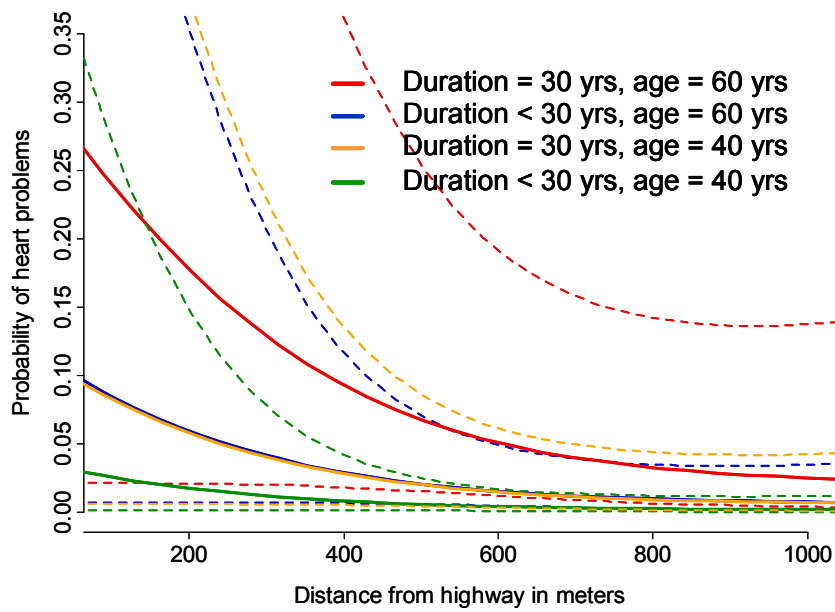


Figure 7: Heart problems: Exposure-response with distance to highway by duration of living at age 60. Adjusted for sex, education, hypertension, weather and noise sensitivity, coping, region, NO₂, overall sound level – [UIT-1study, 1998]

ITEM 11.1.

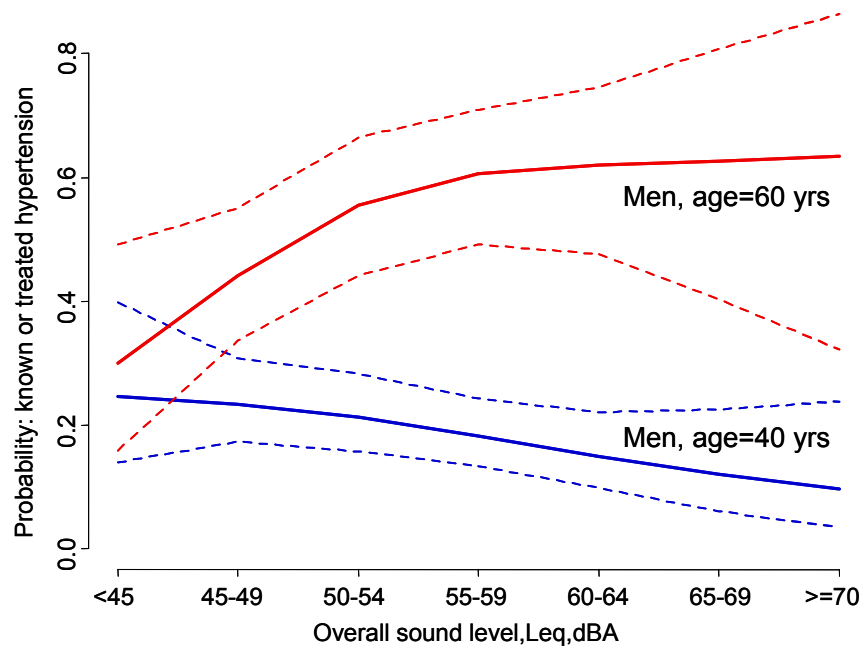


Figure 8: Hypertension: Exposure-response for overall sound exposure (road & rail traffic) by age in men. Adjusted for bmi, family history, cholesterol, education, noise sensitivity, IA sound level*age, sound level*sensitivity – [TRANSIT study, 1989]

ITEM 11.1.

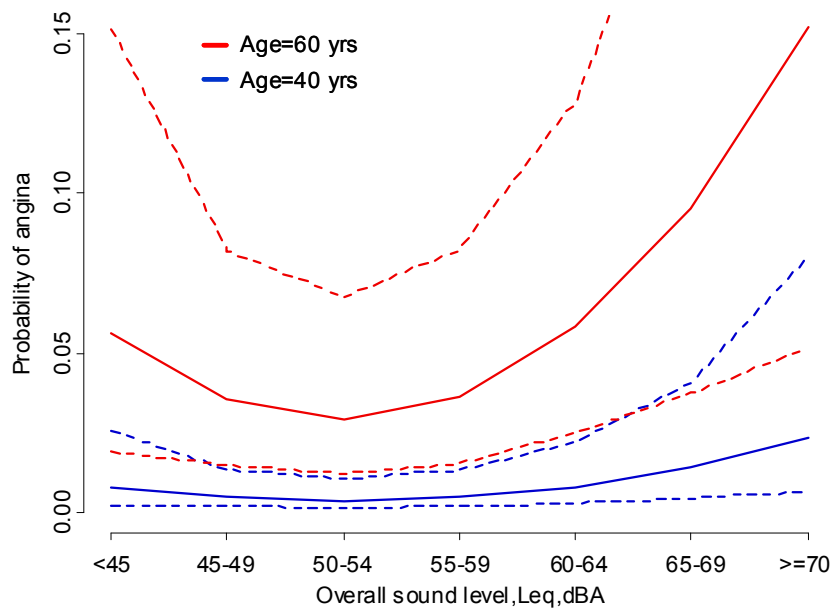


Figure 9: Angina pectoris: Exposure-response for overall sound exposure (road & rail traffic) by age. Adjusted for sex, bmi, family history, cholesterol, education, health, smoking, fat intake, exercise, nightshift, community – [TRANSIT study, 1989]

ITEM 11.1.

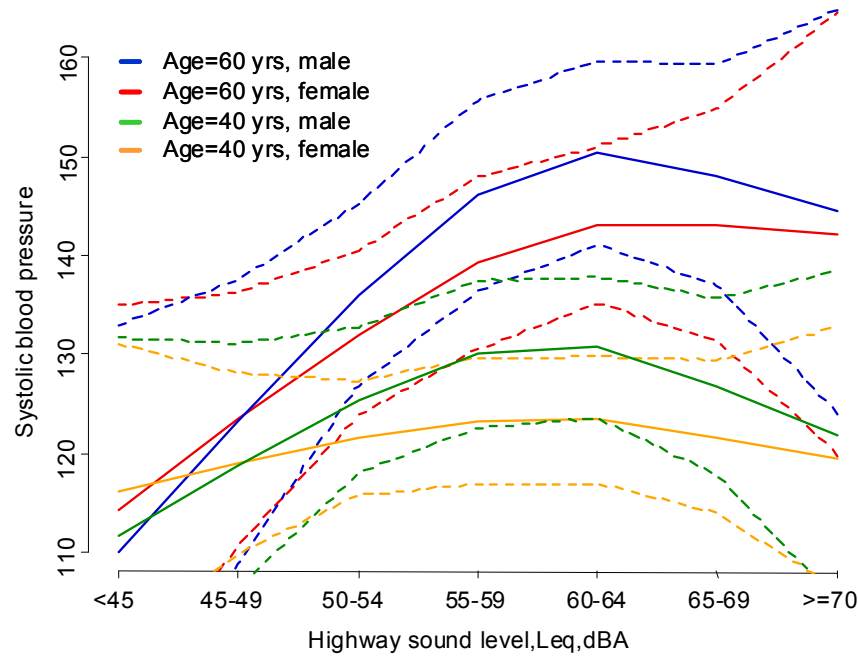


Figure 10: Systolic blood pressure: Exposure-response for highway sound exposure by age and sex. Adjusted for bmi, education, occupational noise, noise annoyance, IA sound level* age, level*sex, level*annoyance, level*occ. noise – [Noise Village study, 1984]

ITEM 11.1.

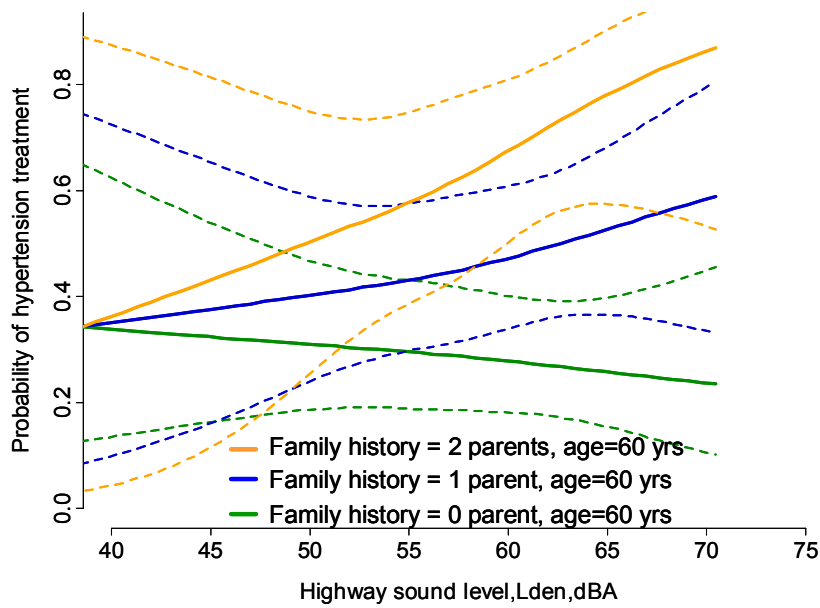


Figure 11: Hypertension treatment: Exposure-response for highway sound exposure at age 60 yrs by family history. Adjusted for age, sex, bmi, education, health status, duration of living, house type, IA sound level*age, level*history, level*health status, age*duration of living – [ALPNAP study, 2006 (sound propagation: MITHRA)]

ITEM 11.1.

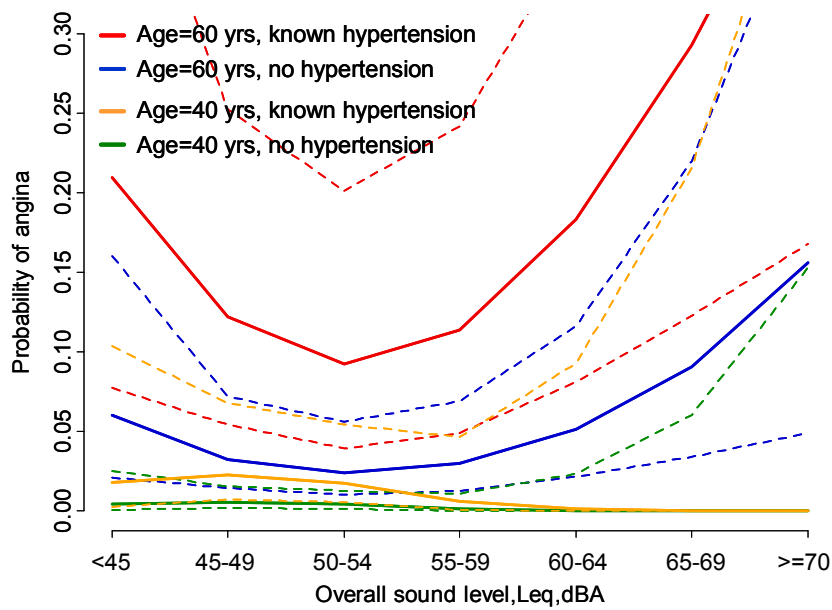


Figure 12: Angina pectoris: Exposure-response for overall sound exposure (road & rail traffic) by age and hypertension. Adjusted for sex, bmi, family history, cholesterol, education, health, noise sensitivity, community, sound level*age – [TRANSIT study, 1989]

ITEM 11.1.

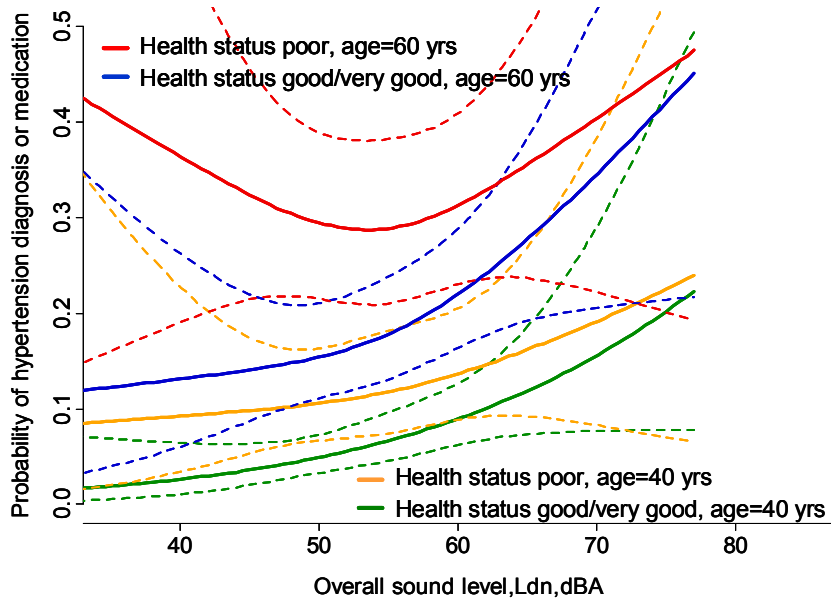


Figure 13: Hypertension diagnosis/treatment: Exposure-response for overall sound exposure (road & rail traffic) by age and health status. Adjusted for sex, annoyance, weather and noise sensitivity, distance to highway, main road, rail, IA sound level*age, sound level*health status – [UIT-1 study, 1998]

ITEM 11.1.

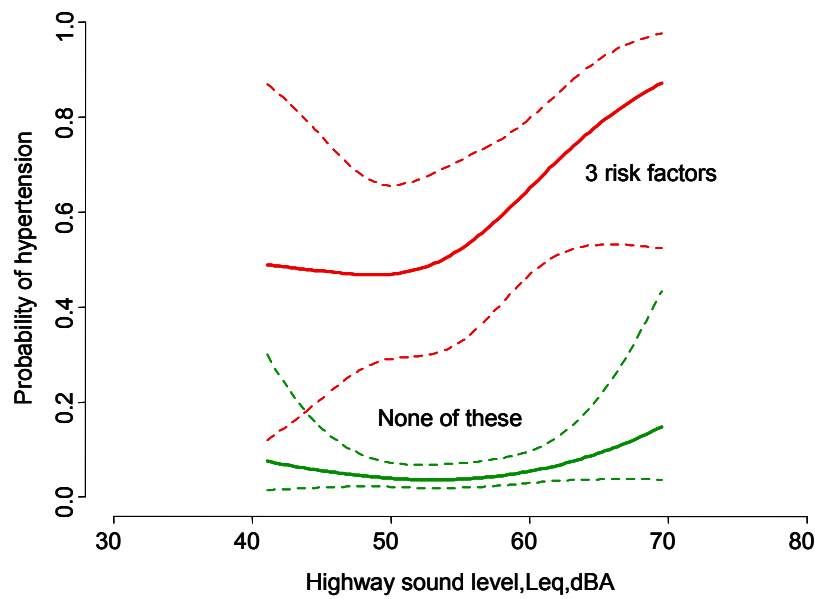


Figure 14: Hypertension diagnosis: Exposure-response for highway sound exposure at age 60 yrs in poor health with a strong family history. Adjusted for sex, bmi, education, house type, annoyance, occup. noise, area, IA sound level*age, level*history, level*health status – [ALPNAP study, 2006 (sound propagation: INTEC)]

ITEM 11.1.

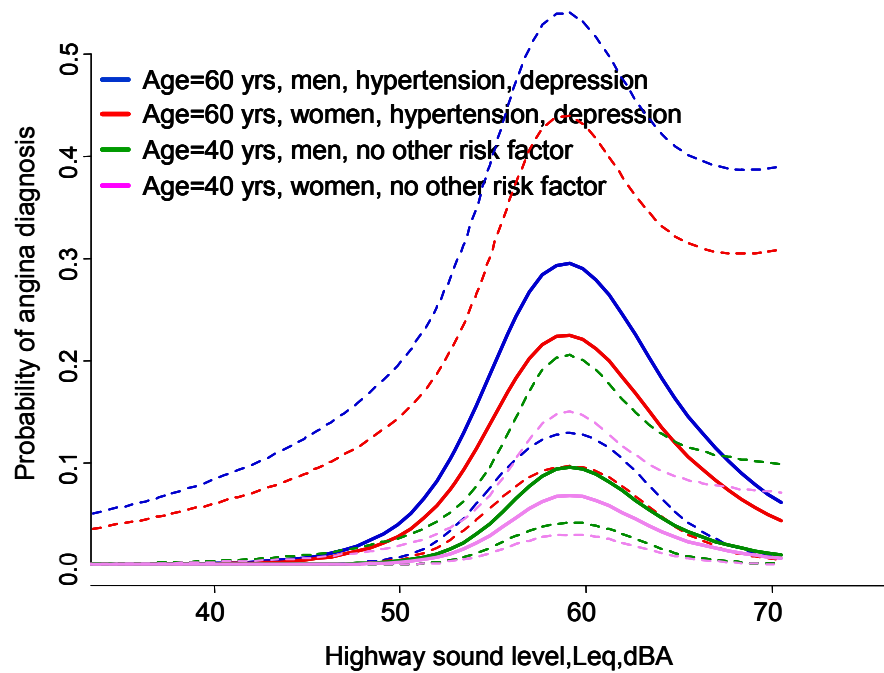


Figure 15: Angina pectoris: Exposure-response for highway sound exposure at age 60 yrs with hypertension and depression by sex. Adjusted for bmi, family history, education, smoking, sensitivity, coping, anger, NO₂-level, IA sound level*age, level*anger, level*hypertension, level*smoking, sex*sensitivity – [ALPNAP study, 2006 (MITHRA)]

ITEM 11.1.

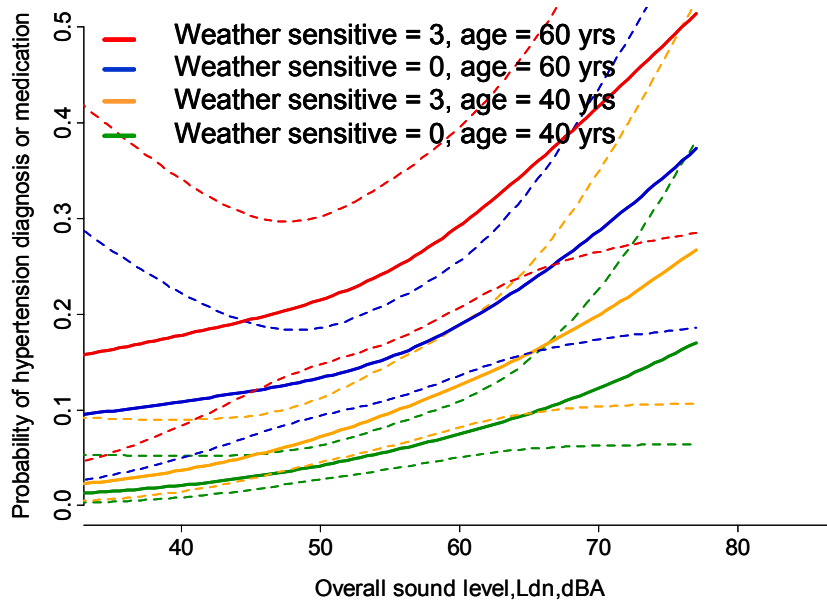


Figure 16: Hypertension diagnosis/treatment: Exposure-response for overall sound exposure (road & rail traffic) by weather sensitivity and age. Adjusted for sex, health status, annoyance, noise sensitivity, distance to highway, main road, rail, IA sound level*age, sound level*health status -[UIT-1 study, 1998]

ITEM 11.1.

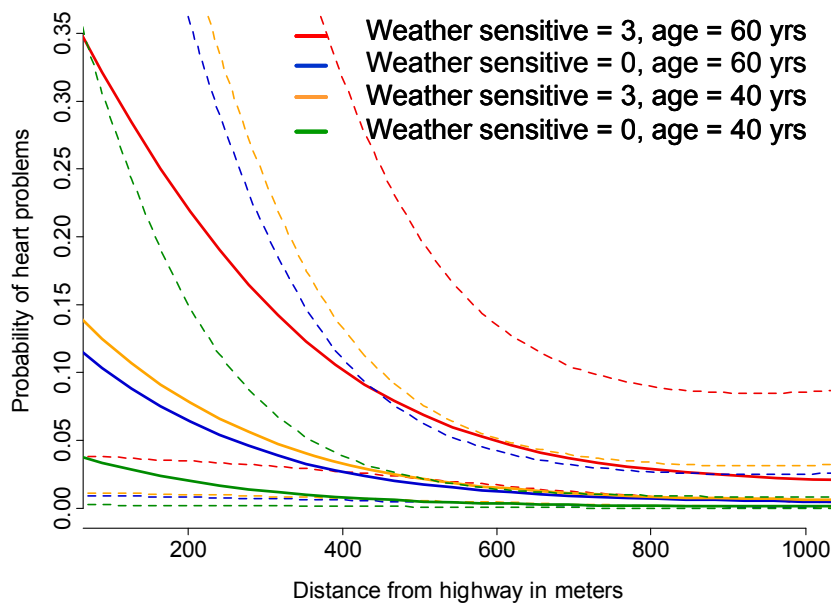


Figure 17: Heart problems: Exposure-response with distance to highway by age and weather sensitivity. Adjusted for sex, education, hypertension, noise sensitivity, duration of living, coping, region, NO₂, overall sound level, IA sound*weather sensitivity – [UIT-1 study, 1998]

ITEM 11.1.

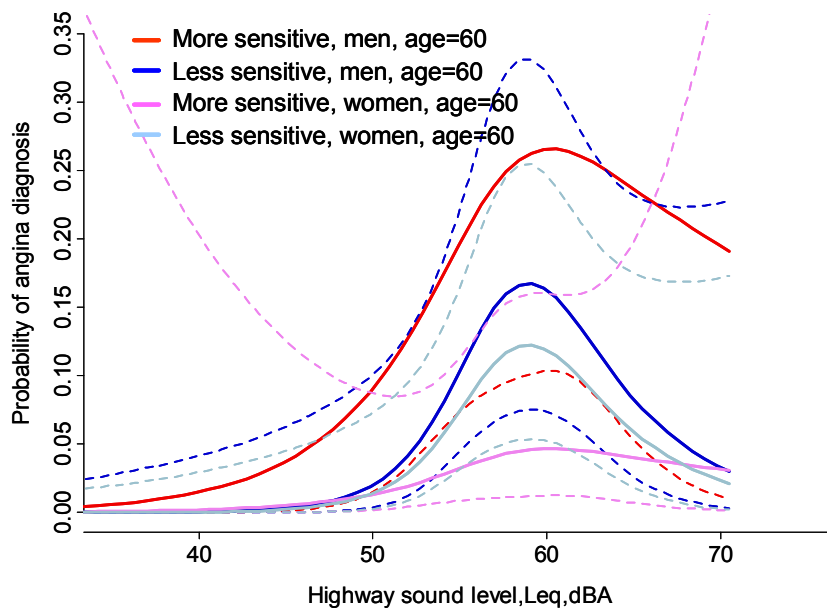


Figure 18: Angina pectoris: Exposure-response for highway sound exposure at age 60 yrs by sex and sensitivity. Adjusted for bmi, education, smoking, sleep, coping, anger, NO₂-level, IA sound level*age, level*anger, level*hypertension, level*smoking, level*sensitivity, sex*sensitivity – [ALPNAP study, 2006 (MITHRA)]

ITEM 11.1.

EXHIBIT 9



Contents lists available at SciVerse ScienceDirect

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

Traffic noise abatement: How different pavements, vehicle speeds and traffic densities affect annoyance levels

E. Freitas ^{a,*}, C. Mendonça ^{b,d}, J.A. Santos ^{b,c,d}, C. Murteira ^b, J.P. Ferreira ^a

^a School of Engineering, Department of Civil Engineering, University of Minho, Portugal

^b School of Psychology, Department of Basic Psychology, University of Minho, Portugal

^c Centro Algoritmi, University of Minho, Portugal

^d Centro de Computação Gráfica, Portugal

ARTICLE INFO

Keywords:

Traffic noise annoyance
Dense asphalt pavements
Open asphalt rubber pavements
Cobblestones pavements

ABSTRACT

In this paper, annoyance ratings from traffic noise recorded on cobblestones, dense asphalt, and open asphalt rubber pavements are assessed with regard to car speeds and traffic densities. It was found that cobblestones pavements are the most annoying; also while open asphalt rubber pavement imposes less annoyance than dense asphalt it is not significantly different. Higher car speeds always lead to greater annoyance, as does higher traffic densities. LAeq and LAmx correlate well with annoyance, but loudness is the best predictor. Roughness and sharpness exhibit inconsistent interactions.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Transportation is a major source of noise but few studies have been carried out on the impact of pavement type on noise annoyance, and most that have, have focused on porous asphalt and dense asphalt surfaces, (Sandberg and Ejsmont, 2002; Golebiewski et al., 2003). Additionally, many studies that have addressed noise annoyance taking into account traffic characteristics have disregarded the influence of road surface type (Griefahn et al., 2008; Paunović et al., 2009).

Here we seek to help establishing a better understanding of links between subjective annoyance ratings and traffic noise levels. Several acoustic measurements are considered when comparing road surfaces; not only LAeq (the equivalent continuous A-weighted sound pressure level) and LAmx (the A-weighted average of the maximum levels of the noise being investigated during a time interval), but also psychoacoustic indicators as loudness, roughness and sharpness.

2. Materials and methods

2.1. Pavement surfaces

We focus on three types of pavement:

- Cobblestones, that is often used in European city centres;
- Dense asphalt, that has been used for many years and can be taken as a reference surface; and
- Open graded asphalt rubber, that has been used in the last decade to delay cracking reflection and reduce rutting (Fontes et al., 2010), and to reduce noise (Donovan, 2005; Paje et al., 2010).

* Corresponding author.

E-mail address: efreitas@civil.uminho.pt (E. Freitas).

ITEM 11.1.

322

E. Freitas et al. / Transportation Research Part D 17 (2012) 321–326

Table 1

Main characteristics of the surfaces.

Type of surface	Cobblestones	Dense asphalt	Open asphalt rubber
Maximum aggregate size	100 × 100 mm ²	16 mm	10 mm
Voids content (%)	–	(3–5)	(10–17)
Rubber content by bitumen weight (%)	–	–	(18–20)
Mean profile depth (mm)	–	0.5	1.0
Age (years)	>20	1	4

Table 2

Noise levels (ordinary vehicles/hybrid vehicle) obtained by CPB method.

Type of surface	LAmax (dBA)				
	30 (km/h)	40 (km/h)	50 (km/h)	60 (km/h)	70 (km/h)
Cobblestones	68.4/65.3	72.6/70.0	75.8/73.7	78.5/76.7	80.7/79.3
Dense asphalt	63.9/59.6	67.5/63.9	70.2/67.2	72.5/69.8	74.4/72.1
Open asphalt rubber	63.2/60.5	66.7/64.2	69.5/67.1	71.8/69.4	73.7/71.4

Table 3

Surface and air temperatures at testing time.

Type of surface	Cobblestones	Dense asphalt	Open asphalt rubber
Air temperature (°C)	11.1	8.6	18.1
Surface temperature (°C)	6.0	12.6	29.8

The vehicles used in the recordings are a small passenger car (Volkswagen Polo), a hybrid (Toyota Prius), and a pickup truck (Mitsubishi Strakar). Representative sections of the road surfaces and the recording methods follow the European ISO Standard 11819-1:1997. Road noise was binaurally recorded with a Brüel & Kjaer Head and Torso Simulator (HATS) type 4128-C, a Brüel & Kjaer Pulse Analyzer type 3560-C and Pulse CPB Analysis software. Speed measurements of each vehicle were obtained with Ultra Lyte LTI 20-20 radar.

The noise samples were recorded with the HATS at 7.5 m from the road centre and at a height of 1.7 m. The controlled pass-by method (CPB) was used. Each single vehicle tyre-road noise was recorded with variable speed profiles. Vehicle speeds were of 30, 40, 50, 60 and 70 km/h. To minimise the meteorological bias all recording sessions were performed with dry pavements, wind speed below 5 m/s, atmospheric temperature between 5 °C and 30 °C, and pavement temperature between 5 °C and 50 °C as recommended in ISO Standard 11819-1:1997.

The main pavement characteristics influencing traffic noise of each surface are presented in Table 1 (Sandberg and Ejsmont, 2002). There is a difference in physical characteristics between dense asphalt and the open asphalt rubber but this only leads to differences of less than 1 dB(A) (Table 2), estimated from the LAmax using the controlled pass-by method and the logarithm (base 10) of the measured speed. If corrections to the temperature effect are made, these differences may be even smaller (Table 3).

Further, the effect of age should not be discarded. Dense asphalt surface layers typically have higher noise levels at the beginning of their lifetime but are more stable with time as opposed to thin layers (Bendtsen et al., 2010), such as the open graded asphalt rubber, which is characterised by lower noise levels at the beginning of their lifetime and a significant increase of noise in their first years of service.

2.2. Experiment

Ninety-six listeners participated in the experiment aged 7–86 years with an average of 37 years, 26 were 19 years and under, 32 were 20–39, 18 were 40–59, and 20 were 60 years and over. They were all voluntary participants, recruited from educational and social institutions in the area where the noise samples were taken. To exclude prior major hearing deficiency all participants underwent audiometric screening tests (250, 1000 and 4000 Hz).

The single vehicle recordings were factorially paired by audio software (Ardour) to produce the stimuli for the annoyance assessment. For each pavement type and vehicle speed, from 30 to 70 km/h with 10 km/h increments, two traffic density compositions were defined (simulating a 2 × 1 road). Traffic composition 1 (TC1) had five vehicles (three small passenger cars, one hybrid and one pickup truck) spaced 2.5 s from each other. Traffic composition two (TC2) had 15 vehicles (nine small passenger cars, three hybrids, three pickup trucks) spaced 1 s from each other. Therefore there were a total of 30 stimuli (three pavements × five speeds × two traffic compositions). Each stimulus had the duration of five seconds.

ITEM 11.1.

The stimuli were presented through a custom built C++ application, running in a computer with a sound card Intel 82801BA-ICH2, and AKG K 271 MKII closed headphones. This system was calibrated to achieve sound pressure levels identical to those found in the original road environments. The values of LAmax, LAeq, sharpness, roughness, and loudness were assessed with the Psysound3 application (Cabrera et al., 2008).

The annoyance assessment of each participant was performed in a quiet room. All 30 stimuli were also presented channel reversed to avoid interaural biases. The resulting 60 samples were repeated twice. Thus each participant listened to 120 noise trials (30 stimuli $\times$ 2 channel sequences $\times$ 2 trials). Trials were presented in a pseudo-random order (method of the constant stimulus) to reduce anticipation and expectation interferences. Participants were requested to assess the annoyance of each noise trial with a ten-graded interval scale from one (less annoying) to ten (very annoying). The interval between trials is varied and depended on the promptness of participants. After the answer to a trial is recorded by pressing a number on a keyboard, the next noise sample is presented. Each session, with the 120 trials, lasts for about 14 min per participant.

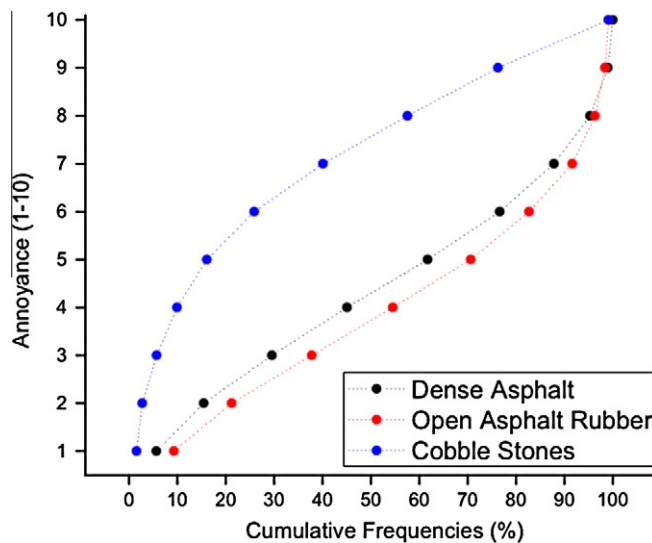
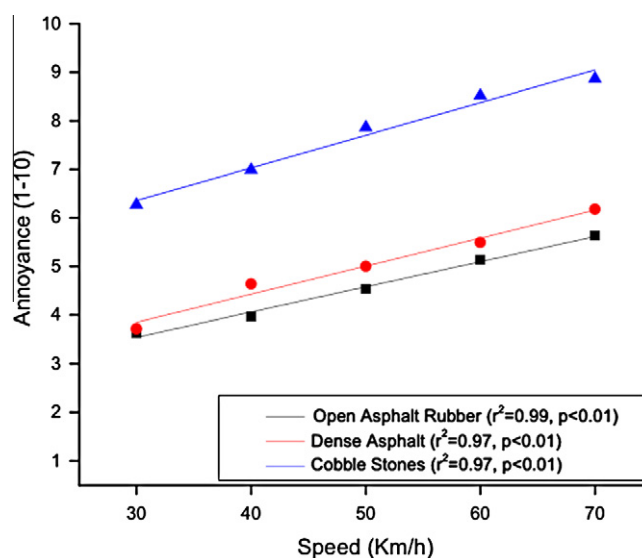


Fig. 1. Cumulative frequencies for the dense asphalt, open asphalt rubber, and cobblestones and annoyance assessment.



Note: 768 trials per dot

Fig. 2. Annoyance results for speed and pavement.

ITEM 11.1.

324

E. Freitas et al. / Transportation Research Part D 17 (2012) 321–326

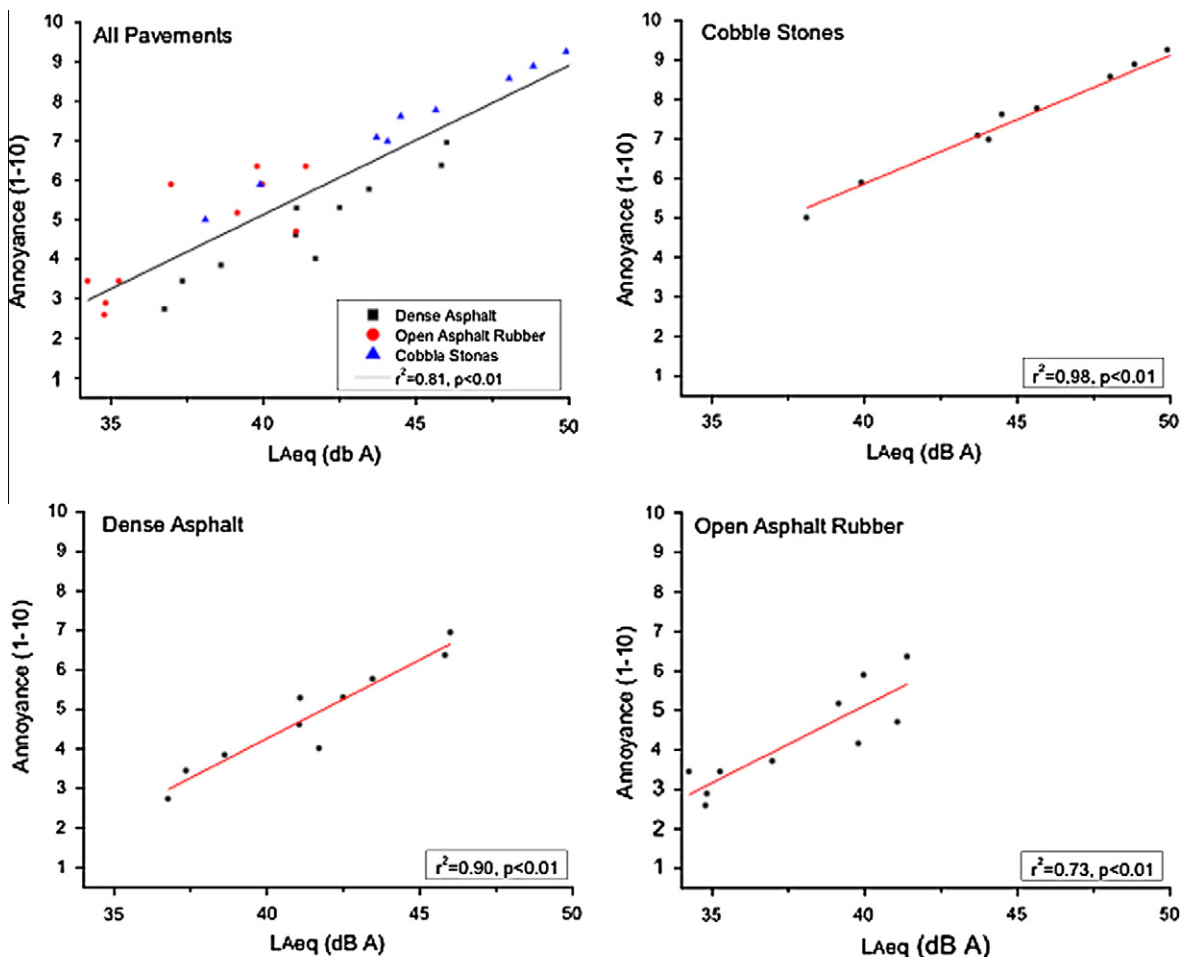
3. Results

3.1. Pavement, speed and traffic composition

A preliminary analysis of the data, intra and inter-participants, revealed a high consistency of annoyance rates as a function of the main variables (pavement, speed and traffic composition). The results were also similar across all age groups: the juvenile had a mean annoyance of 5.59; the early adults had a mean of 5.79; middle adults had 5.47; and late adults had 5.60. These results did not differ significantly. Therefore, unless otherwise stated, the following data analyses are based upon the pooled data of the trials of all participants.

The pooled data per pavements, 3840 trials, points to a small difference of mean annoyance between the dense asphalt and open asphalt rubber pavements. The cobblestones pavement induces the highest rate of annoyance. Percentile 85 indicates the same trend with annoyance values of seven for both dense asphalt and open asphalt rubber, and 10 for the cobblestones pavement. Cumulative frequencies analysis also suggests that annoyance rises steeply for the cobblestone pavement, while both the dense and open asphalt rubber pavements follow a smoother and similar path (Fig. 1).

The analysis of the speed–pavement interactions reveals a linear increase of the mean annoyance as a function of speed (Fig. 2) with similar slopes for all pavements (cobblestones, 0.07; dense asphalt, 0.06; open asphalt rubber, 0.05). Again, the cobble pavement shows the highest rates of annoyance. The dense asphalt and open asphalt rubber pavements have similar rates (mean differences not exceeding 0.5); but with a consistent lower level of annoyance for the open asphalt rubber pavement.



Note: 384 trials per dot.

Fig. 3. Linear regressions of LAeq values and the corresponding annoyance rates for all pavements separately for various types of pavement.

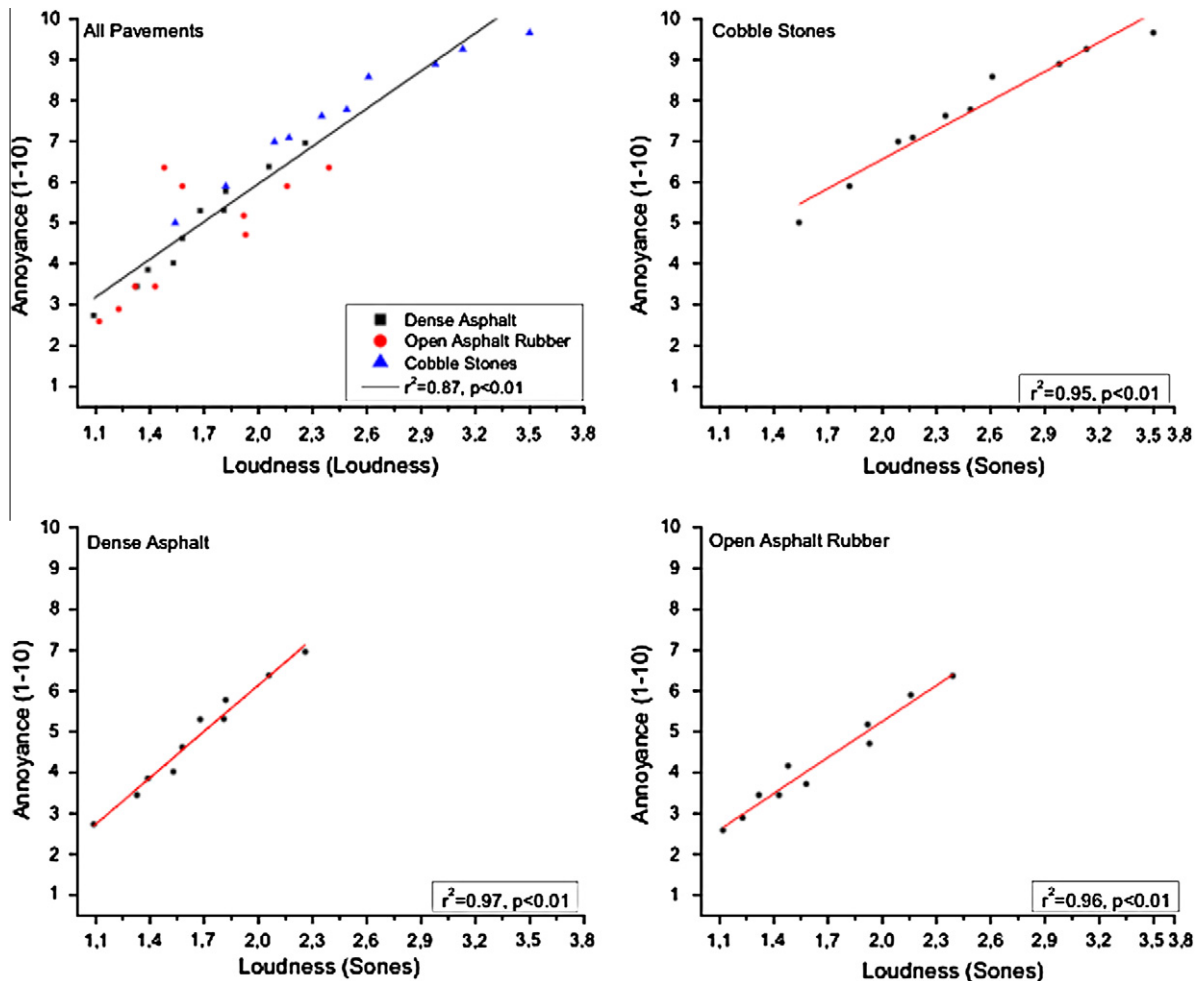
ITEM 11.1.

The relation between speed and pavement type over annoyance ratings was statistically significant. Post-hoc Sheffé test revealed that this difference was significant between the open asphalt rubber and the cobblestones pavement, as well as between dense asphalt and cobblestones. The difference remained not significant between open asphalt rubber and dense asphalt.

In a similar way as found for the traffic speed, the traffic density composition also had an effect over annoyance rates for all pavements, with an increase of the mean annoyance as a function of the density. In line with both the global analysis per pavement and the speed-pavement results, the cobblestones pavement shows the highest rates of annoyance with mean values of 6.8 first (TC1) and 8.5 for the second (TC2) traffic compositions. The dense and open asphalt rubber pavements again have very similar mean rates with mean differences of neither exceeding 0.6. The analysis of 85% percentile reveals identical patterns of annoyance variation and magnitude. For the cobblestones pavement, the TC1 and TC2 values are nine and ten. For the other pavements, the percentile values being six and eight for the dense asphalt, and of five and seven for the opens asphalt rubber.

The relation between pavement and traffic composition is statistically significant, and in the post hoc Sheffé test significant differences again were found between cobble and dense asphalt as well as cobble and open asphalt rubber. No difference was found between dense and open asphalt rubber.

Summarising, all age groups rate traffic noises according to the same standards. Cobblestones pavement lead to more annoying traffic noises than dense asphalt and open asphalt rubber. Open asphalt rubber noise is consistently less annoying than dense asphalt, but these differences are of low magnitude and are not statistically significant. Vehicle speed has a strong relation with annoyance for all pavement types. Traffic composition also has a clear effect over results, with higher density traffic scenes consistently leading to higher annoyance rates.



Note: 384 trials per dot.

Fig. 4. Linear models of loudness values and the corresponding annoyance rates for all pavements and separately for various types of pavement.

ITEM 11.1.

326

E. Freitas et al. / *Transportation Research Part D 17 (2012) 321–326*

3.2. Annoyance and acoustic indicators

To better understand, predict and compare how the different pavements impact annoyance ratings, several acoustic measurements were evaluated, namely LAeq, LMax, loudness, roughness and sharpness. The pooled annoyance results seen in Fig. 3 suggest strong correlations between for all pavements together, and each type separately.

Results for LMax are not as consistent as for LAeq. The linear relationship for all pavement types is relatively fit, mainly because of disparities in values of the pavements. Taken separately, the dense asphalt pavement result do not correlate with LMax, while the cobblestones show a weak interaction and the open asphalt rubber obtains a value equal to that obtained with LAeq. The loudness analysis reveals the best fitting results (Fig. 4). Loudness explains well the annoyance ratings for the pooled data of all pavements. Considering each pavement separately, only the cobblestones ratings correlate less with loudness than with LAeq. Both the dense and open asphalt rubber annoyance are better predicted by loudness than by LAeq.

Sound roughness does not explain annoyance as well as loudness or LAeq, and nor does it explain the annoyance ratings of cobblestones, but it still has some predictability for dense asphalt and more so for open asphalt rubber. Roughness values distinguish the cobblestones pavement from both the dense asphalt and the open asphalt rubber. The first reveals consistently higher roughness levels, whereas the others have similar values. Sharpness analysis was also conducted, although linear regression analyses show barely any interaction between this psychoacoustic factor and annoyance. Again, dense and open asphalt rubber overlap in values and they are not predicted by sharpness. As opposed to the roughness interactions, only cobblestones has a clear relation with sharpness.

In sum, several acoustic properties of the tyre-road noise show an interaction with the annoyance ratings. LAeq correlates well with the annoyance, but it is loudness that best predicts traffic annoyance. Interestingly, not all factors interact equally with each pavement. LMax values do not predict the dense asphalt annoyance ratings. Roughness might have a relation with dense asphalt and open asphalt rubber pavement noises, but not with cobblestones. Conversely, Sharpness relates with cobblestones traffic annoyance, but it does not predict either dense asphalt or open asphalt rubber results.

4. Conclusion

Approaching our findings from a practical point of view, three key factors associated to noise abatement should be considered: pavement type, traffic speed and traffic density. The relation between pavement type and traffic noise abatement should be taken cautiously. Cobblestones pavements have traditionally been used in city centres in Europe and in residential zones, and are still currently used as an option for aesthetical purposes in some areas. In part because these pavements are not the most comfortable to travel and because of noise considerations, over substantial investments have been made in new asphalt rubber mixtures. Although the noise reduction cannot be contested, it should be stressed that the perceived differences by users might not be as significant as expected. A cost-effective approach to reduce noise-related discomfort should also consider traffic speed and density, two factors that in this study revealed a consistent effect on annoyance ratings. Finally, traffic-related annoyance is best predicted by loudness indicators. Other sound measures might correlate with annoyance, but not as robustly across all pavement types.

Acknowledgements

This study was financed by the Portuguese Foundation for Science and Technology and FEDER, Projects FCOMP-01-0124-FEDER-007560, FCOMP-01-0124-FEDER-022674 and PEst-OE/ECI/UI4047/2011.

References

- Bendtsen, H., Kohler, E., Lu, Q., Rymer, B., 2010. California–Denmark study on acoustic aging of road pavements. *Transportation Research Record* 2158, 122–128.
- Cabrera, D., Ferguson, S., Rizwi, F., Schubert, 2008. Psysound 3 a program for the analysis of sound recordings. In: *Proceedings of Acoustics*. IEE, Paris.
- Donovan, P., 2005. Comparative Measurements of Tire/Pavement Noise in Europe and the United States, the NITE-Study. California Department of Transportation/Illingworth & Rodkin, Inc., Sacramento.
- Fontes, L., Trichês, G., Pais, J., Pereira, P., 2010. Evaluating permanent deformation in asphalt rubber mixtures. *Construction and Building Materials* 24, 1193–1200.
- Golebiewski, R., Makarewicz, R., Nowak, M., Preis, A., 2003. Traffic noise reduction due to the porous road surface. *Applied Acoustics* 64, 481–494.
- Griefahn, B., Gjestland, T., Preis, A., 2008. Annoyance of Residents Living in Urban Areas. Report to Partners Deliverable A.D6: Month 36 SILENCE Integrated Project – Contract N. 516288: European Commission, Brussels.
- Paje, S., Bueno, M., Terán, F., Miró, R., Pérez-Jiménez, F., Martínez, A., 2010. Acoustic field evaluation of asphalt mixtures with crumb rubber. *Applied Acoustics Journal* 71, 578–582.
- Paunović, K., Jakovljević, B., Belojević, G., 2009. Predictors of noise annoyance in noisy and quiet urban streets. *Science of the Total Environment* 407, 3707–3711.
- Sandberg, U., Ejsmont, J., 2002. Tyre-Road Noise Reference Book. Informex SE-59040 Kisa.

ITEM 11.1.

EXHIBIT 10

Noise Charges in Road Traffic: Pricing Schedule Based on the Marginal Cost Principle

Henrik Andersson¹ and Mikael Ögren²

Abstract: One way of mitigating the negative effects of noise from road traffic is to include the external cost of noise in a road charging system. This study shows how standardized calculation methods for road traffic noise can be used together with monetary estimates of the social cost of noise exposure to calculate charges based on the social marginal cost. Using Swedish data on traffic volume and individuals exposed to road noise, together with official Swedish monetary values for noise exposure, we estimate road-noise charges for cars and heavy vehicles. DOI: [10.1061/\(ASCE\)TE.1943-5436.0000265](https://doi.org/10.1061/(ASCE)TE.1943-5436.0000265). © 2011 American Society of Civil Engineers.

CE Database subject headings: Noise pollution; Traffic management; Pricing; Scheduling; Costs.

Author keywords: Externalities; Marginal cost; Noise; Road traffic.

Introduction

An environmental problem of growing importance is noise emissions from traffic. Noise exposure is not only a disutility in the sense that it disturbs people, it can also result in health impairments and lost productivity and leisure. The reason why the problem is growing is a combined effect from urbanization and an increase in traffic volume. Whereas the increase in traffic volume means higher noise levels, urbanization has led to more individuals being exposed to traffic noise. These trends are likely to continue, and hence, unless efforts are undertaken to mitigate the problem, it will increase as a result of more people being exposed to higher noise levels in the future (Nijland et al. 2003).

As a mean to mitigate this and other environmental and health problems related to transportation, the European Union (EU) has decided that infrastructure charges in the EU should be based on short-run marginal costs (SRMC) [European Commission (EC) 1998]. Policy makers can choose between reducing either the emission or the exposure, and noise charges based on SRMC give road users incentives to reduce their emissions, since those operators who contribute more to the noise emissions will have to pay more to use the infrastructure. Since infrastructure charges based on SRMC internalize not only the external effects on the rest of the society but also within the transport sector, charges based on SRMC that fully reflect social costs have the potential to result in an optimal traffic volume and use of technology. Several studies have also shown that the costs of reducing emissions at the source are lower than the costs of reducing high noise levels through barriers, façade insulation, etc. (Oertli 2000; de Vos 2003). Following Andersson and Ögren (2007), regarding the conflict between the marginal social cost principle and long-run incremental costs and

full cost recovery, we refer to other literature for discussions on charging principles or financing problems, e.g., Nash (2005), Rothengatter (2003), or Sansom et al. (2001).

In a previous study, Andersson and Ögren (2007) outlined a model on how to estimate noise charges for railway infrastructure based on SRMC. They showed that already obtained knowledge on monetary and acoustical noise evaluation could be used to estimate the charges. In this study, we extend the analysis in Andersson and Ögren (2007), and the aim of this study is to describe how road-noise charges based on the marginal cost principle can be estimated. The challenge of developing a model to estimate noise charges for road compared with rail traffic is the multiple noise sources we have to consider. Whereas it is reasonable to assume that individuals living in a certain area are only exposed to rail noise from a single railway track, it is necessary to take into consideration that several different noise emission sources (roads) can contribute to the noise exposure when the marginal acoustical effect is estimated for road noise. Because it has been decided that charges shall be implemented and based on the SRMC principle to internalize noise, it is important to design a model that calculates the SRMC on the vehicle level, something the model in this study is capable of.

The paper is organized as follows. In the next section, we briefly describe the SRMC in terms of an increase in road traffic. In subsequent sections, we briefly discuss noise and how it is measured, and we describe how to estimate the marginal acoustical effect from road traffic. Then we present a case study from Sweden in which we estimate road-noise charges for passenger cars and trucks and examine the sensitivity of our results to traffic volume and number of exposed individuals. Finally, we offer some conclusions regarding our model and the results.

Marginal Social Cost and Road-Noise Charges

The SRMC of being exposed to road noise is the social cost of one extra vehicle. Following Andersson and Ögren (2007), let $C[L(Q, r, X)]$ denote the individual cost-function which is a function of the noise level L . The noise level is assumed to be determined by the traffic volume (Q), distance to the noise emission source (r), and a vector of other factors assumed to influence the noise level (X), e.g., traffic composition, presence of barriers, meteorological effects, and ground properties. The total social noise cost of road traffic (S) can then be estimated as

¹Associate Professor, Toulouse School of Economics (LERNA, UT1, CNRS), 21 Allée de Brienne, 31000 Toulouse, France. E-mail: henrik.andersson@tse-fr.eu

²Researcher, VTI, Box 8077, SE-402 72 Gothenburg, Sweden (corresponding author). E-mail: mikael.ogren@vti.se

Note. This manuscript was submitted on November 9, 2009; approved on February 1, 2011; published online on February 3, 2011. Discussion period open until May 1, 2012; separate discussions must be submitted for individual papers. This paper is part of the *Journal of Transportation Engineering*, Vol. 137, No. 12, December 1, 2011. ©ASCE, ISSN 0733-947X/2011/12-926–933/\$25.00.

ITEM 11.1.

$$S = \int_0^\infty C[L(Q, r, X)]n(r)dr \quad (1)$$

where $n(r)$ = density of exposed individuals at different distances. The marginal social cost (M) is the change in total cost as a result of a change in traffic volume, i.e.

$$M = \frac{\partial S}{\partial Q} = \int_0^\infty \frac{\partial C[L(\cdot)]}{\partial L} \frac{\partial L(\cdot)}{\partial Q} n(r)dr. \quad (2)$$

However, as explained in Andersson and Ögren (2007), data on distributions of individuals and noise levels (constant within a specific interval) are often available in discrete and not continuous form. The estimation of noise charges is then carried out using discrete models and M can be written as

$$M = \sum_i c[L(\cdot)]n(r)\Delta r \frac{\partial L(\cdot)}{\partial Q}, \quad (3)$$

where i = each discrete interval; and $c[L(\cdot)] = \partial C[L(\cdot)]/\partial L$.

The marginal social cost in Eq. (3) can be seen as the total cost change for a unity change in traffic volume $\Delta Q = 1$. The change in noise level ΔL that the marginal vehicle causes can then be expressed as

$$\Delta L = \partial L(\cdot)/\partial Q. \quad (4)$$

The number of exposed individuals to the noise level L is given by $N(L)$, corresponding to $n(r)\Delta r$ in Eq. (3). Finally, Eq. (5) is the road-noise charge estimated in this paper

$$T = \sum_L c[L(\cdot)]N(L)\Delta L \quad (5)$$

Acoustical Parameters

Noise Indicator

The strength of noise is measured using the sound pressure level (SPL) in decibels (dB). This level is normally A-weighted to account for the average sensitivity of the human ear to different frequencies. Noise exposure is commonly expressed as an equivalent level, which is an energy average over a certain time period, or as the maximum level during the time period. More details on measurement and description of road traffic noise can be found in Sandberg and Ejsmont (2002).

The equivalent level is normally used as an indicator of general annoyance and the maximum level as an indicator of sleep disturbance. The maximum level is also less suitable for SRMC calculations because it is only influenced by the loudest vehicle (or loudest combination of several simultaneously audible vehicles at longer ranges); all other vehicles have no influence at all. The equivalent level, on the other hand, has a clear relation to traffic volume, and, for each extra vehicle added to the traffic along a road, the equivalent level increases.

The equivalent level for a full 24-h period is denoted $L_{Aeq,24h}$, which is the most commonly used noise indicator. In the *Environmental Noise Directive* (EC 2002), another indicator, the L_{den} (level day evening night), is chosen as the noise indicator to be used in the future for road traffic noise in the EU. It is an equivalent level with a penalty for traffic that occurs at evening or night time, and can be calculated from the equivalent noise level during the day (L_d), evening (L_e), and night (L_n), using

$$L_{den} = 10 \log \left[\frac{12}{24} 10^{0.1L_d} + \frac{4}{24} 10^{0.1(L_e+5)} + \frac{8}{24} 10^{0.1(L_n+10)} \right] \quad (6)$$

Using this indicator, the marginal noise contribution of a single vehicle passage is larger at evening and night time, which means that the marginal cost depends on the time the passage occurs.

Calculating the Acoustical Marginal Effect

The marginal effect in acoustical terms (ΔL) is the effect one extra vehicle will have on the noise level. This is determined not only by the acoustical parameters of the extra vehicle but also by the total traffic already on the road. The change in the equivalent sound level can be very small. For a traffic volume of 20,000 vehicles per day one extra light vehicle will only increase the sound level by about 0.0002 dB.

The increase in the level a single vehicle will cause can be calculated using standardized and well-established calculation methods. There are a large number of national methods in use (Nijland and Van Wee 2005), but there is also a common European method called Harmonoise (de Vos et al. 2005). This is a new method that takes recent developments in the field of outdoor sound propagation into account. Harmonoise was developed to gradually replace national methods in the EU, as required by the *Environmental Noise Directive* (EC 2002).

Calculating the increase resulting from one vehicle is then simply a matter of calculating the difference between the noise emitted from the traffic before and after adding the marginal vehicle. This assumes that the vehicle is representative for its class, since the calculation methods calculate the noise from a stream of typical vehicles. If, instead, individual data is known, for example, as a result of introducing low noise technology such as less noisy tires on a specific vehicle, the calculation procedure becomes slightly more complex (the details are omitted here).

If the equivalent sound level is increased by, for instance, 1 dB at a distance of 20 m from the road, the same increase is valid for longer ranges. This is not exactly true, but it is a good approximation for most cases where no extreme shielding is present and the noise from the vehicles does not contain strong tonal components. An example calculation using Harmonoise for ranges up to 200 m for flat terrain and optionally including a 3-m-high screen is given in Table 1. The calculation is based on the Harmonoise engineering method (Nota et al. 2005), which has many parameters. Default values were chosen for temperature, relative humidity, source heights, atmospheric pressure, density, and turbulence. The flow resistivity of the ground was set to 200 kN s m⁻⁴ (corresponding to a normal pasture field). No wind and temperature refraction effects were included. The source strengths were set to the total traffic given, assuming a traffic mix of 10% heavy vehicles (class 3c), with a receiver height of 2 m and an optional 3-m-high sound screen 6 m from the source.

Table 1. Marginal Change in Noise Level as a Function of Distance

	Traffic	20 m	50 m	100 m	200 m
Flat ground	20,000	66.9	56.6	49.0	43.2
	16,000	65.9	55.6	48.0	42.2
	Diff.	1.0	1.0	1.0	1.0
Screening	20,000	53.1	50.3	46.9	43.5
	16,000	52.1	49.4	45.9	42.6
	Diff.	1.0	0.9	1.0	0.9

ITEM 11.1.

That the change in noise level is not dependent on distance simplifies the calculation of the marginal change, but still the total noise level must be calculated for the total traffic in all interesting receiver positions to calculate the monetary effect. Note that this assumes that only one source is contributing to the total noise level, which is normally true for rail traffic noise but not always for road traffic noise, as discussed in the next section.

Effect of Secondary Sources

Noise from railways usually occurs in loud train passages with silent periods in between. Road noise is often a more constant noise, except for roads with very low traffic volumes or in the middle of the night. The positive aspect of road noise compared to railway noise is that the maximum peaks are typically much lower, and the positive aspect for the railway is the silent periods that occur in between events. Another important difference is that railway noise has the most energy at slightly higher frequencies than road traffic noise, which is important for indoor levels because the façade insulation is dependent on the frequency. However, in this study, only outdoor levels are considered.

One important difference between how railway and road traffic noise are handled is that, when calculating the noise at a building façade from railway traffic, normally only one railway line contributes to the level. For road traffic noise, all roads in the vicinity are normally taken into account. This is obviously the correct approach when studying the total noise exposure for inhabitants, e.g., when planning noise-reducing measures in a residential area. However, when calculating the SRMC of using a road and there are secondary roads in the area, it is not straightforward how to proceed.

Consider calculating the SRMC for noise from a major road through a small city. At certain positions in the city, e.g. where the noise from the major road is well-shielded by buildings, the contribution from the traffic on the small streets will dominate, and a change of the traffic volume on the major road will have a negligible effect on the sound level, and thus, a negligible effect on the marginal cost. Hence, assuming that the marginal sound change is the same for all receiver positions will overestimate the marginal cost unless only a single source dominates the level throughout the area to be studied.

This effect is illustrated in Fig. 1, where the noise is displayed as contours of equal noise level for a simple flat landscape with one primary and one secondary road with less traffic. If we increase the traffic at the primary road, the sound level at position A will increase (as illustrated by the moving of the contour line), but at position B, it will hardly increase at all. Therefore, it is important to calculate the marginal change including the effects of secondary

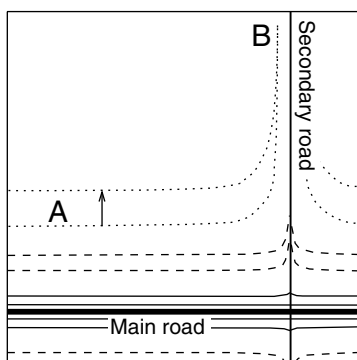


Fig. 1. Illustration of main road crossed by smaller road and effect on noise level contours when traffic is increased on main road

sources for receiver positions where both the main and secondary roads give a substantial contribution to the sound level.

Case Study: Lerum

In 2004, Öhrström et al. (2005) conducted a study in Lerum, a municipality close to Gothenburg, Sweden, with about 36,000 inhabitants and a population density of 146 inhabitants per km². The aim of the study was to determine health effects and annoyance both for railway and road traffic noise and also to look for combined effects when exposed to both sources. Öhrström et al. (2005) did not analyze the social cost or the marginal social cost from traffic noise; instead, we use their data to conduct such an analysis of the social marginal cost.

Two major transport routes cross the municipality—the railway line, Västra Stambanan and the motorway, E20. Both connect Gothenburg and Stockholm. Öhrström et al. (2005) selected a subset of the municipality for detailed noise calculations and a questionnaire survey; see the sketch in Fig. 2. In this study, we use the noise calculations from this survey to estimate the noise levels behind the SRMC.

Note that only the calculated levels from road traffic are used here. One might argue that, if a certain building is exposed to high levels from railway traffic, the effect of the road traffic is masked and should be set to zero, but there is, in fact, evidence that the annoyance caused by the lesser source is more pronounced when another source is present (Öhrström et al. 2005). In principle, the combination of the sources cancels the good aspect of each source, as explained previously, i.e., no more silent periods/absence of loud peaks. This means that, in cases where more than one source is present, the monetary effect is underestimated for both sources, as is the case in Lerum.

Monetary Values Used in Case Study

Since the aim of this study is not to elicit preferences for noise abatement but to outline a model for road-noise charges, we do not estimate any monetary values for noise reductions. Instead, we use the official monetary values used in Sweden for benefit-cost analysis (BCA) within the transport sector (Friberg et al. 2008). These values are based on the results of a Swedish hedonic property-value study (Wilhelmsson 2000) that examined the relationship between property values and exposure to noise from road traffic in a suburb of Stockholm, Sweden. However, it was assumed that values from the hedonic study did not reflect the total

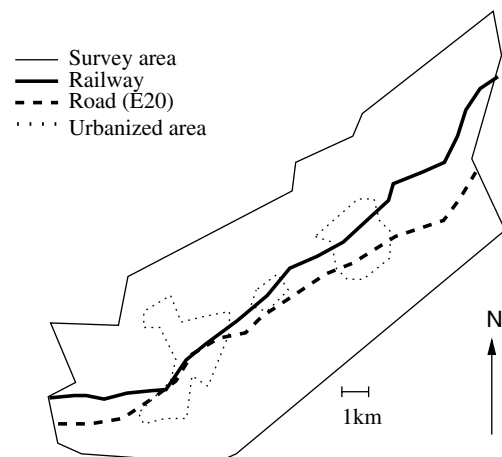


Fig. 2. Sketched map over research area

ITEM 11.1.

social cost, and the values were, therefore, increased by 42% to also reflect health costs.

We use the official monetary values because this is the most likely approach for national agencies to adopt when the SRMC pricing scheme will be implemented. It is well-known that preferences for reducing noise levels are context dependent, and, therefore, the values used in this study may not be representative for other countries. This is, however, not problematic for the aim of this paper because we are describing a method to calculate noise charges, and the difference in monetary values will only change the level of the noise charges. For other studies on the evaluation of noise abatement, see e.g., Day et al. (2007), Navrud (2004) and Nelson (2004).

The official cost estimates for Sweden are only available in table format (Friberg et al. 2008) but can be approximated with the following function:

$$c(L) = 540.3 \frac{0.6634e^{0.6634L-44.6} + 0.05569e^{0.05569L-2.798}}{e^{0.6634L-44.6} + e^{0.05569L-2.798}} \quad (7)$$

where $L = L_{Aeq,24h}$, $L_{Aeq,24h} \in [50, 75]$. $L_{Aeq,24h}$ = equivalent A-weighted noise level in dB. Monetary values are in euros (€) in 2006 price levels and represent the marginal cost, i.e., the yearly cost for a 1-dB increase in noise level per person. The lower bound equals 50 dB because people are presumed not be annoyed at levels below this level; hence, there is no social cost from noise levels below 50 dB (Friberg et al. 2008). The upper bound does not apply in our analysis because no individuals in the case study area are exposed to noise levels above 75 dB.

Marginal Acoustical Effect

The marginal acoustical effects of different vehicle types are calculated using the harmonized European method called Harmonoise (de Vos et al. 2005). The main advantage of using Harmonoise in this study is that it can calculate source strengths for many different vehicle classes, whereas the older Nordic method (Jonasson and Nielsen 1996) only differentiates between light and heavy vehicles. The basic vehicle classes are numbered from 1 to 5 and are: light vehicles (1); medium heavy vehicles (2); heavy vehicles (3); other heavy vehicles (4); and two-wheelers (5). There are also subclasses, denoted by a lower case letter, that differentiate between number of axles, general vehicle type, and so on. The classes selected for calculation in our case are presented in Table 2.

Table 2. Marginal Cost in €/km

	Cars (light) ^a	Trucks		
		Medium (3 axles) ^b	Heavy (5 axles) ^c	Heavy (7 axles) ^d
$L_{Aeq,24h}$				
24 h	0.0010	0.0041	0.012	0.016
L_{den}				
Day	0.00043	0.0017	0.0049	0.0069
Evening	0.0014	0.0054	0.015	0.022
Night	0.0043	0.017	0.049	0.069

Note: Vehicle classification refers to Harmonoise vehicle class.

^aCars: 2 axles max (4 wheels).

^bMedium heavy trucks: 2 axles (6 wheels).

^cHeavy trucks: 4–5 axles.

^dHeavy trucks: ≥ 6 axles.

Traffic Volume and Number of Exposed Individuals

The traffic on the motorway E20 varies from 16,500 vehicles per 24 h at the east border of the research area to about 21,700 at the west border. The percentage of heavy traffic is approximately 9% (vehicles of class 2 and 3, using the Harmonoise terminology).

The number of exposed individuals is determined from the data collected in the study mentioned previously (Öhrström et al. 2005). In research area 3,120 dwellings had $L_{Aeq,24h}$ higher than 45 dB, and 2,751 questionnaires were distributed with a return rate of 71%, i.e. 1,953 households answered the survey. The total number of exposed individuals in our study is estimated based on the respondents' answers about household size and the total number of exposed dwellings. The average number of inhabitants per dwelling were 2.8.

A set of calculations of $L_{Aeq,24h}$ and L_{den} noise levels for both rail and road traffic noise were carried out for those who answered the questionnaire, and it is only the road traffic noise values that are used in this study. The sound levels were determined using the Nordic method (Jonasson and Nielsen 1996). Nonresponding households are excluded from our analysis because less information on noise exposure is available for them, and the number of exposed individuals is, thus, underestimated.

As explained previously, it is important to separate the effect of the primary road and other small roads in the calculations when determining the SRMC. In the calculations available for Lerum, all sources are summed up, there is no information on each road's relative contribution to the total level, and it is outside the scope of this study to redo the calculations for all receiver points to obtain this information. Instead, we identify and remove households whose main noise source is a secondary road, which, again, leads to an underestimation of the SRMC.

Removing households significantly exposed to secondary roads is achieved by plotting the equivalent sound level versus the distance to the main road in Fig. 3. Using the Nordic method for road traffic noise, we calculate what the level should be at different distances in a perfectly flat landscape and plot this line together with the data for all households. The Nordic method is accurate up to 300 m only but is extended here to longer ranges. The resulting line is an average over two calculations, one for acoustically soft and one for acoustically hard ground.

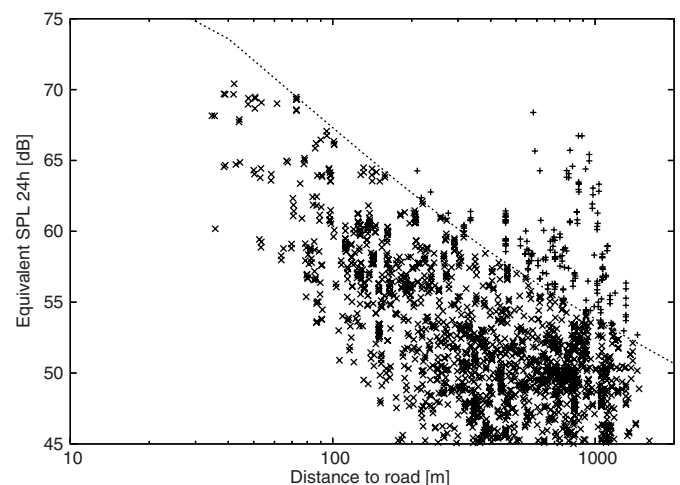


Fig. 3. Scatter plot of calculated sound levels versus distance to main road. Points indicated by × considered to be exposed only to main road (90%), and + considered to be exposed only to secondary roads (10%)

ITEM 11.1.

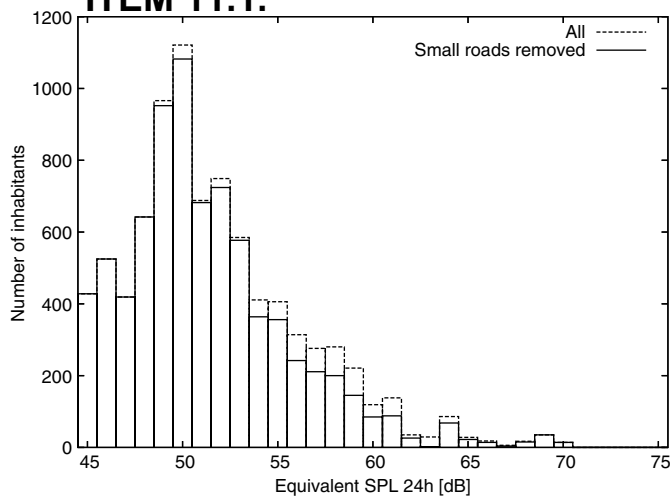


Fig. 4. Histogram of number of inhabitants in each 1-dB interval showing effect of removing influence of secondary roads

In reality, houses are seldom more exposed than in the flat landscape case but may well be less exposed if they are screened by barriers, terrain, or buildings. Therefore, all points that lie above the calculated line represent a household significantly exposed to other roads and are removed from further analysis.

Fig. 4 shows the number of exposed inhabitants in each 1-dB interval. The number of inhabitants removed as discussed previously is also illustrated, which corresponds to 10% of the total number of inhabitants.

Estimation of Road-Noise Charges for Lerum

By combining information about the marginal cost-function and the number of individuals exposed at different noise levels, the social cost associated with a marginal increase in the noise level can be estimated. Using the marginal change in sound level, the annual marginal cost (T) in the survey area is calculated by multiplying the number of inhabitants in a 1-dB interval with the cost-function and the acoustical change

$$T = \sum_{L=50}^{75} c(L)N(L)\Delta L \quad (8)$$

where L defines $L_{Aeq,24h}$; and $N(L)$, $c(L)$, and ΔL = number of inhabitants exposed in the 1-dB interval centered around L , the annual cost-function from Eq. (7), and the change in sound level owing to the marginal vehicle, respectively.

Fig. 5 shows how the contribution to the marginal cost from one extra vehicle varies with $L_{Aeq,24h}$. Levels below 50 dB do not contribute at all because the cost-function is not defined below 50 dB. It is interesting to note that, even though the marginal cost per inhabitant is substantially lower for the inhabitants at the lower noise levels, their contribution is important because there are many more inhabitants at lower levels. For instance, inhabitants exposed to levels below 55 dB [a level often considered to be tolerable (Nijland and Van Wee 2005)] account for 63% of the total marginal cost. In Andersson and Ögren (2007), inhabitants below 55 dB accounted for 32% of the total marginal cost for railway traffic.

For a charging scheme to be fair and efficient, charges should be based on distance covered by the vehicle (EC 2001). To get the calculated total marginal cost for the survey area in €/km, it must be adjusted by the number of days per year and the length of the distance traveled for the examined vehicle (s) (17 km).

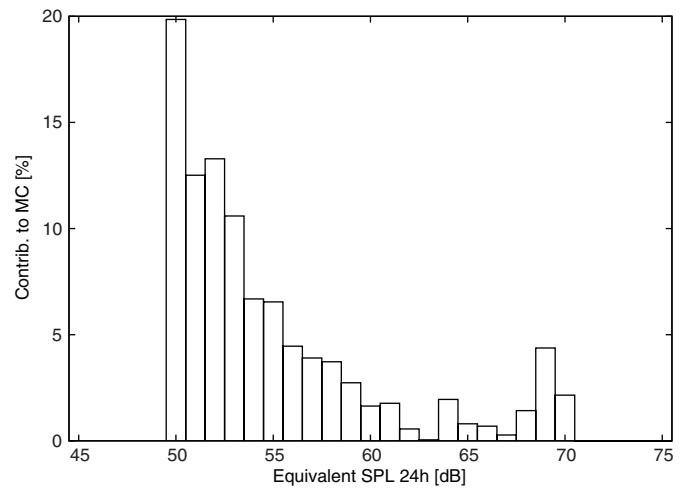


Fig. 5. Histogram of contribution to total SRMC from inhabitants in each 1-dB interval

The marginal cost estimates per km for a representative subset of vehicle classes is presented in Table 2. Based on a 10% increase in traffic, Sansom et al. (2001) estimated, for Great Britain, SRMC for cars and trucks in the ranges of 0.00017–0.0087 €/km and 0.0010–0.072 €/km, respectively. These values were originally presented in British pounds (GBP) 1998 price levels but have been adjusted using consumer price indices and exchange rates [www.econstats.com (Jun. 7, 2006)].

As already discussed, the SRMC will depend on the time of passage if the noise indicator L_{den} is used because it introduces a penalty for evening and night time traffic. If the normal equivalent level $L_{Aeq,24h}$ is used, then it does not matter at what time the vehicle passage occurs. Note that using L_{den} gives a lower daytime cost than using $L_{Aeq,24h}$, but the evening and night time costs are higher. The cost-function in Eq. (7) is based on the equivalent level, which may introduce errors when calculating the cost for the level day evening night indicator (Andersson and Ögren 2007).

In Andersson and Ögren (2007), the SRMC was determined for railway traffic through the same research area, and the results are also presented as a cost per km for different train sets. It is tempting to directly compare the cost for a freight train to that of a truck, but there are two difficulties with this approach. First, the number of exposed persons is not the same because the railway line and the road are separated in the landscape. Second, the cost-function used in both studies was determined for road noise only and is either used as it is or is adjusted to railway values using a crude railway bonus of 5 dB (Andersson and Ögren 2007).

Sensitivity to Total Traffic Volume

The marginal acoustical effect and the SRMC of a single vehicle passage depends on both the noise source strength of the vehicle and on the traffic already present on the road. Given a certain traffic volume and noise level, the SRMC from a single vehicle is ambiguous—a high (low) noise level means a high (low) marginal social cost but a small (large) marginal acoustical effect (Andersson and Ögren 2007). To examine how the SRMC is affected by a change in traffic volume, we, therefore, rely on a numerical example. In Fig. 6, the upper curve is the calculated marginal cost for a 1-dB change in sound level, and the lower curve is the change in sound level a single vehicle passage will cause. Note that the y-axis is logarithmic, and 100% corresponds to the traffic used in the case study (approximately 20,000 vehicles per 24 h).

ITEM 11.1.

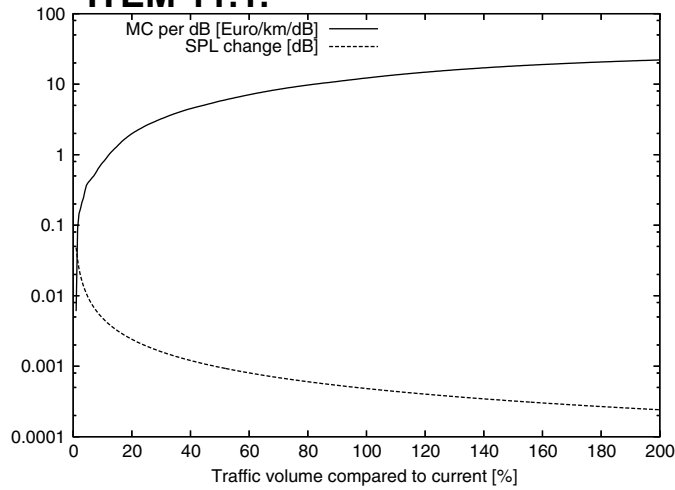


Fig. 6. Marginal cost per dB and marginal change in equivalent sound level as function of total traffic volume

The vehicle used for the example is a heavy truck with 5 axles (class 3c, using Harmonoise terminology).

In Fig. 7 the SRMC, which is the product of the two effects from Fig. 6, is calculated as a function of total traffic volume. Note that both of the effects are strictly increasing/decreasing, but their product is not. Between 50% and 150% traffic, the curve is more or less constant ($\pm 4\%$), meaning that the estimated marginal costs are rather robust even if the traffic is changed. This insensitivity to traffic volume was also found for rail traffic in Andersson and Ögren (2007).

As the source strength increases individuals are shifted from low noise levels and up to higher, but no new individuals enter at low levels owing to the limited size of the research area. Therefore, the area is too small to accurately estimate the effect at traffic volumes higher than 150%, and a slight drop-off can already be noted above 120%.

Sensitivity to Number of Individuals Exposed to Noise

As illustrated in Fig. 7, the SRMC is insensitive to changes in the total traffic volume. Changing the number exposed has a large

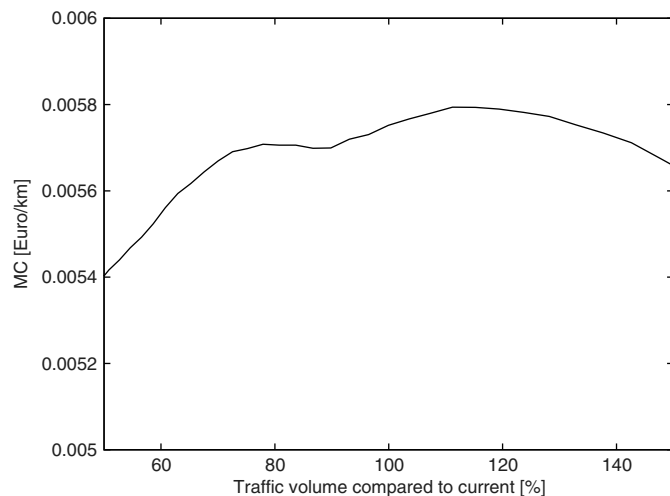


Fig. 7. Marginal cost expressed as €/km through research area for class 3c vehicle as function of total traffic volume

influence though—doubling the number of individuals exposed will double the marginal cost. It is also important to include areas with relatively low noise levels if there is a large number of people living there. In our case study, the areas with lower levels were more important than areas with high levels, as illustrated in Fig. 5.

The *Environmental Noise Directive* (END) (EC 2002) required that all European road infrastructure managers report the number of persons exposed to noise levels in 5-dB intervals of L_{den} . The first set, which is for roads with more than 6 million vehicle passages and railroads with more than 60,000 train passages per year, was delivered during 2008. For details on the END calculation procedures, see Hinton (2007). Using these data, the total cost of noise along the reported road sections can be calculated, but to get the SRMC, the marginal noise change must be calculated for the different vehicle types. Although the END data will only be available for roads with high traffic volumes, smaller roads should also be taken into account when designing a road charge system.

The most efficient way to calculate appropriate noise charges for larger areas (regions or nations) would, therefore, be to make detailed calculations for a number of representative areas and then extrapolate to whole regions. This extrapolation could be based on the assumption that the distribution of inhabitants in the larger areas are similar to the example areas used in the detailed analysis and should then be corrected for traffic volume, road length through the area, and the population density.

An example of a very simple extrapolation is to base it on population density and road length through each subarea only. Our research area, Lerum, is part of the region, Västra Götaland, and in Fig. 8, the situation is summarized for the 10 municipalities north of Gothenburg that are part of the region and where E20 is passing through. Assuming that the distribution of inhabitants relative to the road is similar in all areas, the marginal cost for one municipality can be calculated from the marginal cost in the reference area (Lerum) as

$$m = m_{\text{ref}} \frac{\sigma}{\sigma_{\text{ref}}} \left(0.05 \frac{Q}{Q_{\text{ref}}} + 0.95 \right), \quad (9)$$

where m = marginal cost in €/km; σ = population density; and Q = traffic volume. The subscript, ref, denotes the same variables for the reference area. Units are not important as long as the same units are

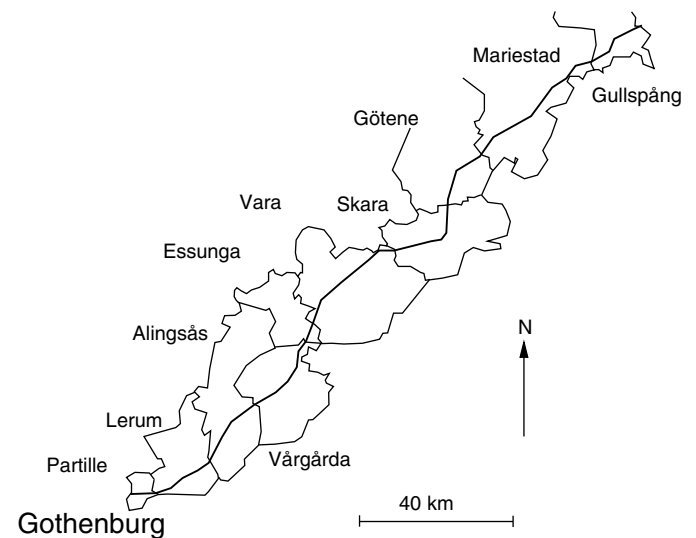


Fig. 8. Map outline over municipalities used for extending marginal cost estimation in Lerum to larger region

ITEM 11.1.

Table 3. Extending Marginal Cost Calculation Using Inhabitant Density and Road Length for 5-Axle Heavy Vehicle (Class 3c)

Municipality	E20 length (km)	Pop. dens. (inh./km ²)	Traffic flow (veh./24 h)	MC (€/km)
Partille	8	591	29,000	0.0741
Lerum	17	146	19,000	0.0120
Alingsås	21	78	19,000	0.0064
Vårgårda	23	26	11,000	0.0012
Essunga	5	24	8,000	0.0008
Vara	32	23	8,000	0.0008
Skara	23	42	9,000	0.0016
Götene	17	32	8,000	0.0011
Mariestad	41	40	11,000	0.0019
Gullspång	17	17	7,000	0.0005
Total	203			0.0055

used in both areas. Note that a doubling of the population density doubles the marginal cost, but a doubling of the traffic flow only increases the marginal cost ~5%, which is in line with the analysis. The last part of Eq. (9) has been obtained by a linear regression over the interval 50–150% of the dependence on traffic volume described in Fig. 7.

The resulting marginal cost for driving a heavy truck with 5 axles is presented in Table 3 and is lowered from 0.012 to 0.0055 €/km, compared to only driving through Lerum. The same calculation can easily be repeated for the different vehicle classes and also using the L_{DEN} indicator but is omitted here for brevity.

Discussion

This study describes a method to estimate road-noise charges based on the marginal cost of a change in traffic volume. To demonstrate the estimation procedure and the feasibility of the method, we also estimated road-noise charges based on a Swedish case study. We advise against direct comparisons between the values for road traffic presented here and the railway values from our previous study (Andersson and Ögren 2007). Different values for the social cost of noise have been used in the two studies because the official Swedish values have been updated since the study by Andersson and Ögren (2007) was published, and, moreover, the relationship between the two is only valid within the research area used in the case study.

The absolute values of the noise charges are of limited value because they are based on a single case study, but the qualitative results have important policy implications. The case study shows that the SRMC: (1) is insensitive to changes in total traffic (within reasonable limits); (2) is sensitive to the number of individuals exposed; and (3) can be diversified according to vehicle type using standardized calculation methods. The first two findings suggest that policy makers generally can ignore changes in traffic volume but that it is important that the number of exposed individuals is accurate when noise charges for a specific road segment are estimated. The latter is especially relevant for individuals at lower noise levels, since most individuals belong to this group. Moreover, it also suggests that charges are sensitive to changes in the number of individuals exposed. However, generally this can be ignored because it is reasonable to assume that the number of exposed individuals, in the short-run, is fairly constant.

An important aspect when designing a charging system is that it should be able to diversify between different vehicle types and

technologies. A charge that is the same for all vehicles is an obvious problem, because it might destroy the incentive to drive more quiet vehicles and/or to utilize technology that reduces the noise emission. As an example, changing to low-noise tires on a truck can lower the noise emission by as much as 5 dB (Sandberg and Ejsmont 2002, Chapter 20). Lowering the sound emission of the heavy truck with 5 axles (class 3c) in our example by 5 dB lowers the marginal cost from €0.012/km to €0.0038/km, a strong incentive to reduce noise if it is available within the road charge system. Sandberg shows that reducing tire noise is cost-effective (Sandberg 2008, Chapter 15).

We have shown that, with information on the number of people exposed, it is possible to calculate the SRMC for road noise by using standardized calculation methods and estimates of monetary values already in use by national authorities. The road-noise prediction methods will be harmonized within the European Union in the future, and noise maps including information on the number of exposed inhabitants will be available for all major roads and cities as required by the *Environmental Noise Directive* of the European Commission (EC 2002). What remains before the SRMC can be determined is only to calculate the marginal change in the noise level for the different vehicle types under study, which can be done using either the relevant national noise calculation methods or Harmonoise.

Acknowledgments

The writers would like to express their gratitude to Evy Öhrström, Helena Svensson, and Annbritt Skånberg for support with data. Financial support from Vinnova, Banverket, and the Swedish National Road Administration is gratefully acknowledged. The writers are solely responsible for the results presented and views expressed in this paper.

References

- Andersson, H., and Ögren, M. (2007). "Noise charges in rail infrastructure: A pricing schedule based on the marginal cost principle." *Transp. Policy*, 14(3), 204–213.
- Day, B., Bateman, I., and Lake, I. (2007). "Beyond implicit prices: Recovering theoretically consistent and transferable values for noise avoidance from a hedonic property price model." *Environ. Resour. Econ.*, 37(1), 211–232.
- de Vos, P. (2003). "How the money machine may help to reduce railway noise in Europe." *J. Sound Vib.*, 267(3), 439–445.
- de Vos, P., Beuving, M., and Verheijen, E. (2005). "Harmonized accurate and reliable methods for the EU directive on the assessment and management of environmental noise—Final technical report." European Union, EC Contract No. IST-2000-28419.
- European Commission (EC). (1998). "White paper: Fair payment for infrastructure use: A phased approach to a common transport infrastructure charging framework in the EU." European Union (EU). (http://aei.pitt.edu/1136/1/transport_infra_wp_COM_98_466.pdf) (Nov. 17, 2011).
- European Commission (EC). (2001). "White paper: European transport policy for 2010: Time to decide." European Union (EU). (http://ec.europa.eu/transport/strategies/doc/2001_white_paper/lb_com_2001_0370_en.pdf) (Nov. 17, 2011).
- European Commission (EC). (2002). "Environmental noise directive 2002/49/EC." European Union (EU). (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0049:EN:NOT>) (Nov. 17, 2011).
- Friberg, G., et al. (2008). "Samhällsekonomiska kalkylprinciper och kalkylvärden för transportsektorn [Monetary valuation principles and recommended values for the transport sector—ASEK4]." SIKA PM 2008:3, SIKA (Swedish Institute for Transport and Communications Analysis), Stockholm, Sweden.
- Hinton, J. (2007). "Good practice guide for strategic noise mapping and the production of associated data on noise exposure: Version 2." Position

ITEM 11.1.

- paper, European Commission Working Group Assessment of Exposure to Noise (WG-AEN). (http://ec.europa.eu/environment/noise/pdf/wg_aen.pdf) (Nov. 17, 2011).
- Jonasson, H., and Nielsen, H. (1996). "Road traffic noise—Nordic prediction method." *TemaNord*, Vol. 525, Nordic Council of Ministers, Copenhagen, Denmark.
- Nash, C. (2005). "Rail infrastructure charges in Europe." *J. Transp. Econ. Policy*, 39(3), 259–278.
- Navrud, S. (2004). "The economic value of noise within the European Union—A review and analysis of studies." *Proc., ACUSTICA 2004, IV Ibero-American Congress on Environmental Acoustics*, European Commission.
- Nelson, J. P. (2004). "Meta-analysis of airport noise and hedonic property values: Problems and prospects." *J. Transp. Econ. Policy*, 38(1), 1–28.
- Nijland, H. A., and Van Wee, G. P. (2005). "Traffic noise in Europe: A comparison of calculation methods, noise indices, and noise standards for road and railroad traffic in Europe." *Transp. Rev.*, 25(5), 591–612.
- Nijland, H. A., Van Kempen, E. E. M. M., Van Wee, G. P., and Jabben, J. (2003). "Costs and benefits of noise abatement measures." *Transp. Policy*, 10(2), 131–140.
- Nota, R., Barelds, R., and van Maercke, D. (2005). "Harmonoise WP 3 engineering method for road traffic and railway noise after validation and fine-tuning." *Tech. Rep. No. HAR32TR-040922-DGMR20*.
- Oertli, J. (2000). "Cost-benefit analysis in railway noise control." *J. Sound Vib.*, 231(3), 505–509.
- Öhrström, E., et al. (2005). "Undersökning av hälsoeffekter av buller från vägtrafik, tåg och flyg i Lerums kommun [Investigation of the health impact of road, railway, and aircraft noise in Lerum]." *Rep. No. GU-MMED-R-2005/1-SE*, Dept. of Environmental Medicine, Sahlgrenska Academy, Univ. of Gothenburg, Gothenburg, Sweden. (http://www.medicine.gu.se/digitalAssets/1321/1321312_slutrapport-lerum-inklusive-appendix.pdf) (Nov. 18, 2011).
- Rothengatter, W. (2003). "How good is first best? Marginal cost and other pricing principles for user charging in transport." *Transp. Policy*, 10(2), 121–130.
- Sandberg, U. (2008). "Economic incentives to encourage the use of consumer label for tires in Europe." *Final Rep.*, European Federation for Transport and Environment (T&E), Brussels, Belgium.
- Sandberg, U., and Ejsmont, J. A. (2002). "Tire/road noise reference book." Informex, Kisa, Sweden.
- Sansom, T., Nash, C. A., Mackie, P. J., Shires, J., and Watkiss, P. (2001). "Surface transport costs and charges: Great Britain 1998." *Final Rep.*, Institute for Transport Studies, University of Leeds, Leeds, UK.
- Wilhelmsson, M. (2000). "Trafikbuller och fastighetsvärden—En hedonisk prisstudie [Traffic noise and property values]." Ph.D. dissertation, Dept. of Real Estate and Construction Management, Royal Institute of Technology, Stockholm, Sweden.

ITEM 11.1.

EXHIBIT 11

May 2010

Reprint Report: UCPRC-RP-2010-03

Highway Noise Abatement: Planning Tools and Danish Examples

Author:

Hans Bendtsen, Danish Road Institute—Road Directorate

This report is based on research performed by the Danish Road Institute-Road Directorate on behalf of the University of California Pavement Research Center for the California Department of Transportation, and is reprinted here in its original form.

Work Conducted as Part of the “Supplementary Studies for Caltrans QPR Program” Contract

PREPARED FOR:

California Department of Transportation
(Caltrans)

Division of Research and Innovation

PREPARED BY:

The Danish Road Institute—
Road Directorate and
University of California
Pavement Research Center



ITEM 11.1.

DOCUMENT RETRIEVAL PAGE			Reprint Report UCPRC-RP-2010-03	
Title: Highway Noise Abatement: Planning Tools and Danish Examples				
Author: Hans Bendtsen				
Prepared for: Caltrans	FHWA No.: CA101735C	Date Work Submitted: July 2009	Date: May 2010	
Contract/Subcontract Nos.: Caltrans Contract: 65A0293 UC DRI-DK: Subcontract 08-001779-01		Status: Final	Version No: 1	
Abstract: This report presents a series of methods implemented in Denmark and other European countries for the assessment and control of the impacts of highway noise on the neighboring public. It introduces Danish guidelines for the assessment of noise impact. Also described are examples of noise abatement planning for three different cases: planning of new highways, planning of highway widening projects, and noise abatement on existing highways. Experience shows that there is no single approach that can remove all noise problems along highways. It will be necessary for more effective noise abatement to take different approaches together, including noise-reducing pavements, noise barriers, facade insulation, and proper land use strategies. Harmonized public-private partnership is also critical for successful implementation of public policy and regulations related to noise abatement.				
Keywords: Highway noise, Noise abatement, Noise-reducing pavements, noise barriers, facade insulation				
Proposals for implementation: No recommendations				
Related documents: • H. Bendtsen, H., Q. Lu, and E. Kohler. 2009. <i>Temperature Influence on Road Traffic Noise: Californian OBSI Measurement Study</i>. Reprint Report: UCPRC-RP-2009-02 • Bendtsen, H. 2009. <i>Noise Barrier Design: Danish and Some European Examples</i>. Reprint Report: UCPRC-RP-2010-04 • H. Bendtsen, H., Q. Lu, and E. Kohler. 2009. <i>Acoustic Aging of Asphalt Pavements: A Californian/Danish Comparison</i>. Reprint Report: UCPRC-RP-2010-01				
Signatures:				
Hans Bendtsen 1st Author DRI-DK	John T. Harvey Technical Review UCPRC	John T. Harvey Principal Investigator UCPRC	S. David Lim Contract Manager Caltrans	

ITEM 11.1.

DISCLAIMER

This report is based on a subcontract research study performed by the Danish Road Institute-Road Directorate (DRI-DK) on behalf of the University of California Pavement Research Center (UCPRC) for the California Department of Transportation (Caltrans). The contents of this report reflect the views of the authors and DRI-DK who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the UCPRC, the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. The content of the original is unchanged in this version and has been reprinted with the consent of DRI-DK.

For more information:

University of California Pavement Research Center, Davis
One Shields Avenue, Davis, CA 95616

University of California Pavement Research Center, Berkeley
1353 S. 46th St., Bldg. 452, Richmond, CA 94804

www.ucprc.ucdavis.edu

ITEM 11.1.



Highway noise abatement

Planning tools and Danish examples

Hans Bendtsen

Danish Road Institute
Report 173
2009

ITEM 11.1.

Contents

Executive summary	5
Sammenfatning	7
Preface	9
Forord	10
1. Introduction	11
1.1 Methods for noise abatement	11
1.2 Organisation of noise abatement	12
1.3 Structure of the report	15
2. Good governance in noise abatement	17
3. Guidelines, prediction and evaluation	19
3.1 Noise guidelines	19
3.2 Noise prediction	20
3.3 The Noise Exposure Factor	22
3.4 Socio-economic assessment of noise	25
4. Planning of new highways	27
4.1 An example	27
4.2 General measures of noise abatement	30
5. Planning of widening existing highways	33
5.1 Environmental Impact Assessment	34
5.2 Evaluation of noise reducing pavements	36
6. Noise abatement on existing highways	39
6.1 Façade insulation	39
6.2 Noise action plan	41
6.3 System for tendering noise reducing pavements	43
6.4 Other measures of noise abatement	45
7. New housing along exiting highways	49
8. References	53

ITEM 11.1.

Executive summary

When constructing new buildings or roads in Denmark, special consideration is given to traffic noise. A new national noise map indicates that around 30 % of Danish homes are exposed to noise levels that exceed the threshold value of 58 dB (L_{DEN}) and that noise problems are concentrated in cities. This report presents a series of methods and strategies for noise abatement. There is no single method that can remove all noise problems along highways and in cities. It will be necessary to address the noise abatement on several different levels:

- **At the source:** this covers vehicles, tire, pavements, traffic and speed.
- **Along the propagation path:** in the form of noise barriers etc.
- **At the receiver:** in the form of façade insulation and local barriers.

The background for the report is experiences and ideas from the Danish Road Directorate as well as from other European countries. As an introduction, fourteen recommendations to National Road Administrations for good governance regarding noise management and abatement are presented.

In Denmark dwellings with road traffic noise of more than 58 dB (L_{DEN}) are considered exposed to noise. When planning of new residential areas the national metric of guideline for outside noise exposure is 58 dB (L_{DEN}). The Nordic prediction method, Nord2000, is used for road traffic. The Noise Exposure Factor (NEF) is the basis of all cost-benefit analyses of noise from road traffic. NEF is an expression of the accumulated noise load on all the dwellings in an area. It is calculated as the sum of the weighted noise loads on the individual dwellings in the area, so that dwellings with high noise levels weigh more than dwellings with less noise. The economic valuation of noise effects are based on market prices of dwellings as well as health effects.

As an important part of planning new highway sections in Denmark, an Environmental Impact Assessment (EIA) study is performed. Noise is one of the environmental components included in the EIA. When planning of new highways the noise guideline of 58 dB as L_{DEN} is used whenever possible. The guideline is used when a group of houses/dwellings are exposed to road traffic noise. For single houses in rural districts the noise guideline is normally not taken into account, instead façade insulation is offered if the noise exceeds 63 dB. Different measures of noise abatement can be considered in the planning of new highways. If it is possible and realistic to locate an alignment of the new highway that maximizes the distances to residential areas, this is normally a preferable solution. Noise reducing pavements are normally used when a new highway passes group of houses/dwellings.

Like in new highway projects noise is also taken into consideration when enlargements of existing highways are planned.

ITEM 11.1.

During the last decade the Danish Road Directorate has used around 20 mill DKK (2.7 mill € or 3.6 mill USD) every year for noise abatement along the existing highways and other state roads. Noise barriers have been the primarily tool applied for noise abatement. In some situations where it has not been possible to use noise barriers to achieve sufficient noise reduction, façade insulation has been used instead, typically by changing windows and doors to new and better noise reducing types.

In spring 2009 the Danish Road Directorate published a proposal for a new noise action plan for the existing state road network. The purpose of the plan is to describe initiatives that are planned to reduce road traffic noise along the state road network where the noise is considered unacceptable. The plan also describes noise initiatives in relation to maintenance of the road network as well as the improvement and enlargement of the state road network.

Since the mid 1980's noise has been integrated in municipal land use planning. In the planning process of new residential areas a land use plan has to be developed and approved by the local municipality. A noise guideline at dwellings of 55 dB ($L_{Aeq,24h}$) has to be respected. In 2007 the noise indicator L_{DEN} was introduced to replace $L_{Aeq,24h}$ and the noise guideline was changed to 58 dB (L_{DEN}) to ensure the same protection level.

This report is produced by the Danish Road Directorate/Danish Road Institute for the California Department of Transportation. For comprehensive guidance on traffic sound issues in California please reference Caltrans' *Technical Noise Supplement* and *Traffic Noise Analysis Protocol* manuals.

Sammenfatning

Når der bygges nye veje eller bygninger i Danmark tages der særlige hensyn til vejtrafikstøj. Et nyt nationalt støjkort viser, at omkring 30 % af danske hjem udsættes for støj som overskrider den vejledende grænseværdi på 58 dB (L_{DEN}) og at støjproblemerne hovedsageligt forekommer i byerne. Denne rapport præsenterer metoder og strategier til støjbekæmpelse. Der findes ingen enkel metode for at fjerne alle støjproblemer langs motorveje og i byer. Det er nødvendigt at anvende støjbekæmpelse på forskellige niveauer:

- **Ved kilden:** dette dækker køretøjer, dæk, belægninger, trafik og hastighed.
- **Under udbredelse:** i form af støjskærme, etc.
- **Ved modtageren:** i form af facadeisolering og lokale skærme.

Baggrunden for denne rapport er erfaringer og idéer fra det danske Vejdirektorat samt andre europæiske lande. Som en introduktion præsenteres 14 anbefalinger for ”good governance” angående støjledelse og -bekæmpelse.

I Danmark anses boliger at være udsat for støj hvis niveauet er højere end 58 dB (L_{DEN}). Når der planlægges nye boligområder anvendes normalt en grænseværdi på 58 dB (L_{DEN}). Den nordiske støjberegningsmetode, Nord2000, anvendes for vejtrafik. Støjbelastningstallet (SBT) er grundlaget for økonomiske analyser af støj fra vejtrafik. SBT er et udtryk af den samlede støjbelastning på alle boliger i et område. Det er beregnet som summen af de vægtede støjbelastninger på individuelle boliger i området, således at boligerne med høje støjniveauer vægtes tungere end boliger med mindre støj. Den økonomiske vurdering af støj er baseret på markedsværdien af boliger samt indflydelsen på helbred.

Som en vigtig del af planlægning af nye motorvejsstrækninger i Danmark, udføres normalt en VVM analyse. Støj er en af de miljømæssige faktorer, som tages med i VVM undersøgelserne. Når der planlægges nye motorveje, bliver en støjgrænseværdi på 58 dB som L_{DEN} anvendt, hvis det er muligt. Grænseværdien anvendes, når en gruppe huse/boliger er udsat for støj fra vejtrafik. For enkelte huse på landet, tages normalt ikke hensyn til grænseværdien. Der tilbydes i stedet facadeisolering, såfremt støjen overstiger 63 dB. Forskellige virkemidler til at reducere støjen kan anvendes, når der planlægges nye motorveje. Hvis det er muligt og realistisk at finde en linjeføring for den nye motorvej, som giver den maksimale afstand til boligområder, er det normalt den foretrukne løsning. Støjreducerende belægninger bruges normalt, når en motorvej passerer en gruppe huse/boliger.

Som ved nye motorvejsprojekter, tages også støj i betragtning, når der planlægges en udvidelse af eksisterende motorveje.

ITEM 11.1.

I løbet af den sidste 10-års periode har Vejdirektoratet gennemsnitlig brugt ca. 20 mio. DKK (€ 2.7 mio. eller USD 3.6 mio.) hvert år på støjbekæmpelse langs eksisterende motorveje og hovedlandsveje. Støjskærme er det vigtigste virkemiddel. I nogle situationer, hvor det ikke har været muligt at anvende støjskærme for at opnå tilstrækkelig støjreduktion, er facadeisolering anvendt, typisk ved at udskifte vinduer og døre til mere støjreducerende typer.

I foråret 2009 udgav Vejdirektoratet et forslag for en ny støjhandlingsplan for det eksisterende vejnet. Formålet med planen er at beskrive tiltag for at nedsætte vejstøj langs statsvejene, der hvor støjniveauet anses for at være uacceptabelt. Planen beskriver også støjinitiativer i forhold til vedligeholdelse og udvidelse af statens vejnet.

Siden midten af 1980'erne er støj indgået i lokalplanlægningen i forbindelse med planlægning og bygning af nye boliger. En støjgrænseværdi for boliger på 55 dB ($L_{Aeq,24h}$) skal overholdes. I 2007 blev støjindikatoren L_{DEN} introduceret som erstatning for $L_{Aeq,24h}$ og støjgrænseværdien blev ændret til 58 dB (L_{DEN}) for at sikre samme beskyttelsesniveau.

Denne rapport er udarbejdet af Vejdirektoratet/Vejteknisk Institut i Danmark for California Department of Transportation i USA.

Preface

Noise abatement is a big challenge for European and American transportation agencies.

Noise is an important factor to be considered when it comes to developing, upgrading and maintaining national highway networks in Europe. Significant financial resources are used to incorporate noise abatement measures in developing or upgrading national highways. This report presents a series of methods and strategies for assessing and addressing noise impacts. The background for the report is procedures and experiences from the Danish Road Directorate as well as from other European countries.

The project is carried out under the framework of the research technical agreement titled “Supplementary Studies for the Caltrans Quieter Pavement Research Program” between California Department of Transportation (Caltrans) and University of California Pavement Research Centre (UCPRC) as a part of the task: “Policy documents: guidelines for Caltrans policy”. The Danish Road Institute/Road Directorate (DRI-DK) is subcontracted by UCPRC to work on the project.

Caltrans has asked DRI-DK to produce this brief catalogue of ideas on noise abatement and integration of noise considerations when planning and constructing new highways as well as when maintaining existing roads based on Danish experiences. The use of different measures for noise abatement like implementing noise reducing pavements, noise barriers, facade insulation, etc. are included. Land use planning and design of new housing along existing highways as well as noise policies and strategies will also be presented.

The report is compiled and written by Hans Bendtsen DRI-DK. Jakob Fryd from the Planning Division of the Danish Road Directorate and Bruce Rymer from Caltrans, Division of Environmental Analysis has given comments and advice. The author will like to thank everybody who has made it possible to compile this report for their efforts and qualified work. This report is written from the Danish perspective and does not represent official Caltrans policy. This report is produced by the Danish Road Directorate/Danish Road Institute for the California Department of Transportation. For comprehensive guidance on noise issues in California please reference Caltrans’ *Technical Noise Supplement* [8] and *Traffic Noise Analysis Protocol* [9] manuals.

Forord

Støjproblemer er en stor udfordring for vejmyndighederne både i Europa og USA.

Støj er en vigtig faktor som indgår i forbindelse med nybygning, opgradering og vedligeholdelse af de nationale vejnetværk i Europa. Væsentlige økonomiske ressourcer anvendes på støjreducerende foranstaltninger. Denne rapport præsenterer en serie metoder og strategier for integration af støjensyn i vejplanlægningen. Baggrunden for denne rapport er metoder og erfaringer fra det danske Vejdirektorat samt andre europæiske lande.

Projektet er gennemført som en del af den tekniske forskningsaftale "Supplementary Studies for the Caltrans Quieter Pavement Research Program" mellem California Department of Transportation (Caltrans) og University of California Pavement Research Centre (UCPRC), som en del af opgaven: "Policy documents: guidelines for Caltrans policy". Det danske Vejteknisk Institut/Vejdirektorat er underleverandør til UCPRC for at arbejde på projektet.

Caltrans har bedt Vejteknisk Institut/Vejdirektorat om at producere dette idékatalog om støjbekæmpelse og integrering af støjensyn når der planlægges og bygges nye motorveje samt i forbindelse med vedligeholdelse af eksisterende veje. Anvendelse af forskellige virkemidler som støjreducerende belægninger, støjskærme, facade isolering etc. er medtaget. Fysisk planlægning og design af nye boligområder langs eksisterende motorveje såvel som politikker og strategier for støjbekæmpelse er også medtaget.

Rapporten er udarbejdet og skrevet af Hans Bendtsen Vejdirektorat/Vejteknisk Institut. Jakob Fryd fra Planlægningsafdelingen i Vejdirektoratet i Danmark og Bruce Rymer fra Caltrans, Division of Environmental Analysis har kommenteret rapporten. Forfatteren vil gerne takke alle, som har gjort det muligt at udarbejde denne rapport. Rapporten er skrevet fra et dansk perspektiv og præsenterer derfor ikke officiel Caltrans politik.

1. Introduction

When constructing new buildings or roads in Denmark special consideration is given to traffic noise. A new national noise map indicates that around 30 % of Danish homes are exposed to noise levels that exceed the guideline value of 58 dB (L_{DEN}) and that noise problems are concentrated in cities.

Road traffic noise may impact people in different ways such as impacting communication, and interrupting sleep. New studies show that noise can contribute to an increased risk of cardio-vascular diseases. The effects of noise are also of an economic nature because noise influence housing prices in areas exposed to noise. Furthermore, health related issues caused by noise also incur costs. The socio-economic costs related to road traffic noise have been calculated to amount to between 0.8 and 1.2 billion Euro (1.1 to 1.6 billion USD) annually in Denmark [6].

1.1 Methods for noise abatement



Figure 1.1. Façade insulation by applying a “glass box” in front of an existing window of bedroom or living room. Example from an apartment building in Århus, Denmark [10].

There is no single method that can remove all noise problems along highways and in cities. It will be necessary to address noise abatement on several different levels [7]:

- **At the source:** this covers vehicles tires, pavements, traffic, speed and driving patterns. When noise is reduced at the source, it has an effect on all buildings and open space areas that are affected by the noise along a given roadway section. Noise reduction on pedestrian and bicycle paths along the road will also be an improvement for pedestrians and cyclists.

ITEM 11.1.

- **Along the propagation path:** in the form of noise barriers and berms. By using noise barriers, a noise reduction will be experienced in buildings and open space areas that are behind the barriers, but not for the areas in front of the barriers.
- **At the receiver:** in the form of façade insulation and local barriers. Façade insulation is limited to reducing the noise level inside when the windows are closed, whereas the noise level outside remains unaffected.

Additional methods can be applied to reduce noise such as barriers, noise reducing pavements, traffic diversion, speed reductions, limiting heavy vehicle access at night, vegetation, and façade insulation to name a few. Environmental zones with speed limits can also be used to reduce noise levels.

1.2 Organisation of noise abatement

Often nothing is done to reduce noise problems, perhaps due to the fact that there often is no clear “owner” of the problem or a lead organisation has not been identified to take initiatives for improvements. Also, problems might seem overwhelming; there could be a lack of useful ideas or alternatives to finance the proposed activities all resulting in nothing being done. However, it is very important to support and stimulate positive development, even though the hurdles seem insurmountable and the results in the beginning are very limited.

To aid in initiating and carrying out the noise related work in the municipal authorities or road administrations, a special noise secretariat could be established, whose employees would mainly deal with planning, initiating and managing the local efforts. A concerted effort of different municipal departments and other affected parties such as private citizens, owner and tenants’ associations and the business community is advisable.

A municipal authority is a large organisation that continuously plans and implements activities in the construction, running and maintenance fields. It could be considered a municipal goal that traffic noise issues become an integral part in all relevant activities such as road maintenance, building maintenance and renovation of open space areas and parks.

City planning and possible adjustments within existing urban areas are tasks that are handled by the municipal authorities. Noise is an important parameter that is normally taken into consideration when building new housing areas. However, it would also be useful to include noise as a parameter when addressing issues such as rebuilding and expanding housing areas as well as in projects on rebuilding and widening roads or traffic calming. A starting point could be drawing up a set of municipal goals for noise related issues in existing urban areas.

There is a need to activate as many assets as possible for the work to reduce noise. A municipal authority can play an important role in relation to private citizens and the business community. Danish research shows that in certain cases private citizens are willing to participate in funding noise reducing measures [34]. It is important to inform citizens of the technical and economic possibilities as these are not always common knowledge.

ITEM 11.1.

A noise secretariat can play an important role as an “idea bank”, initiative taker, and coordinator. In this forum one could gather citizens affected by noise and present them with technical solutions as well as helping them to organise noise reducing efforts that could be achieved and paid for, either in part or fully, by the house owners and the citizens themselves. The municipal efforts could consist of organisation and coordination with a view to activating the assets and resources available amongst the citizens, and also to take part in the carrying out of certain tasks. Furthermore the possibility to share the costs of certain activities could be examined.



Figure 1.2. When fences at residential areas are to be renewed by the owner they can be constructed as noise barriers. This might not increase the cost significantly but the noise has to be considered when selecting design, construction and material for the new fence [10].

There are several examples from both Denmark and abroad that show how road traffic noise reducing projects have been financed [35]. House owners can implement noise reducing measures at their own homes at their own cost. A rise in property value as a result of the noise reducing measures can motivate some home owners to finance these measures themselves. Depending on the current tax situation, increased property values mean that the both the state and the municipality receive increased taxes, that can again be reinvested in other noise reducing projects. In apartment buildings noise reduction can be achieved by changing to specialized noise insulating windows that can be financed over the annual maintenance budget that could also be used to finance other noise reducing projects.

ITEM 11.1.



Figure 1.3. When the windows of apartment buildings and single family houses along highways have to be replaced by the owner, noise can be taken into consideration when selecting the new windows. Without a significant increase in cost, improved noise reduction and energy reductions can often be achieved [10].



Figure 1.4: Public meeting on noise abatement etc in relation to a highway project.

In connection with noise reducing projects that are planned, it can be recommended to involve those citizens that will be affected by these projects. This will give the citizens influence on which solutions that will be chosen and give them a realistic picture of which level of noise reduction to expect. Citizens can become actively involved and in some cases even be joint partners in the planned projects. Involved citizens might become motivated to implement further measures which can improve the effect and quality of the planned improvements.

ITEM 11.1.

1.3 Structure of the report

As an introduction, fourteen recommendations to National Road Administrations for good governance regarding noise management and abatement are presented in Chapter 2. Noise guidelines, prediction of noise and socio-economic evaluation of noise are introduced in Chapter 3. This is followed by three typical planning situations where noise can be considered in relation to highways:

- Planning of new highways in Chapter 4.
- Planning of widening existing highways in Chapter 5.
- Noise abatement at existing highways in Chapter 6.

Finally Chapter 7 presents, how noise is taken into consideration when building new residential areas along highways.

All the noise levels presented in this report are A-weighted. The unit “dB” is used in this report and it is equal to what is often denoted “dB(A)” and “dBA”. The following exchange rates are assumed in this report: 1 € = 7.45 DKK and 1 USD = 5.50 DKK.

ITEM 11.1.



2. Good governance in noise abatement

The following fourteen recommendations to National Road Administrations (NRA) for good governance regarding noise management and abatement [3] were developed by a European noise group from the Conference of European Directors of Roads (CEDR) [5]:

1. In Europe, the main noise problems occur along the existing road network and the order of magnitude of the problems is increasing with increasing traffic volume. Therefore, noise abatement along these roads is crucial in order to start a process where the noise exposure over the long term is reduced.
2. It is important to include noise issues at the early planning stage for new road developments. In adopting such an approach, future noise problems may be avoided. The basis for such an approach will normally be the national noise guidelines.
3. Noise should be included as an important parameter in projects where existing roads are improved to accommodate increasing traffic volumes or increasing speeds. This can improve the noise environment for people living in close proximity to the upgraded road.
4. When planning to incorporate noise abatement measures on new, existing and reconstructed roads, it is important to adopt a time horizon of 20 to 30 years, when predicting future noise from increasing traffic volumes and planning noise measures. This will enhance the robustness of specific noise projects.
5. When road construction work is carried out in close proximity to residential areas, it is relevant to consider construction noise when planning and realizing such works. Residents close to the construction site should get sufficient information.
6. In projects where noise abatement measures are planned and designed, it is recommended to establish a good communication strategy to ensure a two way communication process with the public. In this way, residents may take ownership of the project and their expectations to what noise mitigation may deliver in terms of noise reductions may be more realistic.
7. Noise barriers erected on roads have not only visual impacts for the residents living in close proximity to the road but also the driver and their passengers. It is therefore, important to use barrier designs that are appropriate to the specific location where they are installed.
8. The use of noise reducing pavements should be considered when selecting noise mitigation measures because such pavements are purported to provide a cost effective tool in noise abatement. In upgrading existing roads, the use of noise reducing pavements is often a low cost measure of noise abatement.

ITEM 11.1.

9. Integration of noise as an active component in Pavement Management Systems can increase the optimal use of noise reducing pavements in the ongoing road pavement renewal process.
10. To enhance the current market for noise reducing pavements the development and use of a noise labeling system in member states should be considered.
11. In order to reduce noise emissions from individual vehicles, it would be invaluable if individual NRAs lobby at EU level to promote tighter noise limits for the EU type approval of new vehicles and tires.
12. Like all elements of infrastructure, noise abatement measures such as pavements, barriers, façades, etc. need to be maintained on a regular basis.
13. There is a need for further research and development in improved and long time durable measures of noise abatement like optimized noise reducing pavements, tires, vehicles etc.
14. A continuation of international cooperation on noise abatement and management between the NRAs is value adding and fruitful. In the coming years issues like noise mapping and noise action plans in relation to European Noise Directive (END) [22] seems highly relevant.



Figure 2.1. When road construction work is carried out in close proximity to residential areas, it is relevant to consider construction noise when planning and realizing such works.

3. Guidelines, prediction and evaluation

3.1 Noise guidelines

For many years, the noise indicator $L_{Aeq,24h}$ has been used in Denmark when assessing noise from road traffic. $L_{Aeq,24h}$ is an expression of the “average” noise level over the 24 hours of the day. The guideline for noise exposure outside at the façade of residential buildings has been 55 dB (not including the noise reflected from the façade).

On the background of a European Union Directive on environmental noise [22] the new indicator L_{DEN} was introduced by the Environmental Protection Agency in 2007 in a new guideline on road traffic noise [23]. For L_{DEN} the noise (as L_{Aeq}) is predicted for the day, evening and night period. 5 dB is added to the evening time level and 10 dB is added to the night level in order to make a kind of compensation for when people are more sensitive to noise than during daytime. The three time periods are in Denmark defined as:

- **Day:** 07 – 19, length 12 hours
- **Evening:** 19 – 22, length 3 hours
- **Night:** 22 – 07, length 9 hours

L_{DEN} is then calculated as the weighted sum of the adjusted noise levels for the three periods of the day using the below formula:

$$L_{DEN} = 10 \log \{ 12 \cdot 10^{L_{day}/10} + 3 \cdot 10^{(L_{evening}+5)/10} + 9 \cdot 10^{(L_{night}+10)/10} \} \quad (1)$$

According to [23] for Danish conditions with a “normal” distribution of the traffic over the 24 hours of the day L_{DEN} can be predicted by adding 3 dB to $L_{Aeq,24h}$:

$$L_{DEN} = L_{Aeq,24h} + 3\text{dB} \quad (2)$$

Therefore the existing noise guide lines were adjusted by 3 dB when L_{DEN} was introduced in order to maintain the same level of noise protection as when $L_{Aeq,24h}$ was used. In other European countries other relations between L_{DEN} and $L_{Aeq,24h}$ are used [3].

ITEM 11.1.

Table 3.1. Danish noise guidelines for road traffic noise expressed as L_{DEN} [23].

Type of area	Guideline L_{DEN}
Recreational areas at the countryside, summer house areas, campsites etc.	53 dB
Residential areas, kindergartens, schools and education facilities, homes for elderly people, hospitals etc. Allotment gardens, outside recreational areas and parks.	58 dB
Hotels and offices etc.	63 dB

The new Danish noise guidelines for road traffic noise, expressed as L_{DEN} , can be seen in Table 3.1. It must be emphasised that it is guidelines and not mandatory noise levels that must not be exceeded anywhere along the highway and road network. These guidelines are generally used when planning and constructing new residential areas etc, but are also taken into account when planning new roads and highways.

Noise metrics and guidelines are not consistent throughout Europe and a report from CEDR [3] gives an overview of noise guidelines used in different European countries. Denmark is currently in a transition period where $L_{Aeq,24h}$ has been replaced with L_{DEN} . This is reflected in this report, where some examples use $L_{Aeq,24h}$ and other examples use L_{DEN} .

3.2 Noise prediction

In Denmark, the Nordic model for road traffic noise has been the official prediction method since the 1970s. In 2007 the Environmental Protection Agency [23] introduced a new version called Nord2000 [25, 26] which was developed as a joint Nordic project. Nord2000 is a completely new model and in principle there are no links to the old model. Both the source data and propagation model are new components.

The idea was to develop a general sound propagation model and source-specific prediction methods for road and rail traffic as well as other types of environmental noise sources. Nord2000 now consists of source models for road and rail traffic and a propagation model. The model works in 1/3 octave bands and for any normal weather type. Noise levels – for historical reasons – have been computed for different weather conditions in the earlier Nordic models. Now all types of environmental (road and rail etc) noise can be computed for the same weather.

The source model distinguishes between: 1) light, 2) medium and 3) heavy vehicles. The 1/3 octave-band sound power level of each source is calculated from input parameters selected by the user, determining the sound power of tire/road noise and propulsion noise, respectively. The noise emission data are based on comprehensive way-side noise measurements. The Danish noise emission data are based on measurements taken during 1999 – 2000 of 4000 vehicle pass bys at 21 sites with speed limits of 30 - 110 km/h on pavements of 2 – 18 year old dense asphalt concrete or stone mastic asphalt and constructed with 8 – 12 mm maximum aggregate.

ITEM 11.1.

Emission levels of the new data set tend to be higher than in the former 1996 version of the Nordic method. It is not clear whether the higher emission values are due to changes in vehicle fleet or tyres.

The propagation model is based on geometrical ray theory and gives algorithms for computing 1/3 octave band sound attenuation along the path from source to receiver taking into account the terrain shape as well as ground type (impedance) and roughness.

Nord2000 deals with attenuation under different weather conditions and is suited for computing yearly average noise levels. Various classes of weather have been defined and their frequency of occurrence has been determined based on data from meteorological observations. The yearly average is obtained by computing the noise level for each weather class and then combining these levels weighted with their occurrence. For example: the effect of using precise weather conditions at 300 m from a road with a North-South alignment, the yearly average noise level in Denmark is 2 dB higher at receivers east of the road than at receivers west of the road. The reason for the difference is that the most common wind direction is from the west. The NORD2000 model predicts outdoor noise levels and does not specifically deal with indoor noise.

The Nord2000 method is developed for the environmental and transportation authorities of the Nordic countries. This taxpayer-developed method consists of a users guide [26] and a large series of formulas that are available for free (see reference list of [26]). It is the challenge of private software companies on the open market to provide commercial computer based versions of Nord2000. Currently, there are commercial software products based on the NORD2000 model available on the market. But in order to make NORD2000 available to governmental authorities and the public that supported its development, a simple or 'lite' version of the Nordic model is available. The 'lite' version covers a series of typical standard cases for roads, barriers and geometry with pre-calculated transfer functions for 30 selected cases. Default traffic data for five typical types of road configurations can be edited by the user to fit any specific case. This PC version is working in English language and can be downloaded free of charge from [27]. The user has to define input data like traffic, distribution of traffic over the day, road surface type, noise barriers etc.

ITEM 11.1.

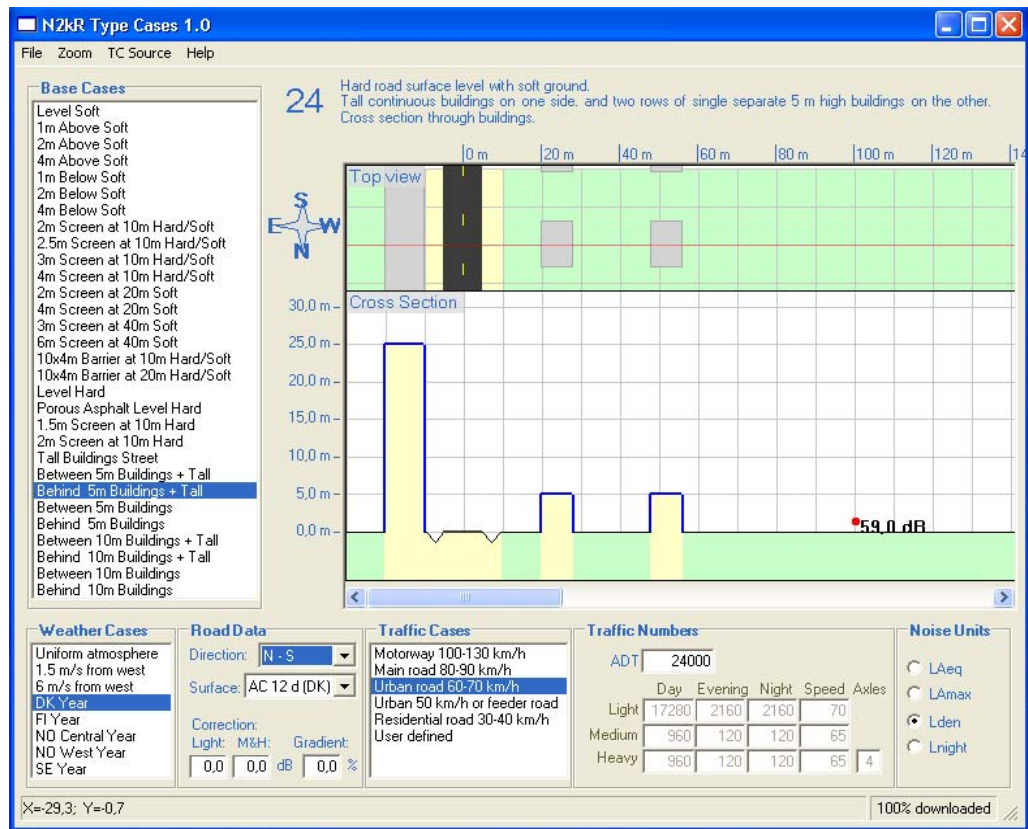


Figure 3.1. "Front page" of the simple PC program for the Nord2000 road traffic noise prediction method used in Denmark and the other Nordic countries [27].

The free downloadable version of the software communicates with a server in Norway with a huge database of pre-predicted results. The results are outdoor noise levels and they can be delivered as $L_{Aeq,24h}$, L_{DEN} , L_{night} and L_{AFmax} . In this way road, traffic and town planners have easy access to Nord2000.

3.3 The Noise Exposure Factor

The Noise Exposure Factor (NEF – in Danish "Støjbelastningstal", "SBT") is the basis of all Danish cost-benefit analyses of noise from road and rail traffic [11]. It is an expression of the accumulated noise load on all the dwellings in an area. It is calculated as the sum of the weighted noise loads on the individual dwellings in the area, so that dwellings with high noise levels weigh more than dwellings with less noise.

Calculations of the NEF are based on noise levels in three locations around a dwelling: inside the dwelling, outside the dwelling, and at outdoor activity areas connected to the dwelling. The noise level outside the dwelling is calculated as free-field values on the facade and can be interpreted as the noise level to which the inhabitants are exposed, when the windows are open. The weight assigned to each of these situations depends on how often it is occupied and whether it is an ordinary dwelling or a weekend cottage/summer house.

ITEM 11.1.

The weights can be seen in Table 3.2. The method to calculate NEF values has been developed when $L_{Aeq,24h}$ was used as the noise indicator. In order to use the method for noise predicted as L_{DEN} 3 dB has to be added to all the noise intervals in Table 3.3 and 3.4.

Table 3.2. Weight assigned to various situations when calculating NEF [14].

	Outside dwelling	Outdoor areas	Inside dwelling
Ordinary dwelling	0.2	0.2	0.6
Weekend cottage etc.	0.1	0.3	0.1

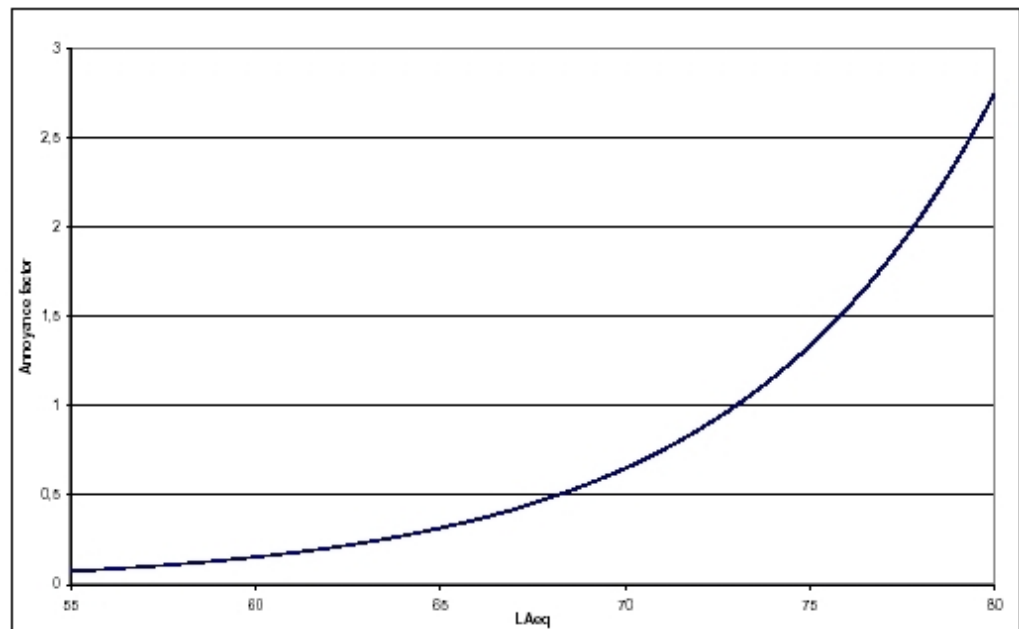


Figure 3.2. The relationship between the annoyance factor and the noise outside ordinary dwellings. Noise levels are free-field levels on the façade [11, 14].

The NEF is based on a dose-response relationship given by:

$$\text{Annoyance factor} = 0.01 * 4.22^{0.1(L_{Aeq} - K)} \quad (3)$$

Where:

$K = 16$ and L_{Aeq} starts at 30 dB for noise inside dwellings.

$K = 41$ and L_{Aeq} starts at 55 dB for noise outside ordinary dwellings.

$K = 36$ and L_{Aeq} starts at 50 dB for noise outside weekend cottages etc.

The actual annoyance factor for a specific noise level is derived from a dose-response relationship for noise outside ordinary dwellings. The relation between the annoyance factor and the noise levels is shown in Figure 3.2.

ITEM 11.1.

The number of dwellings subjected to noise in each of the three situations are calculated in intervals of 5 dB using the NORD2000 noise prediction method (see Section 3.2) and multiplied by the corresponding annoyance factor (Table 3.3). The resulting values are summed and multiplied by the corresponding weight from Table 3.2 to give the NEF for the situation for the type of dwelling. Finally the total NEF is calculated by adding the values for each situation and each type of dwelling. An example for calculating the NEF for ordinary dwellings is shown in Table 3.4.

Written as a formula, the NEF can be calculated as:

$$NEF = \sum_k \sum_j w_{jk} \sum_i a_{ijk} N_{ijk} \quad (4)$$

Where:

k = ord, wec (ordinary dwelling, weekend cottage).

j = od, oa, in (outside dwelling, outdoor areas, onside dwelling).

i = 1, 2, 3, 4, 5, 6 (5-dB intervals starting at 30 dB, 55 dB or 50 dB, see table 3.3).

w_{jk} = {0.2, 0.2, 0.6} k= ordinary dwelling, {0.1, 0.3, 0.1} k= weekend cottage.

a_{ijk} = 0.11, 0.22, 0.45, 0.93, 1.92, 3.94.

N_{ijk} is the number of dwellings in the various 5-dB intervals

Table 3.3. Annoyance factor for the individual dwellings [14].

Noise level in dB	Type of area			
	Ordinary dwelling		Weekend cottage etc	
	Indoors	Outside	Indoors	Outside
30.1-35.0	0.11	-	0.11	-
35.1-40.0	0.22	-	0.22	-
40.1-45.0	0.45	-	0.45	-
45.1-50.0	0.93	-	0.93	-
50.1-55.0	1.92	-	1.92	0.11
55.1-60.0	3.94	0.11	3.94	0.22
60.1-65.0	-	0.22	-	0.45
65.1-70.0	-	0.45	-	0.93
70.1-75.0	-	0.93	-	1.92
75.1-80.0	-	1.92	-	3.94

ITEM 11.1.

The NEF makes it possible to compare the benefits of different noise reducing strategies such as barriers, pavements, and sound insulation in a manner that accounts for the differences in where the noise is reduced. This accounting approach allows several different noise mitigation strategies and combinations of strategies to be compared more equitably. In practice however, NEF-calculations are usually simplified using only the noise level outside the façade of dwellings and assigning this the weight 1, thus omitting the separate valuation of indoor noise and noise on outdoor areas.

Table 3.4. Example of a calculation of NEF for ordinary dwellings [11].

Outside dwellings			Outdoor areas			Inside dwellings		
Noise at façade [dB]	No. of dwellings	Annoy. factor	Noise outside [dB]	No. of dwellings	Annoy. factor	Noise inside [dB]	No. of dwellings	An-noy. factor
65-70	163	0.45	65-70	37	0.45	40-45	163	0.45
60-65	207	0.22	60-65	15	0.22	35-40	207	0.22
55-60	123	0.11	55-60	19	0.11	30-35	123	0.11
Weight		0.2	Weight		0.2	Weight		0.6
NEF		26.5	NEF		4.4	NEF		79.4
Sum of NEF = 110.3								

By using this simplification, it is not possible to make a correct evaluation of the effect of establishing façade insulation as a tool for noise abatement, and evaluations of noise barriers may also be misleading due to actual differences in noise levels at the façade and on the outdoor areas.

3.4 Socio-economic assessment of noise

In 1999, the Danish Ministry of Finance published a guide to preparing socio-economic assessment of consequences [12] of construction works etc. The aim of this was to achieve greater uniformity in socio-economic assessments of initiatives in the traffic and energy sectors and in relation to investments in administration buildings and investments in the educational sector. The choice of Cost-Benefit Analysis (CBA) or of cost-effectiveness assessment (CEA) depends on the characteristics of the initiative, but CBA is presented as the primary method [12].

The guidelines contain standards and principles for calculation of central parameters in the analyses. Valuation should be based on net present value using a calculation interest rate of 6 percent and a 20 % tax cost factor to account for the costs to society due to financing through taxes. For projects with time horizons of more than 20 years the tax cost factor can be left out if a calculation interest rate of 7 percent is used.

ITEM 11.1.

In 2003, the Ministry of Transport published a manual for socio-economic analysis based on the above guidelines from the Ministry of Finance [13]. The assessment of noise is based on annoyance at dwellings whereas noise at occupational buildings and institutions is not included. Noise levels below 55 dB ($L_{Aeq,24h}$) are not included and there is no differentiation between day and night time noise. This relates to the Danish guideline value for road traffic noise at dwellings which is 55 dB ($L_{Aeq,24h}$).

Valuation of noise effects are based on market prices. Ministry of Transport continuously publishes a catalogue of key values for use in analyzes. In the 2004 version of the catalogue [15], the values put on noise are based on a new house price survey (the hedonic method) [16]. The value put on noise annoyance is 35,853 DKK (4,812 € or 6519 USD) per NEF (2003 price level). 23,018 DKK (3,090 € or 4185 USD) per NEF is added for costs to society due to health effects, which are not included in the reduced house prices. The total value of noise is thus 58,871 DKK (7,902 € or 10704 USD) per NEF (2003 price level).

The assessment of health effects is based on a study of the international literature on the subject [17]. It is concluded that the documentation of actual health effects of noise from road traffic is weak and without clear evidence, and the estimates of costs are therefore done with reservation. There is some evidence of a connection between noise and ischaemic heart disease, although the risk factors related to it are uncertain. A risk factor of 1.09 per 5 dB increase in noise levels is adopted, and it is decided also to use this factor for hypertension. Other possible health effects are left out of the assessment of costs.

The catalogue [15] also presents marginal costs of noise from transportation. The noise costs per driven vehicle kilometre (2003 price level) can be seen in Table 3.5. The uncertainty on these values is estimated to be minus 50% to plus 100%.

Table 3.5. Danish estimated noise costs per driven vehicle kilometre (2003 price level) [15].

Vehicle type	DKK/km	€/km	USD/km
Passenger cars	0.12	0.016	0.022
Light Goods Vehicle	0.17	0.023	0.031
Heavy Goods Vehicle	0.25	0.034	0.046
Bus	0.55	0.074	0.100

This subject of socio-economic costs of noise is discussed more in the DRI-DK report “Cost-benefit analysis on noise-reducing pavements” [11].

4. Planning of new highways

As an important part of planning new highway sections in Denmark, an Environmental Impact Assessment (EIA) study is performed. Noise is normally one of the environmental components included in the EIA.

4.1 An example

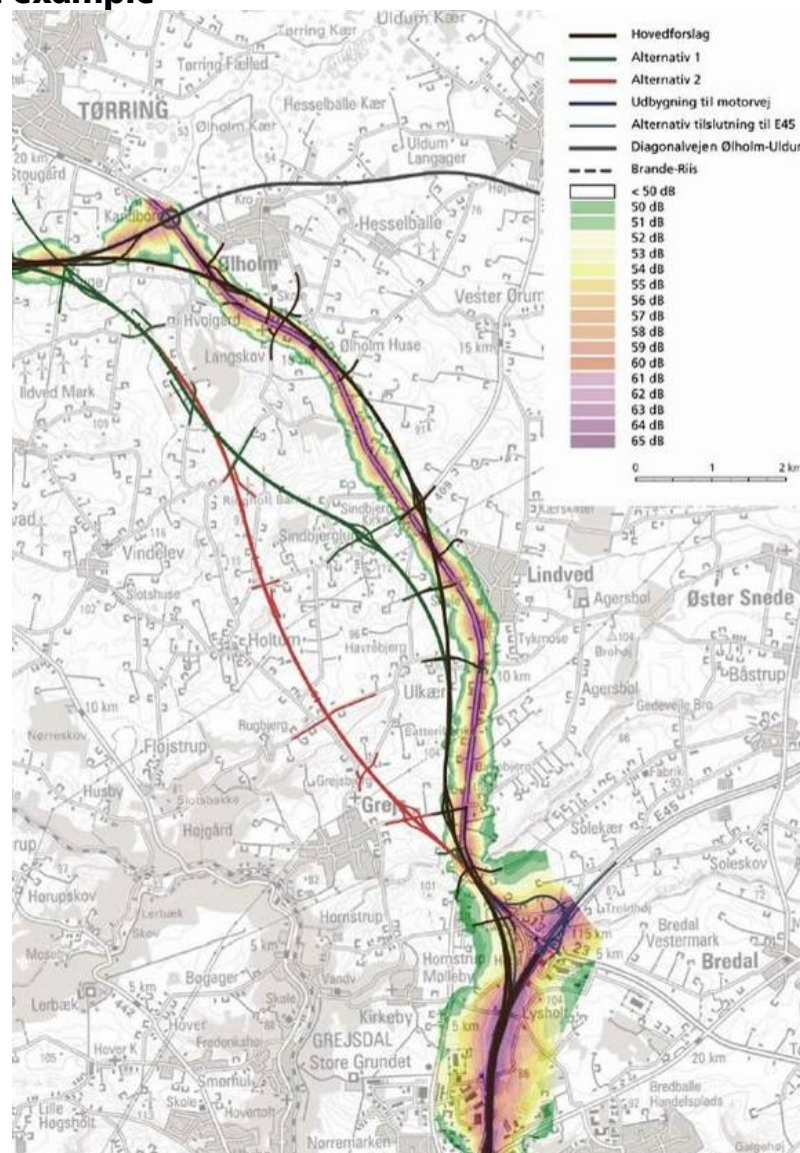


Figure 4.1. Planning of a new highway between Ølholm and Vejle. Noise mapping of the reference situation in 2015 at a receiver height of 1½ m (5 feet). The noise contours along the existing road are presented [21].

The following is an example of how noise was handled in the EIA [21] conducted as a part of planning a new highway in Denmark between Ølholm and Vejle. In this example, $L_{Aeq,24h}$ is used as the indicator for noise.

ITEM 11.1.

For the existing road network with no new highway, the noise was mapped for 2015 taking into consideration an increase in traffic - this is called the reference situation. The existing road network includes the existing highway carrying the main traffic as well as the other roads in the district that will have a change (primarily reduction) of traffic of 15 % or more if the new highway is constructed. Three different traces for the new highway have been evaluated:

- Main Solution (“Hovedforslag” in Danish).
- Alternative 1.
- Alternative 2.

Noise mapping has been conducted for these four situations using the $L_{Aeq,24h}$ noise indicator. The noise maps can be seen in Figures 4.1, 4.2 and 4.3.

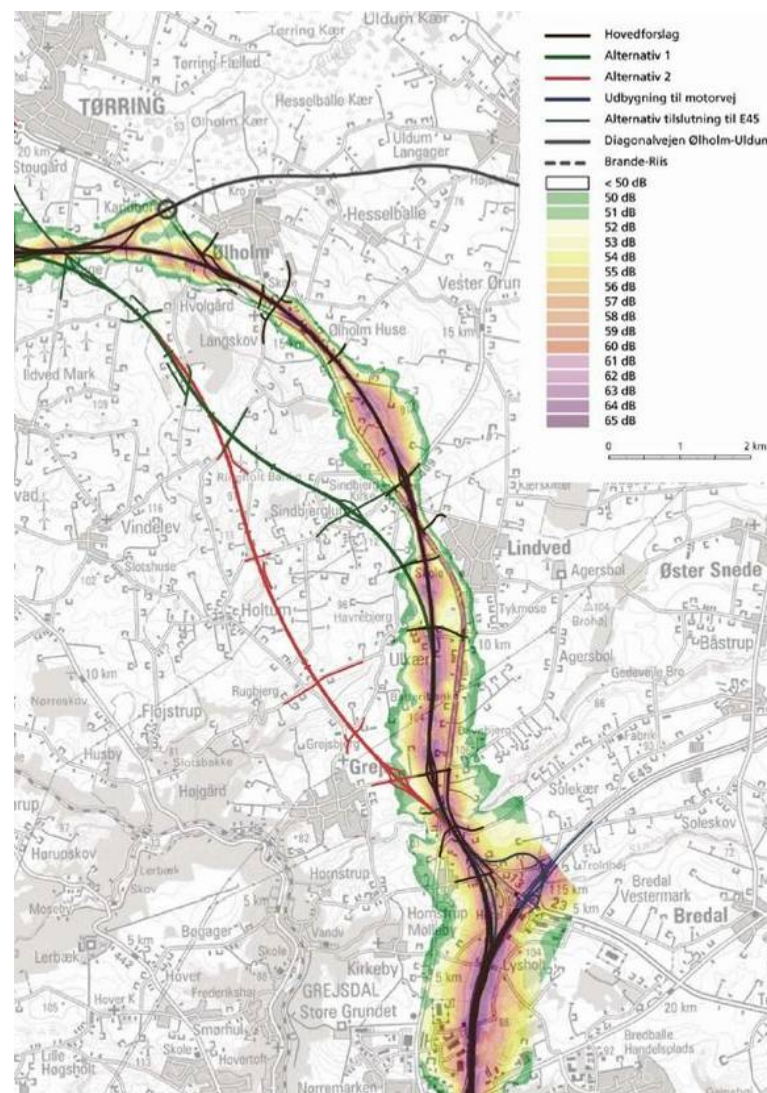


Figure 4.2. Planning of a new highway between Ølholm and Vejle. Noise mapping of the Main Solution in 2015 at a receiver height of 1½ m (5 feet). The noise contours along the existing road as well as the suggested new highway is presented [21].

ITEM 11.1.

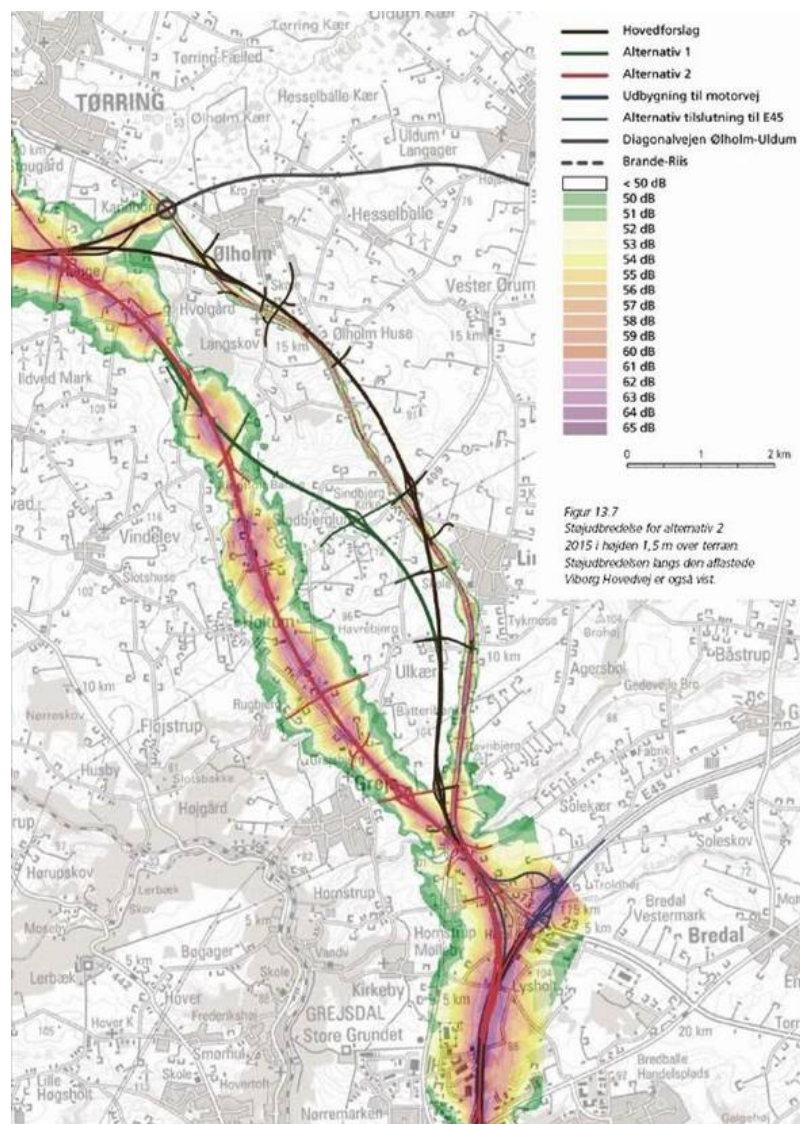


Figure 4.3. Planning of a new highway between Ølholm and Vejle. Noise mapping of Alternative 2 in 2015 at a receiver height of 1½ m (5 feet). The noise contours along the Alternative 2 alignment of the new highway and the existing road are presented [21].

The number of dwellings exposed to different noise levels has been counted on the background of the noise mapping and the Noise Exposure Factor (NEF) which has been predicted (see Table 4.1).

ITEM 11.1.

Table 4.1. Summary of noise mapping. Number of dwellings exposed to noise, the NEF and the change of NET in relation to the reference situation [21].

Scenario	Total of noise exposed dwellings					NEF	Change in NEF
	55-60 dB	60-65 dB	65-70 dB	>70 dB	Total		
Reference	272	153	197	38	660	153.8	-
Main Solution	189	159	214	0	562	122.3	31.5
Alternative 1	201	132	222	0	555	116.2	37.6
Alternative 2	222	133	221	0	576	119.2	34.6

In the reference situation, 660 dwellings along the road network being studied, are exposed to more than 55 dB. This represents a NEF value of 153.8. In the main solution this is reduced by 98 to 562 dwellings with a reduction of NEF by 31.5. Alternative 1 and 2 represents slightly higher reductions of NEF of respectively 37.6 and 34.6. The EIA [21] discusses noise barriers, noise reducing pavements and wide greenbelts as possible measures of noise abatement, but at this state in the planning process no decisions were taken on which measures of noise abatement to implement.

4.2 General measures of noise abatement

The old noise guideline of 55 dB $L_{Aeq,24h}$ was replaced in 2007 with 58 dB L_{DEN} for use in the planning of new highways. The guideline is used when a group of houses/dwellings are exposed to road traffic noise. For a single, isolated house in rural districts, the noise guideline is normally not taken into consideration. Instead façade insulation is offered to the owners if the noise exceeds 63 dB.

Different measures of noise abatement can be considered in the planning of new highways. If it is possible and realistic to locate an alignment of the new highway that ensures long distances to residential areas, this is a preferred solution. But there can be other environmental, technical and/or economical factors that also have to be taken into consideration and which also have an influence on the final decision of the alignment of the new highway through the terrain and urban areas. The following measures of noise abatement are often considered:

- Placing the highway in a cutting and maybe using the surplus soil/material to establish embankments along the highway.
- Noise barriers and earth walls.
- Total covering of the highway by applying a cut and cover process.
- Noise reducing asphalt pavements have been more commonly used in recent years.
- Offer façade insulation to the house/dwelling owners (see Section 6.1).

ITEM 11.1.

- In limited cases, the road administrations might buy houses with high noise exposure and either demolish the buildings or rebuild the structures for less-noise-sensitive commercial use.
- Using a wide belt of vegetation that has a dense appearance all year round.

The actual noise reducing effects of using these measures are normally assessed using the NORD2000 noise prediction method (see Section 3.2).



Figure 4.4. Combination of wave shaped concrete noise barrier and green noise barrier constructed as a "supported" earth wall along the new ring road in Århus, Denmark.



Figure 4.5. 700 m long section of the new highway to Copenhagen airport, Denmark was constructed as a cut and cover strategy in order to reduce the noise exposure for some nearby multi-storey apartment buildings.

ITEM 11.1.



Figure 4.6. Noise insulation of an apartment building by applying glass to cover the façade of the balconies.



Figure 4.7. Close up photo of glass covered balconies. It is possible for the residents to open up the balconies.

5. Planning of widening existing highways

The Danish highway network is primarily developed as four lane roads. Due to increase in traffic, some of the highway sections are being increased to six lanes. One of the projects that was finalized in 2008 is the enlargement of the M3 highway [24].

The M3 is a highway, which functions as a ring road around Copenhagen as well as being part of the E47/E55 European corridor, which connects Sweden and Germany. Being the only ring road around Copenhagen, which is built fully as a motorway, the Average Daily Traffic on the two lanes in each direction is as high as 75,000 vehicles. Congestion is frequent, and during rush hours travelling speeds of 25-30 km/h are normal. In order to improve the traffic situation, it has been decided to widen the M3 from four to six lanes.

The M3 highway passes through densely populated residential districts. As part of the planning of the extension, an Environmental Impact Assessment (EIA) has been carried out, including noise mappings and planning of noise abatement measures. The Road Directorate, which is responsible for the extension, has made a great effort to inform and reach out to the neighbours of the highway.



Figure 5.1. Highway M3 passes through densely built up residential areas around Copenhagen.

ITEM 11.1.

5.1 Environmental Impact Assessment

An Environmental Impact Assessment study [19] has been carried out in relation to the road enlargement project considering the following factors:

- Population
- Landscape
- Culture and history
- Flora and Fauna
- Water resources
- Green areas
- Energy and CO₂
- Air pollution
- Health effects
- Noise and vibrations
- Use of resources and waste production
- Light and reflections
- Soil and contaminated soil

Noise mapping has been performed for the existing situation including the noise contribution from other main roads in the area. In this example $L_{Aeq,24h}$ is used as the indicator for noise. On the background of the noise mapping, the consequences of using noise barriers with different height have been analysed. Table 5.1 shows a summary of the results. In the existing situation 10,305 dwellings were exposed to more than 55 dB equivalent to a Noise Exposure Factor (NEF) value of 1717. By using noise barriers of respectively 3, 4 and 5 meters height, reductions of NEF by 149, 630 and 769 can be achieved.

Table 5.1. Evaluation of the effect on noise exposed dwellings and the NEF value to use 3,4 and 5 m high noise barriers along M3 [20].

Scenario	Number of noise exposed dwellings				Total noise exposed dwellings	Total NEF	Δ NEF
	55-60 dB	60-64 dB	65-69 dB	≥ 70 dB			
Existing	6503	3244	482	76	10305	1717	-
3m barrier	5472	2985	526	78	9061	1568	149
4m barrier	4766	1890	253	36	6945	1087	630
5m barrier	4027	1663	238	35	5963	948	769

ITEM 11.1.

Table 5.2. Evaluation of the price and cost effectiveness of the different barrier solutions [20].

Scenario	Price per m ² in DKK	Total price in mill. DKK	Total price in mill. €	Total price in mill. USD	ΔNEF	ΔNEF per 1 mill. DKK
3m barrier	2600	138	19	25	149	1.1
4m barrier	2380	169	23	31	630	3.7
5m barrier	2400	212	28	39	769	3.6

In order to evaluate the cost effectiveness of noise barriers with different heights, the ΔNEF per mill. DKK invested has been predicted (see Table 5.2). The predictions show that a 1 mill. DKK investment in a 3 m high noise barrier gives a NEF reduction of 1.1 and for a 4 m high barrier the reduction in NEF is 3.7 per million DKK invested. The 4 m high noise barrier is in this prediction slightly more cost effective than the 5 m barrier and the total investment needed for 4 m barriers is 169 mill. DKK (€ 23 mill. or USD 31 mill.) whereas the total investment for 5 m barriers will be 212 mill. DKK (€ 28 mill. or USD 39 mill.).

The cost effectiveness study supported a decision to use a combination of 3 and 4 m high noise barriers. The consequence of this solution was a reduction of the total NEF value by 677 at a total noise barrier cost of 162 mill. DKK (€22 mill. or USD 29 mill.) and with a NEF reduction of 4.2 per 1 mill. DKK invested in noise barriers.

On the background of the Environmental Impact Assessment and an evaluation of cost effectiveness, it was decided in this specific project to use 60 dB ($L_{Aeq,24}$) as the noise guideline for the noise exposure from the M3 highway. 60 dB represents a significant reduction in noise for many of the dwellings situated along the M3 highway. In order to achieve 60 dB, the following measures have been implemented:

- 17,900 m of noise barriers have been constructed.
- Noise reducing pavements have been used.

Where these measures have not been enough to achieve 60 dB noise levels from the highway noise exposure, façade insulation has been offered to the owners.

ITEM 11.1.



Figure 5.2. 3 to 4 m high noise barriers have been constructed along highway M3 as part of the enlargement project.

5.2 Evaluation of noise reducing pavements

In order to evaluate the effect of using a noise reducing pavement on M3 instead of the normally used Dense Grade Asphalt Concrete or a Split Mastic Asphalt, some calculations have been performed on the background of the noise mapping analysis along highway M3. The background for these calculations is the noise mapping of all the dwellings affected by noise levels exceeding 55 dB in the initial situation after the (widening) enlargement of the M3 highway with a standard pavement. Four scenarios with a noise reduction of 1, 2, 3 or 4 dB have been included. Special types of noise reducing pavements were not specified in this evaluation.

Table 5.3. Results of using noise reducing pavements on the noise exposure along M3. The results are given as the number of dwellings exposed to different noise levels and the corresponding noise exposure factor (NEF) [18].

Scenario	Number of noise exposed dwellings				Total noise exposed dwellings	Total NEF	Δ NEF
	55-60 dB	60-64 dB	65-69 dB	≥ 70 dB			
Standard	4343	1815	292	34	6484	1040	-
-1 dB	3811	1788	197	34	5830	933	107
-2 dB	3285	1705	196	34	5220	856	184
-3 dB	3165	1376	189	34	4764	768	272
-4 dB	2860	1368	188	34	4450	732	308

The results can be seen in Table 5.3. A total of 6484 dwellings are exposed to noise over 55 dB in the situation using the standard pavement. This represents a total NEF value of 1040.

ITEM 11.1.

By using a 2 dB noise reducing pavement, the number of noise exposed dwellings is reduced by 933 and the NEF value is reduced by 184 to 856. Using the pavement with 4 dB noise reduction, the number of noise exposed homes is reduced to 4450 and the NEF value is reduced by 308.

Table 5.4. Value of noise reductions caused by the use of pavements with different noise reduction along the M3 expressed as the annual value in (2001 price level) and the net present value [18].

Scenario	Δ NEF	Annual value of noise reduction			Net Present Value		
		Mill. DKK	Mill. €	Mill. USD	Mill. DKK	Mill. €	Mill. USD
-1 dB	107	5.7	0.8	1.0	85	11	15
-2 dB	184	9.7	1.3	1.8	146	20	27
-3 dB	272	14.4	1.9	2.6	216	29	39
-4 dB	308	16.4	2.1	3.0	244	33	44

The economic benefits from using noise reducing pavements are calculated, based on the reduction in the NEF value achieved for the four scenarios for noise reducing pavements. The calculations are done for noise reductions of 1 to 4 dB. The annual value of the noise reductions is predicted by using the price per NEF unit presented in section 3.4. The results can be seen in Table 5.4. A 2 dB noise reducing pavement is in this project equivalent of a yearly saving of 9.7 mill. DKK (1.3 mill. € or 1.8 mill. USD) due to reduced noise exposure on the dwellings around the highway. This corresponds to a net present value of 146 mill. DKK (€ 20 mill. or USD 27 mill.). These figures can be used in a Cost Benefit Analyses. An example of such an analyses can be seen in “Cost-benefit analysis on noise-reducing pavements” [11] from DRI-DK.

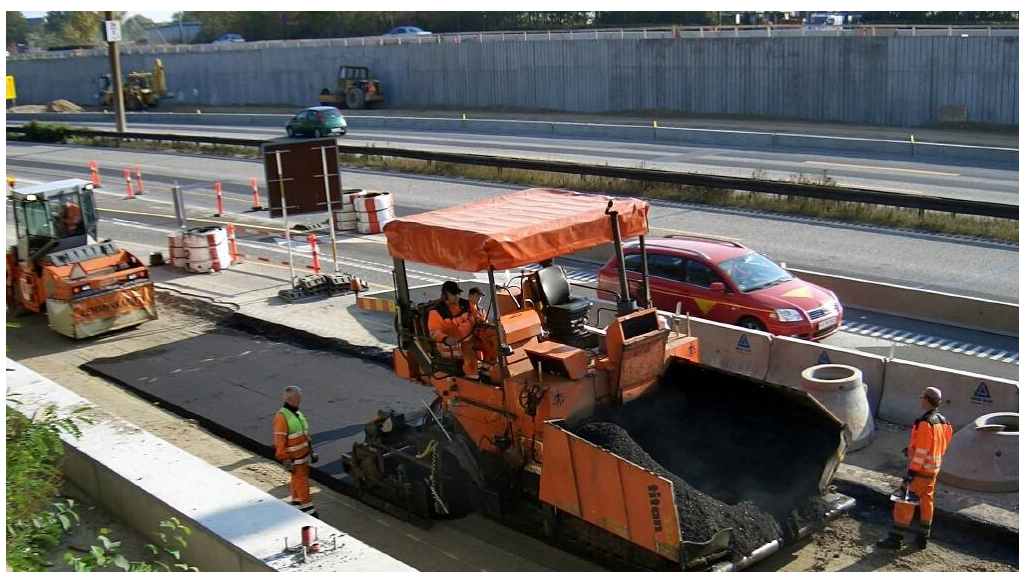


Figure 5.3. Noise reducing pavements were applied on the M3 highway.

ITEM 11.1.



Figure 5.4. Close up of the noise barriers designed for the M3 project (roadside left and urban side right).

6. Noise abatement on existing highways

During the last decade the Danish Road Directorate has used around 20 mill. DKK (2.7 mill € or 3.6 mill USD) every year for noise abatement along the existing highways and other state roads. Noise barriers has been the primarily tool applied for noise abatement [2].



Figure 6.1. Wooden noise barrier constructed along an existing Danish highway [2].

6.1 Façade insulation

In some situations where it has not been possible to use noise barriers to achieve sufficient noise reduction façade insulation has been used instead, typically by changing windows and doors to new and better noise reducing types (and often also heat insulation saving energy). Subsidies for noise insulation can be given to bedrooms, living rooms and kitchens with a dining table. An indoor noise reduction of at least 5 dB must be obtained and the resulting indoor noise level must not exceed 30 dB. The Road Directorate does not carry out work on private properties. Instead the Road Directorate contacts the owners of the impacted dwellings and offers to pay them for noise insulation. If the owners accept the offer the procedure is the following [28]:

- An acoustical consultant inspects the building and describes what kind of noise insulation has to be carried out.
- The owner gets a price for the work from a private contractor.
- The Road Directorate has to accept the price.
- The owner orders the contractor to carry out the work.

ITEM 11.1.

- An acoustical consultant inspects and approves the work carried out.
- The owner pays the contractor.
- The owner sends the invoice to the Road Directorate for reimbursement.

The Road Directorate does not accept projects that cost more than 96,600 DKK including VAT (€ 13,999 or USD 17,600) per dwelling for reimbursement (price level 2004). The reimbursement depends on the actual noise level as can be seen in Table 6.1. For noise levels over 70 dB ($L_{Aeq24,h}$) the percentage is 90. The owner of the dwelling does not have to pay income tax on the money received from the Road Directorate for noise insulation.

Table 6.1. Reimbursement of costs of façade insulation against noise from the Road Directorate in approved projects [28].

Noise zone ($L_{Aeq24,h}$)	Noise level	Reimbursement percentage
Zone 1	>70 dB	90 %
Zone 2	65 – 70 dB	75 %
Zone 3	60 – 65 dB	50 %



Figure 6.2. Façade insulation against noise has been carried out at dwellings along the Danish highway network and the Road Directorate has reimbursed parts of the costs.

ITEM 11.1.



Figure 6.3. Elevated highway through a densely built up urban area in Frederiksberg/Copenhagen with five to six storey apartment buildings. Transparent noise barriers have been used in combination with façade insulation.

6.2 Noise action plan

In spring 2009, the Danish Road Directorate published a proposal for a new noise action plan for the existing state road network [1]. The purpose of the plan is to rank/rate initiatives that are planned to reduce road traffic noise along the state road network, where the noise is considered unacceptable. Another purpose to rank/rate noise initiatives in relation to planned maintenance of the road network.

New noise mapping using the (new) L_{DEN} indicator has been performed along 950 km (694 miles) of the 3,800 km (2,375 miles) state road network where the traffic is higher than 16,000. A total of 58,277 dwellings are exposed to more than the guideline of 58 dB (see Table 6.2). Of these, nearly 4,400 are heavily exposed to noise higher than 68 dB.

Table 6.2. Number of dwellings exposed to road noise (L_{DEN}) along state roads with more than 16000 vehicles daily [1] at a height of 1.5 m (5 feet).

	58 – 63 dB	63 - 68 dB	68 – 73 dB	> 73 dB	Total
Number of dwellings	39,216	14,660	2,984	1,417	58,277

Noise maps have been produced for all the municipalities with state roads passing through with more than 16,000 vehicles daily. Figure 6.4 shows an example of one of these noise maps for the municipality of Solrød.

ITEM 11.1.

The noise mapping statistics for Solrød can be seen in Table 6.3. 1,388 dwellings are exposed to more than 58 dB and 7 dwellings are exposed to over 68 dB. The sky blue dots on the noise map represent highly exposed noise areas with more than five dwellings where at least one dwelling is exposed to more than 68 dB. There are three such areas along the highway through Solrød.

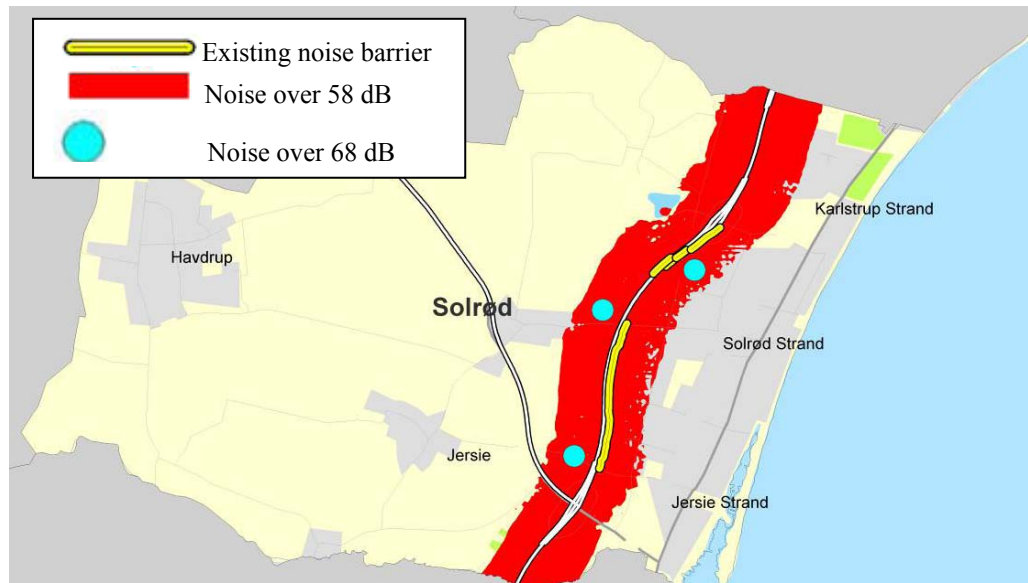


Figure 6.4. Noise map of the state highway through the municipality of Solrød [1].

Table 6.3. Statistics for the noise map of the state highway through the municipality of Solrød [1].

	58 – 63 dB	63 – 68 dB	68 – 73 dB	> 73 dB	Total
Number of dwellings	898	483	7	0	1,388

The five year goal of the noise action plan is to reduce the noise annoyance for as many dwellings as possible along the highway sections with the highest noise levels.

In the “Green Transport Policy” from the Danish government in 2009, a budget of 400 mill. DKK (€ 54 mill. or USD 72.7 mill.) has been allocated for noise abatement in the period from 2009 to 2014. The actual resources for noise abatement will be set aside in the yearly national budgets. The first priority is to focus on dwellings exposed to more than 68 dB and to get noise reduction at as many dwellings as possible for the invested money. The second priority is to use noise barriers at road sections where the most cost effective solutions can be reached. The third priority is to use façade insulation along sections where it is not physically possible to use noise barriers and where the solution is cost effective.

In relation to the ongoing maintenance of roads, another goal of the noise action plan [29] is that the Danish Road Directorate will use noise reducing pavements wherever pavements need to be renewed.

ITEM 11.1.

This goal will be applied at road sections where the noise exposure is over the 58 dB guideline and the road passes through large residential areas.

6.3 System for tendering noise reducing pavements

In order to facilitate the use of noise reducing pavements, a system for tendering such pavements has been developed in Denmark. In 2006, Danish road authorities in conjunction with pavement industry and consultants worked out a system for the specification and documentation of noise reducing asphalt pavement [30], the SRS-system, SRS being the acronym for the Danish wording of Noise Reducing Surfacing. The system is based on the Close Proximity Method (CPX) [31] similar to the On Board Sound Intensity (OBSI) method [32] commonly used in California and USA for noise measurements. In order to ensure reliability and transparency, it allows various independent providers of CPX measurements to offer their service as long as they participate in an annual field calibration of equipment.



Figure 6.5. The CPX-trailer "deciBella" operated by the Danish Road Directorate/Danish Road Institute.

The system encompasses:

- A guide to the use of asphalt surfacing in traffic noise abatement.
- A system for the documentation and declaration in classes of the noise reduction of the asphalt surfacing.
- Three classes A, B & C, where class A surfacings exhibit the highest noise reducing effect and class B & C exhibit lower noise reducing effects as compared to regular dense graded asphalt surfacings at eight years of age.
- Reference values of the noise emission as determined by the CPX method.
- A description of the CPX method including the definition of method variables and requirements on supplementary calibration of the measuring device.
- A paradigm for the contracting and preparation of tender documents.

ITEM 11.1.

This is the first Danish attempt to provide a process for contracting noise reducing asphalt surfacings. It has limitations and several subjects need addressing. In particular, there is a need for better knowledge on the accuracy of CPX measurement, and for the development of appropriate acceptance criteria for contracting. The intention is for the classification system to certify the noise reduction ability of road surfacings including new products as well as to improve the ability of the local road administrations (which typically lack expertise in noise considerations) to purchase proven solutions fit for use.

A contractor who wants to declare a SRS (Noise Reducing Surface) must work out a declaration form. In this form the contractor declares the actual noise class and presents the documentation achieved during CPX measurements on a trial section. The contractor must build a test section of at least 100 m length. The CPX-trailer must run over the trial section at the appropriate reference speed while recording the noise levels with its two standard reference tires.

The system to declare the noise reducing ability enables the contractor to produce documentation of the noise reduction of a specific SRS by comparing measured values with a national reference value. The reduction in noise emission (compared to the reference) is used by the contractor in the declaration of the SRS in a specific noise class. The first generation system describes three noise classes – A, B, and C.

The reference values were derived as pass-by noise levels [33] calculated for reference conditions using the Danish noise emission data of the Nordic prediction method for road traffic noise, Nord2000 [26]. Using data between vehicle pass-by noise levels and CPX noise levels, the Nord2000 pass-by noise levels were transformed to their corresponding CPX_{DK} values, which are used in the first generation system.

When declaring the noise reduction of an asphalt surfacing (by comparison to the reference used in Denmark), one of the following noise classes A, B, or C should be used.

Table 6.4. Noise classes in the Danish “SRS” (Noise Reducing Surface) system for noise labeling of asphalt pavements [30].

Noise class	Description	Noise reduction in dB
A	Very good noise reduction	$x \geq 7.0$
B	Good noise reduction	$5.0 \leq x < 7.0$
C	Noise reduction	$3.0 \leq x < 5.0$

The Danish SRS-system is a voluntary road standard for contracting of noise reducing pavements. In the contract for a specific job, the voluntary standards become legally binding. However, at present the system is in an experimental phase with no legal ramifications if the pavement fails to fulfill the noise performance requirements.

ITEM 11.1.



Figure 6.6. When the pavement on an existing highway has to be replaced, the road administration might consider using a new noise reducing pavement type. Here noise reducing two-layer porous asphalt is applied on a highway in a densely built up area in the municipality of Copenhagen.

6.4 Other measures of noise abatement

The following represents different kind of measures of noise abatement that can be applied along existing highways and other main roads.



Figure 6.7. Earth embankment with a path on the top designed to fit into the urban landscape along a highway. Earth embankments can be made of surplus soil from road or housing construction projects in the region where a plan for the earth embankment is made and over a period of many years, dirt is delivered to the site before the embankment is finished. It is important to have a plan for the embankment in order to get a good final appearance in the visual environment.

ITEM 11.1.

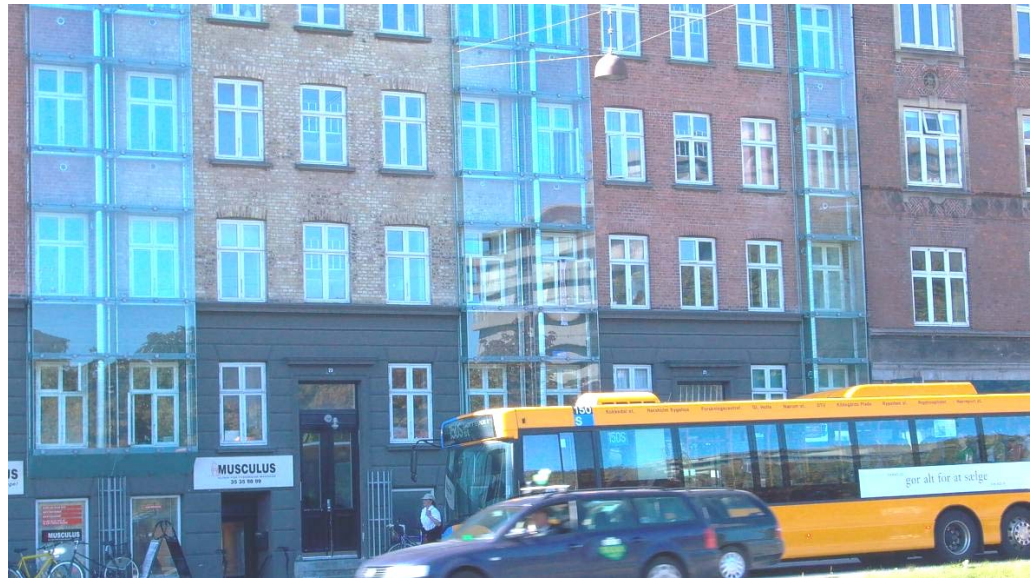


Figure 6.8. Glass covering has been mounted as noise insulation for bedrooms and living rooms at the façade of a multi-storey apartment building along a highway in Copenhagen, Denmark. Cleaner air from the backside of the building is used for ventilation between the glass covering and the existing windows. The noise abatement was financed as a part of an overall renewal of the building.



Figure 6.9. Noise reducing window constructed as a "noise shutter" that makes it possible to open the window. Placed in front of bedrooms and living rooms facing the highway (photo Allan Jensen, Rambøll).

ITEM 11.1.



Figure 6.10. Close up of "noise shutter" window where the extra noise insulating glass layer can be pulled to the right side in order to be able to open the "original window" (photo Allan Jensen, Rambøll).



Figure 6.11. Speed monitoring is normally used as a measure to improve traffic safety. If it has an effect on reducing the actual speed it can also have a noise reducing effect [10].

ITEM 11.1.



Figure 6.12. Reducing the speed where a highway passes noise sensitive areas could reduce the noise. A solution where the reduced speed limit is only effective in the evening and night period could be considered in order to reduce noise annoyance when people are sleeping. This measure is only effective at reducing noise only if the speed is actually reduced.

Another innovative idea that has been considered in Switzerland [29] is to build a concrete roof over the highway where it passes through noise sensitive and densely built-up urban areas. Then the “land” developed on top of the covered highway is sold as construction sites for urban development like dwellings and offices. The revenue from the ‘new’ land sales might finance or partly finance the noise abatement project.

7. New housing along exiting highways

In the mid 1980's, noise was integrated in municipal land use planning in Denmark. In the planning process of new residential areas a land use plan has to be developed and approved by the local municipality. According to guidance from the Danish Environmental Protection Agency, noise has to be taken into consideration in land use planning and a guideline of noise at dwellings of 55 dB ($L_{Aeq,24h}$) and the recent introduction of L_{DEN} 58 dB has to be respected [23]. All urban land development and construction of new housing has followed these noise guidelines for more than 25 years. The noise abatement measures have been enforced by the municipalities and normally been paid for by the developer or contractor building new dwellings.



Figure 7.1. Earth embankment constructed at the same time as a new housing district to reduce the noise from an existing road at the houses and the gardens at Kvistgård, Denmark.

The measures that normally have been used to fulfil the noise criteria are the following:

- Long distance between roads and new buildings.
- Construction of noise barriers in some cases as an integrated part of the building design (see Figure 7.3 and 7.5).
- Earth embankments that might be constructed of surplus material from the construction site (see Figure 7.1).
- Using secondary buildings like garages, carports, bicycle sheds, laundry buildings etc as parts of noise barriers facing the road (see Figure 7.2).

ITEM 11.1.

- In built-up urban areas, it is sometimes allowed to use the building itself as a noise barrier in such a way that the building design has both a noisy and a silent side. In such cases, noise insulation has to be applied to provide an indoor noise level not to exceed 30 dB. The planning solution of the dwellings shall then be designed so the windows of living rooms and bedrooms faces the quieter side of the building and only "secondary rooms" face the noisy side of the building (see Figure 7.4).



Figure 7.2. A new district of row houses constructed along an existing highway. A common carport facility was constructed as a two storey high noise barrier.



Figure 7.3. New residential apartment building for elderly people where a transparent noise barrier has been integrated in the building design.

ITEM 11.1.



Figure 7.4. New three and four storey apartment buildings constructed close to a highway with high noise levels. At the façade facing the noise, the windows are small and highly noise insulated. The apartments are planned so that secondary rooms like bathrooms, corridors, storage rooms, etc are adjacent to the noisy façade. Bedrooms and living rooms are adjacent to the silent façade.



Figure 7.5. Brick noise barrier constructed as an integrated part of a new apartment building project.

ITEM 11.1.



8. References

- [1] Sauer, Christian; Fryd, Jakob; Nøhr Michelsen, Lene. Noise action plan 2008-2013. Action plan for larger state roads. (Støjhandlingsplan 2008-2013. Handlingsplan for store statslige veje (in Danish)). Danish Road Directorate. March 2009.
- [2] Bendtsen, Hans. Noise Barrier Design. Danish and some European examples. Danish Road Directorate/Danish Road Institute. Report 174, 2009. See: www.roadinstitute.dk.
- [3] Bendtsen, Hans et. al. Knowledge Sharing on Noise Management and Abatement. Report from CEDR, 2009. See: www.cedr.fr/.
- [4] Bendtsen, Hans; Kragh, Jørgen; Nielsen Erik. Use of Noise Reducing Pavements - European Experience. Danish Road Directorate/Danish Road Institute. Technical note 69, 2008. See: www.roadinstitute.dk.
- [5] Conference of European Directors of Roads (CEDR). See: www.cedr.fr/.
- [6] Proposal of a strategy to reduce road noise traffic (Forslag til strategi for begrænsning af vejtrafikstøj (in Danish)). Road Noise Group: Danish Environmental Protection Agency, Ministry of Finance, Ministry of Transport, Ministry of the Interior and Health, Ministry of Justice, Ministry of Economic and Business Affairs, November 2003. See: www.mst.dk.
- [7] Bendtsen, Hans; Michelsen, Lene Nøhr; Kristensen, Brian. New ideas for organising and financing urban noise abatement. Proceedings Forum Acusticum, Budapest 2005.
- [8] Technical Noise Supplement (TeNS). A Technical Supplement To The Traffic Noise Analysis Protocol. California Department of Transportation. Environmental Program. Environmental Engineering – Noise, Air Quality, and Hazardous Waste Management Office. October 1998.
- [9] Traffic Noise Analysis Protocol. California Department of Transportation. Division of Environmental Analysis. August 2006.
- [10] Bendtsen, Hans; Ellebjerg, Lars; Andersen, Bent. New methods for noise abatement in municipalities – a catalogue of ideas (Nye veje til støjbekæmpelse i byer - et idékatalog (in Danish)). Danish Road Directorate, Report 295, 2004. See: www.vd.dk.
- [11] Ellebjerg, Lars. Cost-benefit analysis on noise-reducing pavements. Danish Road Directorate/Danish Road Institute. Report 146, 2005. See: www.roadinstitute.dk.
- [12] Guide to preparing socio-economic assessment of consequences (Vejledning i udarbejdelse af samfundsøkonomiske konsekvensvurderinger (in Danish)), Danish Ministry of Finance, 1999. See: www.fm.dk.

ITEM 11.1.

- [13] Manual for socio-economic analysis – applied method and practice in the field of transport (Manual for samfundsøkonomisk analyse – anvendt metode og praksis på transportområdet (in Danish)), Danish Ministry of Transport, June 2003. See: www.trm.dk.
- [14] Considering noise when planning new roads (Støjensyn ved nye vejanlæg (in Danish)), Danish Road Directorate, 1989. See: www.vejregler.dk.
- [15] Catalogue of key values – for use in socio-economic analyses in transportation, (Nøgletalskatalog – til brug for samfundsøkonomiske analyser på transportområdet (in Danish)), 2nd version, Danish Ministry of Transport, 2004. See: www.trm.dk.
- [16] Damgaard, C. What does noise cost? – Valuation of road traffic noise by use of the house price method (Hvad koster støj? – værdisætning af vejstøj ved brug af husprismetoden (in Danish, English summary)), Environmental project no. 795, Danish Environmental Protection Agency, 2003. See: www.mst.dk.
- [17] Ohm, A., Lund, S.P., Poulsen, P.B. and Jakobsen S. Strategy for limiting road traffic noise – Report 2. Noise, annoyance and health (Strategi for begrænsning af vejtrafikstøj – Delrapport 2. Støjgener og sundhed (in Danish)), Work report no. 53, Danish Environmental Protection Agency, 2003. See: www.mst.dk.
- [18] Nielsen, Carsten B. Noise reducing pavements on the Motorring 3. Technical and socio-economic analysis (Støjdæpende vejbelægninger på Motorring 3. Teknisk og samfundsøkonomisk analyse (in Danish)). External note no. 19, Danish Road Directorate/Danish Road Institute, 2004. www.vd.dk.
- [19] Enlargement of highway M3. EIA report – Environmental assesment (Udbygning af Motorring 3. VVM-redegørelse – Miljøvurdering (in Danish)). Danish Road Directorate. Report 266, 2002. www.vd.dk.
- [20] Enlargement of highway M3. EIA report – Noise and vibrations (Udbygning af Motorring 3. VVM-redegørelse – Støj og vibrationer (in Danish)). Danish Road Directorate. Report 264, 2002. www.vd.dk.
- [21] Route 18: Highway Riis-Ølholm-Vejle. EIA-statement - Environmental document (Rute 18: Motorvej Riis-Ølholm-Vejle. VVM-redegørelse - Miljøvurdering (in Danish)). Danish Road Directorate. Report 297, 2005. www.vd.dk.
- [22] Directive 2002/49/EC of 25 June 2002 of the European parliament and of the council on the assessment and management of environmental noise, L 189/12 Official. Journal of the European Communities 18.7.2002.
- [23] Noise from road traffic (Støj fra veje (in Danish)). Guideline from the Environmental Protection Agency no. 4, 2007. www.mst.dk.
- [24] Motorring 3 – a modern urban highway (Motorring 3 – en moderne bymotorvej (in Danish)). Danish Road Directorate. Report, 2007. www.vd.dk.
- [25] Kragh, Jørgen. Nord2000 for predicting road traffic Noise. Proceedings Euronoise 2006 Tampere, Finland.
- [26] Kragh, Jørgen et. al. User's Guide Nord2000 Road. Delta, SINTEF, SP and VTT.

ITEM 11.1.

- [27] The Nord2000 PC version can be downloaded from:
www.sintef.no/Projectweb/N2kR/.
- [28] Noise insulation of dwellings against road traffic noise. Project guide for the administration of the Road Directorates system. (Støjsisolering af boliger med trafikstøj. Projektvejledning for administration af vejdirektoratets tilskudsordning (in Danish)). Danish Road Directorate, 2004. www.vd.dk.
- [29] Bendtsen, Hans; Ellebjerg, Lars. Noise Reduction Efforts in Germany and Switzerland – A Report of a Study Tour (Støjbekæmpelse i Tyskland og Schweiz - Rapport fra en studietur (in Danish)). Note 73, 2000, Road Directorate.
- [30] Kragh, Jørgen. Noise classification- asphalt pavement, Danish Road Institute/Road Directorate, Technical Note 61, 2007. www.roadinstitute.dk.
- [31] ISO/CD 11819-2. (Acoustics) – Method for Measuring the Influence of Road Surfaces on Traffic Noise – Part 2: “The close proximity method”, 2000-12-03.
- [32] Further Development of the Sound Intensity Method of Measuring Tire Noise Performance of In-Situ Pavements. Illingworth & Rodkin, Inc. Report prepared for the California Department of Transportation January 4, 2006. See: http://www.i80.dot.ca.gov/hq/env/noise/pub/2_Probe_SI_Report_04Jan06.pdf.
- [33] ISO 11819-1: 1997. "Acoustics – Measurement of the influence of road surfaces on traffic noise – Part 1: Statistical Pass-by method." 1997.
- [34] Bendtsen, Hans; Ellebjerg, Lars; Mikkelsen, Bo. Traffic Noise Annoyance. A Survey in Aarhus, Odense and Randers. Report 5, 2002. Danish Transport Research Institute, www.dtf.dk.

ITEM 11.1.

ITEM 11.1.

EXHIBIT 12

ITEM 11.1.



[Am J Ind Med](#). Author manuscript; available in PMC 2019 Dec 6.

PMCID: PMC6897488

Published in final edited form as:

NIHMSID: NIHMS1045084

[Am J Ind Med](#). 2018 Jun; 61(6): 477–491.

PMID: [29537072](#)

Published online 2018 Mar 14. doi: [10.1002/ajim.22833](#)

Cardiovascular conditions, hearing difficulty, and occupational noise exposure within US industries and occupations

[Ellen Kerns](#), MPH, CPH, COHC,^{1,2} [Elizabeth A. Masterson](#), PhD, CPH, COHC,² [Christa L. Themann](#), MA, CCC-A,² and [Geoffrey M. Calvert](#), MD, MPH²

¹Association of Schools and Programs in Public Health (ASPPH)

²National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention, Cincinnati, Ohio

Correspondence: Elizabeth A. Masterson, Division of Surveillance, Hazard Evaluations and Field Studies, National Institute for Occupational Safety and Health, 1090 Tusculum Avenue, MS-R17, Cincinnati, OH 45226., emasterson@cdc.gov

AUTHORS' CONTRIBUTIONS

EK participated in the design of the work; the acquisition, analysis, and interpretation of the data; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work. EM participated in the design of the work; the interpretation of data for the work; critically revising the work for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work. CT participated in the design of the work; the interpretation of data for the work; critically revising the work for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work. GC participated in the design of the work; the interpretation of data for the work; critically revising the work for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work.

[Copyright notice](#)

[Publisher's Disclaimer](#)

Abstract

Background:

The purpose of this study was to estimate the prevalence of occupational noise exposure, hearing difficulty and cardiovascular conditions within US industries and occupations, and to examine any associations of these outcomes with occupational noise exposure.

Methods:

National Health Interview Survey data from 2014 were examined. Weighted prevalence and adjusted prevalence ratios of self-reported hearing difficulty, hypertension, elevated cholesterol, and coronary heart disease or stroke were estimated by level of occupational noise exposure, industry, and

ITEM 11.1.

occupation.

Results:

Twenty-five percent of current workers had a history of occupational noise exposure (14% exposed in the last year), 12% had hearing difficulty, 24% had hypertension, 28% had elevated cholesterol; 58%, 14%, and 9% of these cases can be attributed to occupational noise exposure, respectively.

Conclusions:

Hypertension, elevated cholesterol, and hearing difficulty are more prevalent among noise-exposed workers. Reducing workplace noise levels is critical. Workplace-based health and wellness programs should also be considered.

Keywords: cardiovascular disease, hearing loss, National Health Interview Survey, occupational noise, surveillance

1 |. INTRODUCTION/BACKGROUND

Hazardous noise is one of the most common occupational hazards in the United States with over 22 million workers exposed.¹ Along with hearing difficulty, noise exposure has been linked to many health effects. Particularly concerning is its proposed link to several manifestations of cardiovascular disease, including hypertension (chronically elevated blood pressure), arteriosclerosis (abnormal thickening or hardening of the arterial walls), and ischemic or coronary heart disease (CHD).² The pathway from noise exposure to these manifestations has been theorized to work through both the autonomic nervous system and endocrine system via a stress response that elevates many of the key biological risk factors for cardiovascular disease such as blood pressure and blood lipids (ie, cholesterol).³

The distribution of these conditions among workers have not been well-characterized in nationally representative studies by industry and occupation. A study analyzing Behavioral Risk Factor Surveillance System (BRFSS) data estimated hypertension and elevated cholesterol prevalence in current workers by occupation, but its generalizability may be limited due to being based on data from only 21 states.⁴ Another study estimated the prevalence of CHD or stroke among current US workers by industry using 2010 National Health Interview Survey (NHIS) data, but did not include estimates for those over age 55.⁵ Existing hypertension and hearing difficulty prevalence estimates by industry and occupation are based on 2010⁶ and 2007 NHIS data respectively.⁷ The most recent published estimates of hazardous noise exposure prevalence by industry are based on 1999–2004 National Health and Nutrition Examination Survey (NHANES) data.¹ To our knowledge, there are no studies presenting the distribution of elevated cholesterol by industry, CHD or stroke by occupation, or job-related noise exposure by occupation among US workers. New and updated surveillance information is needed for targeting prevention efforts among workers and assessing progress over time.

It follows that the association between occupational noise exposure and hypertension, elevated cholesterol, CHD or stroke is of interest; especially if reducing noise exposure may also reduce the risk of developing these cardiovascular conditions [the causal relationship between noise and hearing difficulty is already well-established]. Research exploring the association between occupational noise exposure and these cardiovascular conditions has had mixed results. The available literature is consistent in finding a moderate association between occupational noise and hypertension.^{8–10} However, research regarding associations with other manifestations of cardiovascular disease, such as elevated cholesterol and CHD, has been less consistent, with some studies finding no association.^{11,12} Many studies assessing the association between occupational noise and cardiovascular conditions have

ITEM 11.1.

suffered from small sample sizes,¹³ inadequate control of important covariates such as BMI or socioeconomic status,¹⁴ or lack of generalizability due to being conducted in a single occupation or industry.¹⁵ Additionally, most studies were conducted on workers outside of the United States.^{10,12}

Using 2014 NHIS data, the objectives of this study were to: (1) estimate the current prevalence of elevated cholesterol, CHD or stroke, hypertension, hearing difficulty, and occupational noise exposure among US workers by industry and occupation; and (2) examine any associations between occupational noise exposure and hypertension, elevated cholesterol, CHD or stroke. The adjusted risk and the proportion of cases of each outcome attributable to noise exposure, if any, were estimated.

2 |. MATERIALS AND METHODS

2.1 |. Study design and population

This study was conducted using publicly available 2014 NHIS data. The NHIS is a cross-sectional in-person household survey of the non-institutionalized US civilian population conducted by the National Center for Health Statistics (NCHS) to monitor the health of the nation. NHIS survey participants are chosen through a complex, stratified, multi-stage sampling procedure in order to achieve a nationally representative sample.¹⁶ Data are generally collected via a computer-assisted face-to-face interview in the participant's home. The survey year 2014 was chosen as it is the most recent NHIS survey that includes questions regarding occupational noise exposure and hearing difficulty. The 2014 NHIS was approved by the Research Ethics Review Board of the National Center for Health Statistics and the US Office of Management and Budget. All 2014 NHIS participants orally consented prior to participation and the overall adult response rate for that year was 58%.

Our sample included male and female current workers aged 18 or older with valid industry and occupation codes for their most recent main job. Participants were determined to be current workers if they reported working at any time in the 12 months preceding interview. Open-ended responses were obtained from each employed sample adult respondent regarding his/her industry (employer's type of business) and occupation (employee's type of work), for the main job held in the past 12 months. The industry and occupation of each worker's main job were coded based on their verbatim response. These responses were reviewed by US Census Bureau coding specialists who assigned 4-digit industry and occupation codes. The data were coded using 2011 US Census codes based on the 2007 North American Industry Classification System (NAICS) and 2010 Standard Occupational Classification (SOC) system.^{17,18} To allow for sufficient sample size to obtain more reliable estimates, we used less detailed 2-digit industry and occupation (I&O) recodes. The industry recodes include 21 simple categories, and the occupation recodes include 23 simple categories. The 2-digit industry recodes were also sorted into sectors similar to the NIOSH, National Occupational Research Agenda (NORA) sectors.¹⁹ The Management of Companies and Enterprises industry (NAICS 55) was excluded from industry analyses due to insufficient sample size.

2.2 |. NHIS outcome and exposure questions

The outcomes of interest in this study were hearing difficulty, hypertension, elevated cholesterol, and CHD or stroke. Hearing difficulty was assessed based on the question "Is your hearing excellent, good, a little trouble hearing, moderate trouble, a lot of trouble, or are you deaf? [without the use of hearing aids or other assistive devices]" Answers of "a little trouble hearing," "moderate trouble," and "a lot of trouble" were grouped together as "Yes" (has difficulty) and answers of "excellent" or "good hearing" were grouped together as "No" (does not have difficulty). Those who reported excellent hearing in one ear and deafness in the other were excluded from the analysis as this kind of hearing impairment is

ITEM 11.1.

unlikely to be caused by occupational exposures.²⁰ Those who reported being deaf in both ears were also excluded as this is unlikely to have been caused predominately by occupational noise, and because bilateral deafness would prevent the worker from having any potential cardiovascular effects from noise.²¹ Workers who reported having any level of hearing difficulty were asked about the main cause. Workers who reported that their hearing difficulty was: (1) present at birth due to the mother having an infectious disease or a genetic defect; (2) present after birth due to an infectious disease; or (3) from a brain tumor, were excluded from the analysis. These causes are definitive and verifiable, and with the exception of a brain tumor (14 cases), would likely have occurred before encountering any occupational noise.²¹

All of the cardiovascular conditions assessed were defined as “Yes” if the respondent reported “ever having been told by a doctor or other health professional” that they had the condition. CHD was considered present if the subject reported ever being told by a health professional that they had at least one of the following conditions: CHD, angina pectoris, or myocardial infarction.¹² CHD and stroke were examined together as a single outcome due to the small numbers of respondents with these conditions; workers with these conditions usually leave the workforce.⁵ To examine the effect that this loss from the workforce had on the association of noise with these conditions, all analyses regarding CHD or stroke were performed on both the entire study sample and among those under age 56.²² Hypertension and elevated cholesterol were assessed only among those who reported ever having this condition checked. Thirteen percent of workers reported never having their cholesterol levels checked and 2% reported never having their blood pressure checked.

History of occupational noise exposure was assessed using the following two questions asked in order: (1) “Have you ever had a job, or combination of jobs, where you were exposed to very loud sounds or noise for four or more hours a day, several days a week? Very loud means so loud that you must SHOUT in order to be understood by someone standing three feet (arm’s length) away”; and (2) “Have you ever had a job, or combination of jobs, where you were exposed to loud sounds or noise for four or more hours a day, several days a week? Loud means so loud that you must SPEAK IN A RAISED VOICE to be heard.” Only those who answered “No” to the first question were asked the second question. Workers who answered “Yes” to the first question were categorized as having had “Very Loud” exposure; those who answered “Yes” to the second question were categorized as having had “Loud” exposure, and those who answered “No” to both questions were categorized as having had “No Exposure.” When analyzed dichotomously, workers who answered “Yes” to the first or second question were categorized as having “Very Loud or Loud” exposure. Occupational noise exposure within the last 12 months was also assessed using a follow-up question but was not the primary noise outcome.

The covariates of interest in this analysis were age, gender, race/ethnicity, education, BMI, smoking, alcohol use, and diabetes. Age was grouped into seven categories (18–25, 26–35, ... 76+) for comparison with prior studies.⁷ Race and ethnicity were combined and workers reporting Hispanic or Spanish origin were categorized as Hispanic. Workers with American Indian, Alaska Native, race group not releasable, and multiple race were categorized as Other Race/Ethnicity. The highest education level achieved by a living member of the family was used as a proxy for SES. BMI was based on self-reported height and weight and was dichotomized into obese (≥ 30) and not obese (< 30). Smoking was recoded into current, former, and never. Current alcohol use was regrouped into nondrinker, infrequent/light drinker and moderate/heavier drinker. Finally, diabetes was based on the participant reporting ever having been told by a doctor or other health professional that they had diabetes.

2.3 |. Statistical analysis

Weighted prevalence estimates for each outcome by level of occupational noise exposure, industry,

ITEM 11.1.

occupation, and each covariate were estimated using the SAS surveyfreq procedure. Prevalence estimates with relative standard error (RSE) >30% and <50% are noted and estimates with RSE >50% are not reported. Weighted adjusted prevalence ratios (PRs) with 95% confidence intervals for each outcome by level of occupational noise exposure and each covariate were estimated utilizing the SUDAAN procedure rlogist. The SUDAAN rlogist procedure can produce PRs in addition to odds ratios and these can be interpreted as relative risk estimates.²³ The PRs were adjusted for age, gender, race/ethnicity, education, BMI, smoking status, alcohol use, and diabetes. The adjusted PRs were used to generate the fraction of cases of each outcome attributable to each level of occupational noise exposure $[(PR_{\text{adjusted}} - 1)/PR_{\text{adjusted}}]$. Weighted adjusted PRs with 95% confidence intervals for each of the cardiovascular conditions by history of noise exposure in combination with the presence or absence of hearing difficulty were also estimated.

The reference industry assigned for the industry analyses of hearing difficulty was Finance and Insurance, as it had the lowest prevalence of noise exposure in our study sample, was designated as the reference industry in a previous analysis of NHIS data, and has been shown to have a lower risk of hearing loss.²⁴ Business and Financial Operations was assigned as the reference occupation for the occupation analyses of hearing difficulty, as it had one of the lower prevalences of noise exposure in our study and allows for better consistency of comparison. The literature is inconsistent as to which industry or occupation has the lowest risk for the cardiovascular conditions, so the reference was designated as all other industries or occupations combined. The reference group for noise exposure was “No exposure.” Reference groups for each covariate are designated in [Table 1](#). All analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC) and SUDAAN version 11 (RTI International, Research Triangle Park, NC) statistical software.

ITEM 11.1.

TABLE 1

Hearing difficulty and cardiovascular conditions by level of occupational noise exposure and covariates in current US workers, 2014 ($N = 22,906$)^a

[Open in a separate window](#)

^aData are from the National Health Interview Survey, 2014 adult sample.

^bCHD, coronary heart disease, defined as self-reported angina pectoris, myocardial infarction, and/or coronary

ITEM 11.1.

heart disease.

^cPR, prevalence ratio (adjusted for gender, age, race/ethnicity, education, BMI, smoking status, alcohol use, and diabetes).

^d95% confidence interval.

^eSelf-reported noise exposure (at least 4 hr a day, several days a week) at any time period in a current worker's job history.

^fThe weighted prevalence of noise among US workers is 25% (21% very loud; 4% loud).

^gThese estimates have a relative standard error $\geq 30\%$ and $\leq 50\%$ and should be used with caution as they do not meet the standards of reliability/precision.

3 |. RESULTS

Of the 22 906 current workers, 49% were male, 62% were white and 55% had a college degree ([Table 1](#)). The prevalence of each condition among workers was: hearing difficulty 12%, hypertension 24%, elevated cholesterol 28%, and CHD or stroke 4%. Twenty-five percent of workers self-reported ever having been exposed to occupational noise with 14% exposed in the last 12 months (data not shown). For all the conditions, risk increased with age and was significantly higher among males, former smokers, and obese and diabetic workers. Alcohol use showed more of a mixed association depending on the outcome, with: (1) no significant difference between both infrequent/light and moderate/heavier drinkers and non-drinkers for hearing difficulty or hypertension; (2) a significantly higher risk among moderate/heavy drinkers for elevated cholesterol; and (3) a significantly lower risk among all drinkers for CHD or stroke compared to nondrinkers when all age-groups were included.

3.1 |. Prevalence and risk within industries

The industries with the highest prevalence of self-reported occupational noise exposure were Mining (61%), Construction (51%), Manufacturing (47%), Utilities (43%), and Transportation and Warehousing (40%) ([Table 2](#)). Workers in Mining, Utilities, and Manufacturing had significantly higher risks of hearing difficulty than workers in Finance and Insurance, with 150%, 90%, and 72% higher risks, respectively. Only a few industries had significantly higher risks for the cardiovascular conditions than all other occupations combined. Healthcare and Social Assistance had a significantly higher risk of hypertension (PR:1.10, CI:1.01–2.10) and Public Administration had a significantly higher risk of elevated cholesterol (PR:1.10, CI:1.01–2.10). Arts, Entertainment, and Recreation had a significantly higher risk of CHD or stroke (PR:1.70, CI:1.02–2.83) despite having a significantly lower risk of both hypertension and elevated cholesterol.

ITEM 11.1.

TABLE 2

Prevalence of occupational noise exposure, hearing difficulty, and cardiovascular conditions by industry and sector for current US workers in 2014 ($N = 22\,906$)^a

Bold values signify <0.05 .

^aData are from the National Health Interview Survey, 2014 adult sample.

^bCHD, coronary heart disease, defined as self-reported angina pectoris, myocardial infarction, and/or coronary

ITEM 11.1.

heart disease.

^cNAICS, North American Industry Classification System (2007).

^dPR, prevalence ratio (adjusted for gender, age, race/ethnicity, education, BMI, smoking status, alcohol use, and diabetes). Each industry sector was compared to all other industries combined.

^eCI, confidence interval.

^fThese estimates have a relative standard error $\geq 30\%$ and $\leq 50\%$ and should be used with caution as they do not meet the standards of reliability/precision.

^gEstimates not shown as they have a relative standard error $\geq 50\%$ and do not meet the standards of reliability/precision.

3.2 |. Prevalence and risk within occupations

The occupations with the highest prevalence of self-reported occupational noise exposure were Production (55%), Construction and Extraction (54%), Installation, Maintenance and Repair (54%), Transportation and Material Moving (44%), and Protective Service (36%) ([Table 3](#)). About half of the occupations had significantly higher risks of hearing difficulty when compared with Business and Financial Operations. Installation, Maintenance, and Repair had the highest risk for hearing difficulty (PR: 2.03 CI: 1.36–3.03), followed by Production (PR: 1.82, CI: 1.42–2.34). Healthcare Support had the highest risk of hypertension (PR: 1.27, CI: 1.02–1.58), followed by Production (PR: 1.15, CI: 1.03–1.29). Installation, Maintenance, and Repair had an increased risk of elevated cholesterol (PR: 1.21, CI: 1.02–1.44) and Architecture and Engineering had an elevated risk of CHD or stroke when assessed among just those under age 56 (PR: 2.12, CI: 1.05–4.29).

ITEM 11.1.

TABLE 3

Prevalence of occupational noise exposure, hearing difficulty, and cardiovascular conditions by occupation for current US workers in 2014 ($N = 22\,906$)^a

			Occupational noise exposure	Hearing difficulty			Hypertension		Elevated cholesterol		CHD ^b or stroke		CHD or stroke (<56 years old)	
	Unweighted	Weighted	Weighted	Weighted	PR ^d		Weighted	PR	Weighted	PR	Weighted	PR	Weighted	PR
Current occupation (SOC) ^c	n	N	Prevalence (%)	Prevalence (%)	(95%CI) ^e		Prevalence (%)	(95%CI)	Prevalence (%)	(95%CI)	Prevalence (%)	(95%CI)	Prevalence (%)	(95%CI)
All occupations	22 906	156 223 935	25.41	11.56			24.03		27.67		3.70		2.03	
Food preparation and serving related	1313	9 371 728	22.63	7.67	1.50		15.77	0.98	18.36	0.98	2.21	1.05	1.29	0.80
					(1.07, 2.10)			(0.86, 1.13)		(0.83, 1.17)		(0.71, 1.54)		(0.43, 1.49)
Construction and extraction	1196	8 096 074	54.43	14.62	1.48		26.80	1.05	27.94	0.91	2.76	0.55	1.54	0.50
					(1.08, 2.03)			(0.91, 1.20)		(0.77, 1.06)		(0.36, 0.85)		(0.28, 0.90)
Healthcare practitioners and technical	1280	8 929 134	12.98	8.20	1.07		22.49	1.03	25.59	0.98	2.79	1.03	1.60	1.14
					(0.76, 1.51)			(0.91, 1.17)		(0.87, 1.11)		(0.64, 1.65)		(0.63, 2.09)
Education, training, and library	1506	10 106 058	10.19	9.53	1.15		22.98	1.02	27.65	1.03	2.89	1.02	0.54 ^f	0.37
					(0.84, 1.58)			(0.87, 1.19)		(0.90, 1.18)		(0.70, 1.48)		(0.18, 0.75)
Office and administrative support	2926	19 215 719	16.12	11.45	1.39		24.28	0.98	27.22	0.99	2.99	0.82	1.68	0.78
					(1.06, 1.83)			(0.90, 1.07)		(0.91, 1.08)		(0.63, 1.08)		(0.52, 1.18)
Computer and mathematical	677	5 026 940	18.22	8.16	1.09		21.41	1.03	27.94	1.08	3.17	1.26	1.60 ^f	1.02
					(0.73, 1.61)			(0.87, 1.21)		(0.91, 1.27)		(0.72, 2.21)		(0.39, 2.67)
Personal care and service	903	6 096 238	18.95	8.33	1.31		22.76	1.14	23.32	1.03	3.37	1.21	2.22 ^f	1.44
					(0.92, 1.86)			(0.98, 1.33)		(0.87, 1.23)		(0.79, 1.85)		(0.77, 2.67)
Sales and related	2205	16 015 087	15.83	10.08	1.22		20.12	0.88	27.68	1.04	3.85	1.14	2.40	1.34
					(0.91, 1.64)			(0.79, 0.97)		(0.93, 1.15)		(0.86, 1.51)		(0.86, 2.11)
Transportation and material moving	1401	9 117 041	43.90	13.64	1.49		27.73	0.93	29.07	0.95	3.92	0.75	2.48	0.81
					(1.12, 1.98)			(0.82, 1.05)		(0.83, 1.10)		(0.53, 1.06)		(0.43, 1.50)
Business and financial operations	1074	7 542 697	14.45	8.95	Ref		25.58	1.10	26.70	0.94	4.04	1.18	0.98 ^f	0.55
								(0.97, 1.25)		(0.84, 1.04)		(0.82, 1.70)		(0.28, 1.08)
Management	2108	14 888 885	24.12	13.00	1.21		25.68	0.96	31.38	1.01	4.12	0.92	2.38	1.13
					(0.92, 1.60)			(0.88, 1.06)		(0.91, 1.11)		(0.67, 1.25)		(0.72, 1.76)
Healthcare support	599	3 415 132	12.66	8.68	1.49		27.97	1.27	19.54	0.94	4.17	1.66	2.85 ^f	1.58
					(1.04, 2.13)			(1.02, 1.58)		(0.76, 1.16)		(1.00, 2.75)		(0.77, 3.26)
Production	1361	8 968 010	54.59	17.42	1.82		32.24	1.15	32.59	1.05	4.64	0.99	3.51	1.17
					(1.42, 2.34)			(1.03, 1.29)		(0.93, 1.19)		(0.71, 1.40)		(0.69, 2.00)
Architecture and engineering	403	3 323 538	35.64	14.59	1.50		23.20	1.00	29.56	0.96	5.39	1.47	3.86 ^f	2.12
					(1.05, 2.15)			(0.78, 1.28)		(0.78, 1.18)		(0.86, 2.51)		(1.05, 4.29)
Building and grounds cleaning and maintenance	1039	6 342 484	33.98	12.76	1.52		26.61	0.93	26.22	0.88	5.71	1.20	3.22	1.18
					(1.08, 2.13)			(0.81, 1.08)		(0.75, 1.03)		(0.83, 1.73)		(0.70, 1.97)
Protective service	468	3 221 155	36.20	16.09	1.72		28.76	1.14	32.18	1.15	6.32	1.44	2.30 ^f	1.05
					(1.23, 2.41)			(0.97, 1.33)		(0.96, 1.36)		(0.93, 2.22)		(0.45, 2.43)
Community and social services	427	2 384 589	14.50	11.56	1.29		18.93	0.73	30.39	1.08	3.14 ^f	0.74	■	0.24
					(0.88, 1.89)			(0.58, 0.93)		(0.90, 1.30)		(0.36, 1.49)		(0.05, 1.16)
Arts, design, entertainment, sports, and media	496	3 241 079	27.72	7.90	0.85		18.59	0.83	22.09	0.79	3.39 ^f	0.91	1.05 ^f	0.71
					(0.56, 1.30)			(0.67, 1.02)		(0.61, 1.02)		(0.46, 1.79)		(0.29, 1.73)
Farming, fishing, and forestry	249	1 451 819	34.62	7.67	1.06		20.89	0.87	24.79	0.81	5.26 ^f	1.18	4.56 ^f	1.47
					(0.60, 1.89)			(0.60, 1.25)		(0.54, 1.21)		(0.57, 2.41)		(0.67, 3.21)
Installation, maintenance, and repair	735	5 524 405	54.08	21.93	2.03		29.92	1.15	35.26	1.21	5.94 ^f	1.22	4.36 ^f	1.58
					(1.36, 3.03)			(0.93, 1.42)		(1.02, 1.44)		(0.64, 2.36)		(0.63, 3.98)
Legal	269	1 786 810	7.07	9.77	1.12		18.77	0.84	26.73	0.93	■	0.76	■	1.02
					(0.63, 1.99)			(0.63, 1.11)		(0.72, 1.19)		(0.30, 1.94)		(0.25, 4.14)
Life, physical, and social science	271	1 831 878	18.33	7.49 ^f	0.88		16.23	0.77	30.99	1.11	■	0.61	■	0.17
					(0.45, 1.70)			(0.56, 1.07)		(0.87, 1.42)		(0.24, 1.55)		(0.03, 1.19)

Bold values signify <0.05.

^aData are from the National Health Interview Survey, 2014 adult sample.

^bCHD, coronary heart disease, defined as self-reported angina pectoris, myocardial infarction, and/or coronary

ITEM 11.1.

heart disease.

^cStandard occupational classification system (2010).

^dPR, prevalence ratio (adjusted for gender, age, race/ethnicity, education, BMI, smoking status, alcohol use, and diabetes). Each occupation sector was compared to all other industries combined.

^eCI, confidence interval.

^fThese estimates have a relative standard error $\geq 30\%$ and $\leq 50\%$ and should be used with caution as they do not meet the standards of reliability/precision.

^gEstimates not shown as they have a relative standard error $\geq 50\%$ and do not meet the standards of reliability/precision.

3.3 |. Association between occupational noise exposure and hearing difficulty

There was a clear dose response relationship between self-reported level of occupational noise exposure and hearing difficulty, and these results are presented in the tables/figures. However, since workers can be exposed to both loud and very loud noise throughout their careers and workers who reported very loud noise exposure were not asked about their loud noise exposure, the prevalence of loud noise exposure only includes workers exposed to loud noise alone (ie, not those exposed to both very loud and loud noise). Our results and discussion will mainly focus on any occupational noise exposure (loud or very loud noise exposure).

A history of occupational noise exposure led to a significantly elevated risk of both hypertension (PR: 1.16, CI: 1.09–1.23) and elevated cholesterol (PR: 1.10 CI: 1.01–1.19), but was not significantly associated with CHD or stroke even when the analysis was restricted to those under the age of 56. Based on these data, among US workers, 58% of hearing difficulty cases, 14% of hypertension cases, and 9% of elevated cholesterol cases can be attributed to exposure to occupational noise ([Figure 1](#)). Workers with hearing difficulty, regardless of noise exposure, had a significantly elevated risk of each cardiovascular condition assessed. Workers with a history of noise exposure but no reported hearing difficulty had a significantly elevated risk of hypertension and elevated cholesterol only ([Table 4](#)).

ITEM 11.1.

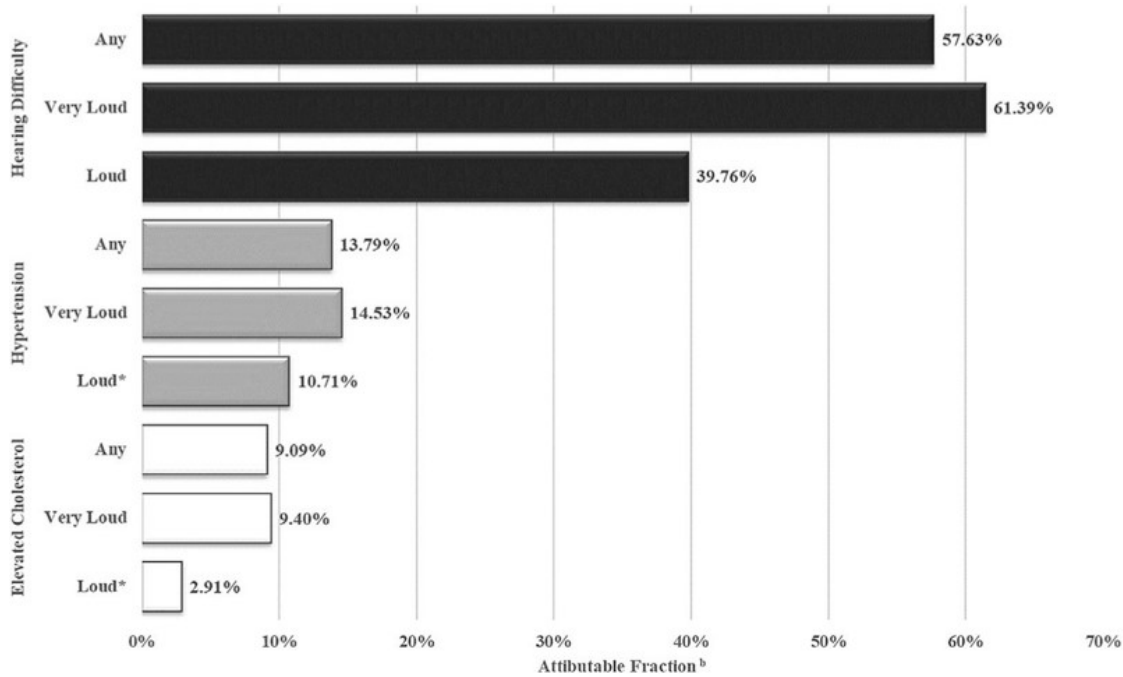


FIGURE 1

Percent of cases of hearing difficulty and cardiovascular outcomes attributable to occupational noise exposure, 2014^a. ^aData are from the National Health Interview Survey, 2014 adult sample. ^bAttributable fractions (in percents) were calculated using prevalence ratios adjusted for gender, age, race/ethnicity, education, BMI, smoking status, alcohol use, and diabetes. *Attributable Fraction is based on a non-significant prevalence ratio

ITEM 11.1.

TABLE 4

Cardiovascular conditions by history of occupational noise exposure and presence of hearing difficulty (HD) in current US workers, 2014 ($N = 22\,906$)^a

HD & noise exposure status	Unweighted		Hypertension		Elevated cholesterol		CHD ^b /stroke		CHD/stroke (<age 56)	
	<i>n</i>	%	PR ^c	(95%CI) ^d	PR	(95%CI)	PR	(95%CI)	PR	(95%CI)
HD and noise exposure	1478	6.31	1.35	(1.21, 1.51)	1.28	(1.09, 1.49)	1.54	(1.16, 2.04)	2.36	(1.47, 3.79)
No HD, but noise exposed	4674	19.96	1.16	(1.07, 1.24)	1.08	(1.00, 1.18)	1.19	(0.92, 1.55)	1.25	(0.85, 1.23)
HD, but no noise exposure	1403	5.99	1.35	(1.21, 1.50)	1.22	(1.10, 1.36)	1.81	(1.29, 2.55)	2.86	(1.41, 5.80)
No HD or noise exposure	15 866	67.74	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref

^aData are from the National Health Interview Survey, 2014 adult sample.

^bCHD, coronary heart disease, defined as self-reported angina pectoris, myocardial infarction, and/or coronary heart disease.

^cPR, prevalence ratio (adjusted for gender, age, race/ethnicity, education, BMI, smoking status, alcohol use, and diabetes).

^d95% confidence interval.

4 |. DISCUSSION

To our knowledge, this is the first study to report the prevalence of elevated cholesterol by industry, CHD or stroke by occupation, and occupational noise exposure by occupation. It is also the first study to generate the fraction of hearing difficulty, hypertension, elevated cholesterol and CHD or stroke attributable to occupational noise exposure. We will first discuss the prevalence of the outcomes among all workers and within industries and occupations, followed by a discussion of the associations with occupational noise exposure.

In this study, hypertension prevalence was similar to that found in an analysis of the 2010 NHIS data (4% higher) and the industries and occupations with the highest prevalences remained nearly the same.⁶ Also similar to Kaur et al,⁶ the Healthcare Support industry and its corresponding occupation, Healthcare and Social Assistance, showed an elevated risk of hypertension compared to all other industries combined and all other occupations combined, respectively. While this industry and occupation did not have a high prevalence of noise exposure in this study and had the lowest noise prevalence among industries in prior research,¹ it is subject to shift work which has been linked to cardiovascular conditions including hypertension.²⁵ Additionally, this elevated prevalence could be influenced by detection bias as workers in this field are more likely to regularly receive blood pressure screening. Production was the only other occupation group with an elevated risk for hypertension. This occupation group had the highest prevalence of noise exposure. Production workers also often work in shifts, leading to increased risk for cardiovascular disease.²⁵

Although the prevalence of elevated cholesterol was recently reported by occupation, those estimates were adjusted for noted demographics and risk factors⁴ and thus are not directly comparable to our study results which are meant to establish the overall prevalence in each occupation. In our study,

ITEM 11.1.

workers in Public Administration had a higher risk of elevated cholesterol compared to all other industries combined. While the noise prevalence was not high, many of these workers are employed in offices with sedentary jobs. Sedentary jobs have been shown to increase one's risk for metabolic syndrome which includes hypertension and elevated cholesterol.^{26,27} Firefighters and police officers also work in this industry, and these occupations often include long segments of inactivity between fires and police actions. Police officers and firefighters also experience a number of physical and psychological stressors, such as noise and trauma, which put them at a higher risk for cardiovascular conditions like elevated cholesterol.^{28,29} The Installation, Maintenance, and Repair occupation group also had a significantly higher risk of elevated cholesterol. This occupation group also had one of the highest prevalences of occupational noise.

The prevalence of CHD or stroke for workers under age 56 (2%) matched a previous study (2%) which also reported prevalence by industry.⁵ In contrast to our industry analysis among all adult workers, when this analysis was restricted to workers under age 56 the distribution among industries and occupations better matched that of occupational noise. This might be explained by the stronger association of CHD or stroke to age than to other risk factors (eg, noise) among older adults,²² and workers transitioning to less physical and correspondingly less noisy jobs as they age.³⁰ This effect of age may also explain why Arts, Entertainment, and Recreation workers had an increased risk for CHD or stroke when assessed among all ages, but not when analysis was restricted to those under age 56.

Associations of studied outcomes with occupational noise exposure varied. Our results confirmed the strong relationship between worker hearing difficulty and occupational noise exposure in that the majority of cases (58%) were attributable to noise. Among the cardiovascular conditions, hypertension appears to be the most strongly linked to noise exposure in our analysis and is the most consistently noise-linked condition in the literature.¹⁰ Our analysis also showed that those exposed to occupational noise had a significantly elevated prevalence of elevated cholesterol. However, this relationship has been less consistently observed in the literature than hypertension. Some studies found no association at all¹¹ and others found an association with only certain types of cholesterol, such as a lower HDL among those with bilateral high frequency hearing loss.³¹

Although our estimates related to the association of occupational noise to CHD or stroke failed to achieve significance, they are consistent in magnitude with the current literature^{10,12} and may have been influenced by the low prevalence of these conditions among current workers and the associated lack of power. While both hypertension and elevated cholesterol were found to be significantly associated with noise exposure among those who did not report hearing difficulty, the prevalence of CHD or stroke was found to be significantly elevated only among workers who had both hearing difficulty and a history of occupational noise exposure. This association was strengthened when the analysis was restricted to those under age 56. This may indicate that noise exposure needs to be of a sufficient duration to cause hearing difficulty before it begins to measurably affect the risk of CHD or stroke. Workers with hearing difficulty and no history of occupational noise also had an elevated risk of CHD or stroke. Workers who reported hearing difficulty but no occupational noise exposure were more likely to report that their hearing loss was due to aging than any other cause (35%; data not shown) and were significantly less likely to report exposure to recreational noise than those reporting both hearing difficulty and occupational noise exposure ($P < 0.0001$). This may be due to a reduced understanding of hazardous environmental noise levels compared to occupationally exposed workers who usually have participated in worksite hearing conservation programs and likely received at least some related safety training.

In light of the significant association between a history of occupational noise exposure and both hypertension and elevated cholesterol, the high prevalence of current workers who have ever been

ITEM 11.1.

exposed (41 million) and, more specifically, exposed in the last 12 months (22 million) is noteworthy. A recent publication, also examining the 2014 NHIS dataset, related to noise exposures among all US adults reported similar results.³² Tak et al¹ also estimated that 22 million US workers were exposed to occupational noise in the past 12 months using 1999–2004 NHANES data. This number has not improved in the subsequent 10–15 years, although the percentage exposed decreased from 17% to 14%. However, the exposure question used in the Tak et al¹ paper allowed for any duration of exposure whereas our analysis required “4 or more hours a day, several days a week.” This may further indicate a lack of real improvement in reducing noise exposures in the workplace. The industries and occupations with the highest risk for exposure remained the same as in 1999–2004.¹ The prevalence of hearing difficulty among US workers is nearly the same as last estimated using 2007 data (1% higher) and the industries and occupations with the greatest risk remain the same.⁷

There were several limitations to this study. We cannot infer causality due to the cross-sectional nature of the NHIS survey, which is prone to reverse causality. However, the causal link between noise and hearing difficulty is well-established.² While all variables were based on self-report which can lead to biased estimates, the survey questions have been validated. The question assessing hearing difficulty was validated against audiometric threshold estimates,²¹ and the hyper-tension and CHD/stroke questions were validated against medical records.³³ All were found to have high specificity and moderate to good sensitivity. However, the question for elevated cholesterol has been shown to be much less reliable in similar validation attempts.³⁴ The arrangement of the noise exposure questions may have led to workers being potentially misclassified into the higher exposure level. However, recall of occupational noise exposure in general has been found to be valid when rating the level of noise.^{35,36} This study was unable to control for the duration of noise exposure as the relevant NHIS questions are insufficient to reconstruct lifetime dose and have yet to be validated. This may have biased estimates of association with cardiovascular disease toward the null. Additionally, there are other factors known to cause cardiovascular disease such as lack of exercise and poor diet that were not controlled for in this study. However, there are no studies linking these factors to self-reported occupational noise exposure making it unlikely that they confound this association. Finally, both hypertension and elevated cholesterol may be subject to under-reporting due to lack of screening. Those reporting not being screened were more likely to be male, a current smoker, work in a high noise prevalence industry or occupation, report occupational noise exposure, and report lower educational attainment (data not shown). Given that these are also risk factors for hypertension and elevated cholesterol, it is likely that the true prevalence and association with noise is higher than estimated in this study.

Greater than a quarter of the US workforce have been impacted by occupational noise. Its causal relationship with hearing difficulty and biological stress is well-established² and this study provides further evidence of an association with hypertension and elevated cholesterol. Significant percentages of worker cases of hearing difficulty (58%), hypertension (14%), and elevated cholesterol (9%) were found to be attributable to occupational noise, and these percentages represent large numbers of workers. Because a causal relationship has been established between occupational noise and hearing difficulty, the attributable fraction identifies how many cases could be prevented if the noise was reduced to safer levels. Specifically, we could prevent 5 302 208 of the 9 200 430 cases of hearing difficulty among noise-exposed workers. Since causal relationships between occupational noise and both hypertension and elevated cholesterol are still under debate, the attributable fraction tells us the number of excess cases of these conditions among noise-exposed workers as compared with among non-noise-exposed workers. We can only speculate that if there was a causal relationship between these variables, then perhaps 1 682 313 cases of hypertension and 1 215 692 cases of elevated cholesterol among noise exposed workers could potentially be prevented if noise was reduced to safer levels.

ITEM 11.1.

Reducing workplace noise and improving strategies for protecting noise-exposed workers is critical for prevention. Worksite health and wellness programs which include screenings for hypertension and elevated cholesterol should also target noise-exposed workers. Interventions can be modest in cost, such as screening workers using portable cholesterol screening systems and portable blood pressure monitors operated by non-medical personnel. Such interventions also have been shown to have a substantial return on investment by reducing losses in productivity from disease progression and boosting morale.³⁷ Finally, although this study makes some strides towards characterizing the association between occupational noise and cardiovascular disease, further research is needed to establish the noise level at which risk increases and the exact nature of this increase.

ACKNOWLEDGMENT

The authors wish to thank Jia Li for her expert advice related to the statistical analysis.

FUNDING

The authors report that there was no funding source for the work that resulted in the article or the preparation of the article.

Footnotes

DISCLOSURE (AUTHORS)

The authors declare no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

Paul Landsbergis declares that he has no conflict of interest in the review and publication decision regarding this article.

ETHICS APPROVAL AND INFORMED CONSENT

Since all data came from the publically available National Health Interview Survey, no ethics review or approval occurred.

Institution at which the work was performed: NIOSH, Centers for Disease Control and Prevention, Cincinnati, OH.

Publisher's Disclaimer: DISCLAIMER

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

REFERENCES

1. Tak S, Davis RR, Calvert GM. Exposure to hazardous workplace noise and use of hearing protection devices among US workers—NHANES, 1999–2004. *Am J Ind Med*. 2009;52:358–371. [[PubMed](#)] [[Google Scholar](#)]
2. Themann C, Suter AH, Stephenson MR. National research agenda for the prevention of occupational hearing loss—part 1. *Semin Hear*. 2013;34:145–207. [[Google Scholar](#)]
3. Basner M, Babisch W, Davis A, et al. Auditory and non-auditory effects of noise on health. *The Lancet*. 2014;383:1325–1332. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]
4. Shockey TM. Cardiovascular health status by occupational group—21 states, 2013. *MMWR Morb*

ITEM 11.1.

Mortal Wkly Rep. 2016;65:793–798. [[PubMed](#)] [[Google Scholar](#)]

5. Luckhaupt SE, Calvert GM. Prevalence of coronary heart disease or stroke among workers aged <55 years—United States, 2008–2012. *Morb Mortal Wkly Rep.* 2014;63:645–649. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]

6. Kaur H, Luckhaupt SE, Li J, Alterman T, Calvert GM. Workplace psychosocial factors associated with hypertension in the U.S. workforce: a cross-sectional study based on the 2010 National Health Interview Survey. *Am J Ind Med.* 2014;57:1011–1021. [[PubMed](#)] [[Google Scholar](#)]

7. Masterson EA, Themann CL, Luckhaupt SE, Li J, Calvert GM. Hearing difficulty and tinnitus among U.S. workers and non-workers in 2007. *Am J Ind Med.* 2016;59:290–300. [[PubMed](#)] [[Google Scholar](#)]

8. Tomei G, Fioravanti M, Cerratti D, et al. Occupational exposure to noise and the cardiovascular system: a meta-analysis. *Sci Total Environ.* 2010;408:681–689. [[PubMed](#)] [[Google Scholar](#)]

9. de Souza TCF, Périssé ARS, Moura M. Noise exposure and hypertension: investigation of a silent relationship. *BMC Public Health.* 2015;15:328. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]

10. Skogstad M, Johannessen HA, Tynes T, Mehlum IS, Nordby K-C, Lie A. Systematic review of the cardiovascular effects of occupational noise. *Occup Med.* 2016;66:10–16. [[PubMed](#)] [[Google Scholar](#)]

11. Arlien-Søborg MC, Schmedes AS, Stockholm ZA, et al. Ambient and at-the-ear occupational noise exposure and serum lipid levels. *Int Arch Occup Environ Health.* 2016;89:1087–1093. [[PubMed](#)] [[Google Scholar](#)]

12. Dzhambov AM, Dimitrova DD. Occupational noise and ischemic heart disease: a systematic review. *Noise Health.* 2016;18:167. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]

13. Vangelova KK, Deyanov CE. Blood pressure and serum lipids in industrial workers under intense noise and a hot environment. *Rev Environ Health.* 2011;22:303–312. [[PubMed](#)] [[Google Scholar](#)]

14. Rosenhall U, Sundh V. Age-related hearing loss and blood pressure. *Noise Health.* 2006;8:88. [[PubMed](#)] [[Google Scholar](#)]

15. Liu J, Xu M, Ding L, et al. Prevalence of hypertension and noise-induced hearing loss in Chinese coal miners. *J Thorac Dis.* 2016;8:422–429. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]

16. National Center for Health Statistics. National Health Interview Survey. https://www.cdc.gov/nchs/nhis/nhis_2014_data_release.htm. Published 2014.

17. U.S. Bureau of Labor Statistics. SOC Major Groups. Bureau of Labor Statistics. https://www.bls.gov/soc/major_groups.htm. Accessed September 18, 2017.

18. US Census Bureau Special Projects Staff S. US Census Bureau Site North American Industry Classification System main page. <https://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2012>. Accessed September 18, 2017.

19. NIOSH. CDC – National Occupational Research Agenda (NORA): Sectors. <https://www.cdc.gov/niosh/nora/sectorapproach.html>. Accessed September 18, 2017.

20. Arslan E, Orzan E. Audiological management of noise induced hearing loss. *Scand Audiol Suppl.* 1998;48:131–145. [[PubMed](#)] [[Google Scholar](#)]

21. Schein JD, Gentile A, Haase KW. Development and evaluation of an expanded hearing loss scale questionnaire. *Vital Health Stat 2.* 1970;37:1–42. [[PubMed](#)] [[Google Scholar](#)]

ITEM 11.1.

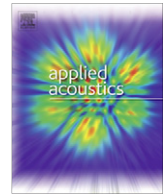
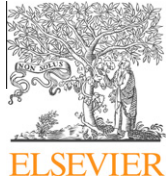
22. Gan WQ, Davies HW, Demers PA. Exposure to occupational noise and cardiovascular disease in the United States: the National Health and Nutrition Examination Survey 1999–2004. *Occup Environ Med.* 2010;68:183–190. [[PubMed](#)] [[Google Scholar](#)]
23. Spiegelman D, Hertzmark E. Easy SAS calculations for risk or prevalence ratios and differences. *Am J Epidemiol.* 2005;162:199–200. [[PubMed](#)] [[Google Scholar](#)]
24. Tak S, Calvert GM. Hearing difficulty attributable to employment by industry and occupation: an analysis of the National Health Interview Survey—United States, 1997 to 2003. *J Occup Environ Med.* 2008;50:46–56. [[PubMed](#)] [[Google Scholar](#)]
25. Milia LD, Waage S, Pallesen S, Bjorvatn B. Shift work disorder in a random population sample—prevalence and comorbidities. *PLoS ONE.* 2013;8:e55306. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]
26. Mozumdar A, Liguori G. Occupational physical activity and the metabolic syndrome among working women: a Go Red North Dakota study. *J Phys Act Health.* 2011;8:321–331. [[PubMed](#)] [[Google Scholar](#)]
27. Zhou Z, Xi Y, Zhang F, et al. Sedentary behavior predicts changes in cardiometabolic risk in professional workers: a one-year prospective study. *J Occup Environ Med.* 2016;58:e117. [[PubMed](#)] [[Google Scholar](#)]
28. Janczura M, Bochenek G, Nowobilski R, et al. The relationship of metabolic syndrome with stress, coronary heart disease and pulmonary function—an occupational cohort-based study. *PLoS ONE.* 2015;10:e0133750. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]
29. Au CT, Lee FYF, et al. Association between leisure time physical activity, cardiopulmonary fitness, cardiovascular risk factors, and cardiovascular workload at work in firefighters. *Saf Health Work.* 2015;6:192–199. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]
30. Ruhm CJ. Bridge jobs and partial retirement. *J Labor Econ.* 1990;8:482–501. [[Google Scholar](#)]
31. Gan WQ, Moline J, Kim H, Mannino DM. Exposure to loud noise, bilateral high-frequency hearing loss and coronary heart disease. *Occup Env Med.* 2016;73:34–41. [[PubMed](#)] [[Google Scholar](#)]
32. Bhatt JM, Lin HW, Bhattacharyya N. Epidemiology of firearm and other noise exposures in the United States. *The Laryngoscope.* 2017. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]
33. Okura Y, Urban LH, Mahoney DW, Jacobsen SJ, Rodeheffer RJ. Agreement between self-report questionnaires and medical record data was substantial for diabetes, hypertension, myocardial infarction and stroke but not for heart failure. *J Clin Epidemiol.* 2004;57:1096–1103. [[PubMed](#)] [[Google Scholar](#)]
34. Tolonen H, Koponen P, Mindell JS, et al. Under-estimation of obesity, hypertension and high cholesterol by self-reported data: comparison of self-reported information and objective measures from health examination surveys. *Eur J Public Health.* 2014;24:941–948. [[PubMed](#)] [[Google Scholar](#)]
35. Neitzel R, Daniell W, Sheppard L, Davies H, Seixas N. Comparison of perceived and quantitative measures of occupational noise exposure. *Ann Occup Hyg.* 2009;53:41–54. [[PubMed](#)] [[Google Scholar](#)]
36. Reeb-Whitaker C, Seixas N, Sheppard L, Neitzel R. Accuracy of task recall for epidemiological exposure assessment to construction noise. *Occup Environ Med.* 2004;61:135–142. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]
37. Arena R, Guazzi M, Briggs PD, et al. Promoting health and wellness in the workplace: a unique opportunity to establish primary and extended secondary cardiovascular risk reduction programs. *Mayo*

ITEM 11.1.

Clin Proc. 2013;88:605–617. [[PubMed](#)] [[Google Scholar](#)]

ITEM 11.1.

EXHIBIT 13



Scenario analysis and noise action planning: Modelling the impact of mitigation measures on population exposure

E. Murphy^{a,*}, E.A. King^b

^a School of Geography, Planning and Environmental Policy, University College Dublin, Ireland

^b Department of Mechanical and Manufacturing Engineering, Trinity College Dublin, Ireland

ARTICLE INFO

Article history:

Available online 11 November 2010

Keywords:

Strategic noise mapping
Environmental noise directive
Population exposure
Noise mitigation
Scenario analysis
Acoustical planning
Action planning
Noise modelling

ABSTRACT

This paper reports on strategic noise mapping research conducted in Dublin, Ireland. Noise maps are constructed for the day–evening–night-time and night-time periods and levels of population exposure are estimated for the same periods. In methodological terms, the research uses the UK's calculation of road traffic noise (CRTN) method for calculating noise levels in the study area. This method has been adopted as the interim calculation method by the Irish authorities responsible for meeting the obligations set out in the EU Environmental Noise Directive (END). The research also investigates the usefulness of three noise mitigation measures for ‘acoustical planning’ purposes: traffic reductions, speed reductions and erection of acoustical barriers. The results indicate that levels of population exposure during night-time are extremely high relative to guideline limits set down by the World Health Organisation. In addition, the results highlight the significant role that certain noise mitigation measures can play in good ‘acoustical planning’.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction and context

In the European Union (EU), problems with noise are often rated at the highest level of concern together with issues such as global warming [1]. The evidence suggesting a link between transportation noise and human health is increasing [2,3]. Recent research from social survey data demonstrates that annoyance and sleep disturbance are considered to be the primary health effects [4,5]. Studies have shown that noise annoyance from transportation produces a variety of negative emotions including anger, disappointment, unhappiness, anxiety and even depression [6–9].

Ohrstrom and Skanberg [10] examined the effect of road traffic noise on sleep disturbance and concluded that sleep quality was reduced by 22.0% in the laboratory and 20.5% at home after exposure to traffic noise when compared to a quiet reference night. Carter [11] has shown that exposure to noise during the night can lead to considerable disruption in the stages of the sleep cycle. His research demonstrated that Slow Wave Sleep (SWS) can be significantly reduced by noise exposure during the night while other research has shown that the rhythm of Rapid Eye Movement (REM) sleep can be adversely affected by night-time noise exposure [12,13]. This suggests that noise exposure can reduce the length of time individuals are engaged in deep sleep stages, which are

considered to be important for physical recuperation. Exposure to night-time noise can also produce a number of secondary effects (i.e. those that can be measured the day after the individual is exposed to night-time noise) including psychological and physiological symptoms as well as reduced performance in adults [14].

More recent research has highlighted the link between noise exposure and cardio-vascular outcomes [15,2,16–19]. In a series of recent studies, Babisch et al. [20,21] have demonstrated that annoyance and disturbance due to road traffic noise is associated with a variety of cardio-vascular outcomes including increased risk of ischaemic heart disease and myocardial infarction. Other negative impacts that are related to quality of life include undue alterations in the everyday behaviour of individuals; examples include preventing the use of residential areas such as balconies and common areas due to excessive noise levels as well as the shutting of windows in homes to prevent noise immission [22].

Within the context of an emerging evidence base suggesting links between exposure to environmental noise and public health concerns, noise policy gained greater prominence in EU environmental policy throughout the 1990s [23,24]. In 2002, this culminated in the adoption of Directive 2002/49/EC, also known as the Environmental Noise Directive (END), into EU legislation [25]. The Directive has two broad-based objectives¹. First, it seeks to develop a common approach towards the avoidance, prevention and

* Corresponding author. Tel.: +353 1 7162810; fax: +353 1 7162788.

E-mail address: enda.murphy@ucd.ie (E. Murphy).

¹ See [5] for an in-depth critique of the Directive.

ITEM 11.1.

488

E. Murphy, E.A. King / Applied Acoustics 72 (2011) 487–494

reduction of the harmful effect of exposure to environmental noise. Second, it aims to provide a basis for the development of community measures to reduce noise emitted by major sources.

Outside of the broader objectives, Murphy and King [5] have identified four key areas of importance for the assessment and management of environmental noise under the terms of the legislation. Three of these are important for the current study: (1) strategic noise mapping; (2) estimating population exposure; (3) noise action planning.

In terms of (1) and (2), the 'global assessment' of exposure is to be achieved using strategic noise maps which are to be used as a basis for identifying levels of population exposure within agglomerations. In this regard the Directive requires competent authorities in each member state to provide estimates of the number of people living in dwellings that are exposed to values of the recently established EU noise indicators L_{den} (day–evening–night-time equivalent sound pressure level) and L_{night} (night-time equivalent sound pressure level) at the most exposed building façade and separately for road, rail, air traffic and for industrial noise [25].

The third key area of concern (3) is that of noise action planning. In the Directive, action plans refer to 'plans designed to manage noise issues and effects, including noise reduction if necessary' [25, p. 14]. It is a requirement that competent authorities draw up action plans for the major roads, railways and agglomerations within their remit and that these plans are reviewed every five years once adopted and on an ongoing basis by accounting for major new developments. In the context of action plans, the Directive also introduces the notion of 'acoustical planning' which refers to 'controlling future noise by planned measures, such as land-use planning, systems engineering for traffic, traffic planning, abatement by sound-insulation measures and noise control of sources' [25].

It is the foregoing three areas of concern which provide greatest interest for the current research. A number of noise mapping and/or population exposure studies have appeared recently in the literature [26–29]. However, few have been undertaken in the European Union within the context of the Directive. A recent exception is that of Murphy et al. [30] who undertook exploratory strategic noise mapping and population exposure analysis for a one square kilometre area in central Dublin and derived estimates of population exposure. They found that population exposure to noise greater than 45 dB(A) during the night-time period was 90.2%. However, as of yet, no study has investigated the extent to which acoustical planning mitigation analysis can assist in reducing levels of population exposure.

The objectives then of the current study were threefold. First, was to develop strategic noise maps for the identification of noise 'hotspots' in the study area. Second, was to provide estimates of the extent of population exposure during day-time and night-time and to relate these to guideline limit values set down by the WHO for day-time [22] and night-time [31]. Third, was to investigate the usefulness of four noise mitigation measures for 'acoustical planning' purposes: (1) traffic reductions, (2) speed reductions, (3) a combination of traffic and speed reductions, and (4) the erection of acoustical noise barriers. Within the noise action planning framework laid down in the Directive, the paper investigates the extent to which the implementation of each of the aforementioned measures can individually and collectively serve to reduce population exposure to noise from road transport.

2. Data and methods

2.1. Study area and data

The study area comprises of approximately a 16 square kilometre area in Dublin's central area. The study area comprises

buildings within the Royal and Grand Canal's which are regarded generally as Dublin's central core area. Fig. 2 provides an outline of the study area as well as a strategic noise map of the area for L_{night} . Strategic noise maps are used for gaining a broad overview of noise emissions levels in the area. The data used in this study was provided by Dublin City Council including 24-h traffic flow information along the road links in the study area for a six month period from January to June 2007. The traffic flow data was derived using Dublin City Council's traffic monitoring system which provides hourly traffic counts at junctions within the study area. Traffic composition data was unavailable on all links and was assumed to be 90% light vehicles and 10% heavy vehicles. This is in keeping with the Good Practice Guide for Noise Mapping [32]. Building geometry, building height information and road network information was provided by Dublin City Council in the form of Geographic Information System (GIS) shapefiles.

2.2. Noise modelling

The harmonised noise indicators L_{den} and L_{night} were used to gauge average noise emission levels in the study area. Both L_{den} and L_{night} represent the annual A-weighted long-term average sound pressure level determined over the entire day and night periods respectively. L_{den} is given by the following equation:

$$L_{den} = 10 \log \frac{1}{24} \left(12 * 10^{\frac{L_{day}}{10}} + 4 * 10^{\frac{L_{evening}+5}{10}} + 8 * 10^{\frac{L_{night}+10}{10}} \right) \quad (1)$$

The day period was taken to be from 07.00 to 19.00 while evening and night-time periods were taken to be from 19.00 to 23.00 and 23.00 to 07.00 respectively. The weighting factors in the above equation are designed to account for the increase in annoyance at different periods throughout the entire day, hence the addition of 10 to the value for L_{night} and 5 to the value of $L_{evening}$.

The noise prediction method used for the current study was the Calculation of Road Traffic Noise (CRTN). The published method [33] is divided into three sections which outline a prediction method, including a procedure to determine the basic noise level at the source, and a measurement method. In a critical review of road traffic prediction models, Steele [34] notes that CRTN is distinguished by its extensive use of curve fitting between empirical data even when this was known not to conform to theory. This greatly simplifies calculations albeit with the concomitant loss of validity.

In the CRTN method the road is approximated as a line source and as such the line of view is the line source i.e. the road is of critical importance in calculations. The method does not calculate attenuation in terms frequency bands, but rather offers an overall

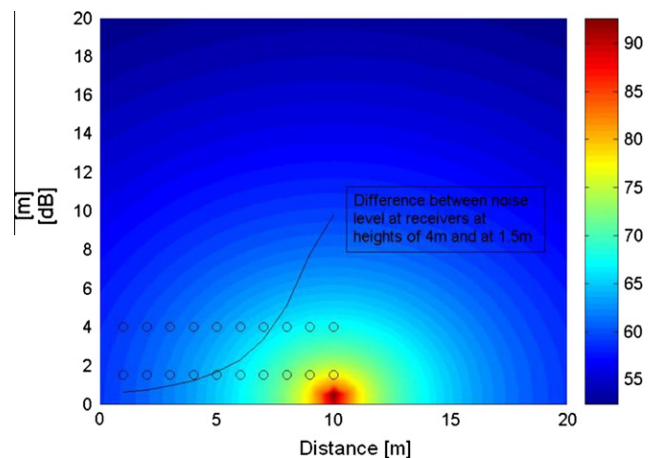


Fig. 1. Comparison of different receiver heights: Vertical view.

ITEM 11.1.

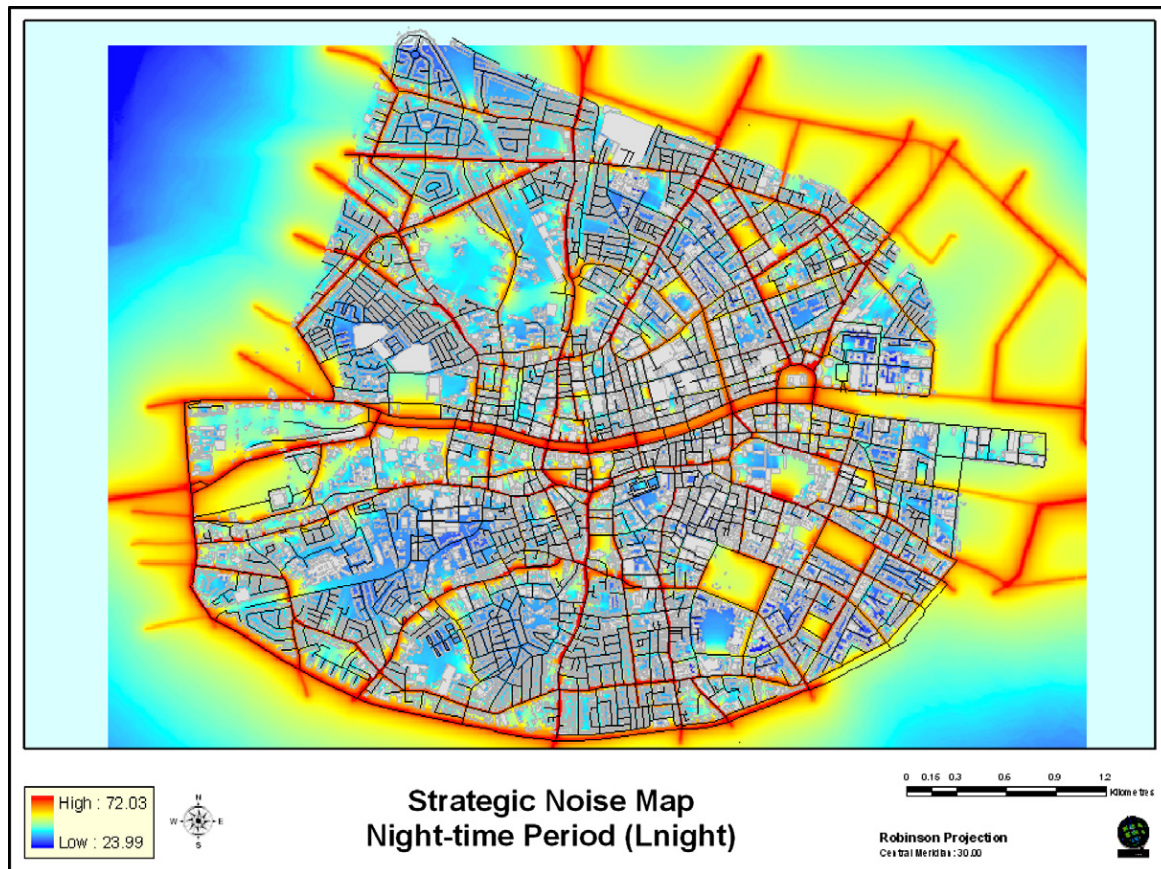


Fig. 2. Strategic noise map for the night-time period (L_{night}).

A-weighted result. All results are expressed in terms of the L_{10} indicator and as such, a conversion factor is required to change results obtained from the CRTN model to satisfy the Directive. This conversion was developed from a regression relationship established between L_{eq} and L_{10} by Abbott and Nelson [35] and was subsequently adapted to an Irish scenario [36]. The Irish conversion formula was selected for use in this case and may be expressed as

$$L_{den} = 0.86 \times L_{A10,18h} + 9.86 \text{ dB} \quad (2)$$

It has previously been noted by the authors that, on average this method under predicts noise levels by 0.01 dB with an r.m.s. error of 1.6 dB.

2.3. Model validation

In order to validate the predicted model a number of measurements were made at selected locations within the test area. These locations were representative of typical city centre streets; some may be considered 'major roads' in terms of traffic volumes as defined by the Directive, but all would have been considered as a source in the development of the strategic noise map for the agglomeration. In one location, measurements were made over a two-week period while all other measurements were 15 min in duration. All measurements were conducted away from any reflecting surfaces such as building façades in an effort to minimise the impact of reflections. All short-term measurements were made at a height of 1.5 m at distances of between 6 m and 10 m from the roadside edge. At each position traffic noise from the adjacent road was the dominant noise source. The long-term monitor was positioned at a height of 4 m on a traffic island between two roads. Traffic noise was again the dominant source at this location.

The long-term measurements were used to determine the variation of noise throughout the day period which would enable an accurate estimation of L_{day} using short-term measurement results. This method was previously applied to a section of the test area by King and Rice [37]. It was found that a 15 min value was generally within 3 dB of the 12-h L_{day} level and results from the current study also follow this trend. Applying this method allows comparisons to be drawn between long-term and short-term measurements taken on-site with the predicted L_{day} values in the noise map. The results of measurements and predicted values are displayed below (Table 1).

The results demonstrate that in general the CRTN model under predicts slightly the noise levels in the test area. The average error is -1.8 dB(A) with a standard deviation of 1.9 dB(A) which suggests that while there is some variation at each individual position, the model is robust enough to use as a strategic action planning tool. Errors in predictions may have arisen due to the limited availability of input data while measurements may have been influenced by everyday urban sources outside the scope of the prediction model. A more detailed measurement campaign would of course improve the results and lead to more definitive validation. However, such an extensive measurement campaign is beyond the scope of the current paper.

2.4. Extrapolating measurements to a height of 4 m

Short-term measurements were taken at a height of 1.5 m while predictions were performed for a receiver height of 4 m. As such it was necessary to extrapolate measurement results to a height of 4 m in order to undertake a direct comparison between predictions and measurements. Fig. 1 shows a noise map plotting the

ITEM 11.1.

490

E. Murphy, E.A. King / Applied Acoustics 72 (2011) 487–494

Table 1
Measured and predicted results.

	Predicted L_{day} [dB(A)]	Measured L_{day} [dB(A)]	Predicted–measured [dB(A)]
Long-term position 1	72.5	73.6	–1.1
Short-term position 1	69.3	66.5	+1.8
Short-term position 2	70.9	74.0	–3.1
Short-term position 3	63.3	65.0	–1.7
Short-term position 4	49.5	54.4	–4.9
Short-term position 5	55.6	56.6	–1
Short-term position 6	70.0	72.9	–2.9
Short-term position 7	65.6	67.4	–1.8

corresponding noise levels in a vertical cross section of a sample area surrounding two simple point sources positioned at heights of 0.3 m and 0.75 m. There are a number of receiver points also displayed at a height of 1.5 m and 4 m and in steps of 1 m from the noise sources. The black line displays the difference between the calculated values at 4 m and 1.5 m. It is evident that the closer the receiver points are to the source the greater the influence that height alterations have on the values. A difference as high as 10 dB is noted directly beside the source, but reduces to below 1 dB over 8 m from the source. This simple analysis suggests that the difference in receiver height is less influential as the receiver points are placed further away from the source.

2.5. Estimating population exposure

Population exposure was estimated by determining the number of residential units for each building in the study area. Once determined, each residential unit was assigned an average household size value equivalent to the census enumerator area (EA) where the building was located. This value was obtained from the 2006 Census of population data for 162 EA's falling within the study area. Information on the number of residential units in each building was acquired from the Irish GeoDirectory database for 2007. The GeoDirectory is a complete database of every building in Ireland which among other things contains information detailing the number of residential units in each building. It is updated on an ongoing basis by the Irish Postal Service and is the most complete building database available in Ireland. Given the number of residential units for each building in the study area and the average household size associated with each building location, it was possible to compute estimates of the residential population for each building.

In order to estimate exposure, the noise level at the most exposed façade must be determined [25]. Thus, for the current study separate calculations were undertaken for the completion of strategic noise maps and for estimates of noise at building façades. For façade calculations the recommendations outlined in the Good Practice Guide for Noise Mapping [32] were followed. Receiver points were placed at 0.1 m in front of the façade; a spacing of 3 m between calculation points was deemed appropriate. For the grid calculations, a standard grid spacing of 10 m was chosen. All calculations were performed at the standard receiver height of 4 m above the ground.

The noise categories chosen (Table 2) are those outlined in the recent Irish statutory instrument-*Environmental Noise Regulations*-which established a schedule for compliance with the EU

Table 2
Estimates of population exposure for study area (all roads included).

	L_{den}	<55	55–60	60–65	65–70	70–75	>75
Residents		35,675	28,411	14,522	12,730	32,668	9033
	L_{night}	45–50	50–55	55–60	60–65	65–70	>70
Residents		27,020	14,591	10,377	20,872	25,346	458

Noise Directive in Ireland [38]. It should be noted at the outset that the guideline value above which the World Health Organisation (WHO) have recommended noise emissions in traffic areas should not exceed during day-time is 70 dB(A) L_{eq} [22] while the corresponding value not to be exceeded during night-time is 40 dB(A) $L_{\text{night, outside}}$ [31]. Prolonged human exposure above these levels is considered to be detrimental to public health and quality of life [22]. In our analysis, we compare the WHO day-time L_{eq} guideline level with L_{den} . As L_{den} is a weighted indicator this comparison is equivalent to a scenario where the general public is overprotected. This is an appropriate comparison due to the fact that L_{den} is the indicator currently used throughout Europe to assess general levels of annoyance.

Murphy and King [5] have pointed out a number of methodological difficulties associated with estimating population exposure within the strategic noise mapping framework. These include the assumption that all individuals living in a particular household are exposed to the noise level at the most exposed building façade. They point out that many bedrooms will not be located at the most exposed building façade. In addition, there is the assumption that individuals reside in their dwelling and sleep there all year around. This ignores the fact that many workers and students leave urban areas at the weekend and thus the assessment method fails to account for migrant and transient populations when providing estimates of population exposure [5]. Because of these assumptions, Murphy and King [5] note that noise exposure estimates are likely to be overstated. The foregoing issues also apply to the current study.

3. Results

3.1. Strategic noise mapping and population exposure

Fig. 2 shows a strategic noise map for the night-time period while Table 2 displays estimates of the number of people exposed to various noise categories for L_{den} and L_{night} . It is notable from Fig. 2, and perhaps unsurprisingly, that very high levels of noise are evident along the main routeways for the night-time period. The results for population exposure are quite striking. They suggest that 27.2% of residents respectively are exposed to noise levels exceeding 70 dB(A) for L_{den} while the corresponding figure for night-time noise exposure (L_{night}) greater than 40 dB(A) is 84.3%. Thus, in proportional terms the exposure estimates are similar, albeit slightly less, than those found by Murphy et al. [30] for a small central area for 2005. The results are unlikely to suggest that the soundscape has improved over that period. Rather, they imply that noise exposure is considerably greater in the central core of the city where many traffic routes converge and that, in relative terms, average exposure rates decline outwards from the central core.

Nevertheless, the rates of exposure are high. Berglund et al. [22] reported that approximately 40% of the total population of the EU were exposed to noise levels from road traffic exceeding a daily equivalent sound pressure level of 55 dB(A) while the corresponding value for night-time exposure was 30% [22]. For our study the corresponding figures are 63.0% and 37.3% for day-time and night-time respectively, indicating a considerably higher rate of exposure for the daily equivalent sound pressure level (L_{den}) than that reported by Berglund et al. [22].

ITEM 11.1.

3.2. Noise action planning and potential 'acoustical planning' mitigation scenarios (L_{night})

As stated earlier, a key objective of the END is to identify areas of acoustical discomfort and apply 'acoustical planning' mitigation measures in the form of action planning to reduce noise exposure in areas that are considered to be of poor sound quality. Using a Geographical Information System (GIS) buildings with a L_{max} exposure at the most exposed façade of greater than 50 dB(A) for L_{night} were identified. They are shown in Fig. 3. Once selected, we identified the roads in the vicinity of these buildings which were then used as a base reference condition to test the impact of four acoustical planning mitigation measures on reducing population exposure to noise for both L_{den} and L_{night} : (1) traffic reductions; (2) speed reductions; (3) a combination of traffic and speed reductions, and (4) acoustical barriers. Table 3 shows the results of the population exposure analysis for the base reference condition. Each of the first three acoustical mitigation measures was simulated and compared with the results for the base reference condition (Table 3). However, mitigation measure (4) had a separate base reference condition described which is outlined later.

3.2.1. Scenario one: Travel demand reduction

Table 4 shows the revised population exposure statistics for travel demand reductions of 10% and 20% for L_{den} and L_{night} ; demand reductions were applied to both light and heavy vehicles. The results show that for a 10% travel reduction, the proportion of people exposed to values above 70 dB(A) for L_{den} – the WHO guideline limit – declines only marginally (1.0%) from the base reference condition although there are significant reduction in exposure in the >75 exposure category (27.8%). The corresponding reduction for people exposed to values above 40 dB(A) for L_{night} – the WHO

Table 3

Population exposure for the base reference condition – selected roads.

	<55	55–60	60–65	65–70	70–75	>75
L_{den} Residents	60,588	22,757	12,064	6174	23,891	7565
L_{night} Residents	45–50	50–55	55–60	60–65	65–70	>70
Residents	21,894	12,587	5854	14,158	18,905	291

guideline limit – is 2.9%. When a 20% reduction in travel demand is implemented the proportion exposed to values above the guideline limits declines by 4.9% for L_{den} and 7.2% for L_{night} from the base reference condition. It is notable also that greater proportional reductions in exposure can be achieved the upper categories when this mitigation measure is implemented. This points toward the usefulness of the measure for aiding reductions in noise exposure to the worst affected households.

3.2.2. Scenario two: Travel speed reductions

Table 5 shows the revised population exposure statistics for speed reductions of 10% and 20% for L_{den} and L_{night} . The results show that for a 10% speed reduction, the proportion of people exposed to values above 70 dB(A) for L_{den} – the WHO guideline limit – declines by 0.2%; the corresponding reduction for people exposed to values above 40 dB(A) for L_{night} – the WHO guideline limit – is 2.0%. For a 20% reduction in speed the proportion exposed to values above the guideline limits are 4.8% for L_{den} and 3.7% for L_{night} . In line with the previous results, those for speed reductions suggest that greater proportional reductions in exposure can be achieved the upper categories; by reducing travel demand, a 2.0% reduction can be achieved for individuals exposed to noise levels greater than or equal to 60 dB(A) for L_{den} while a 15.5% reduction can be achieved for individuals exposed to noise levels greater than

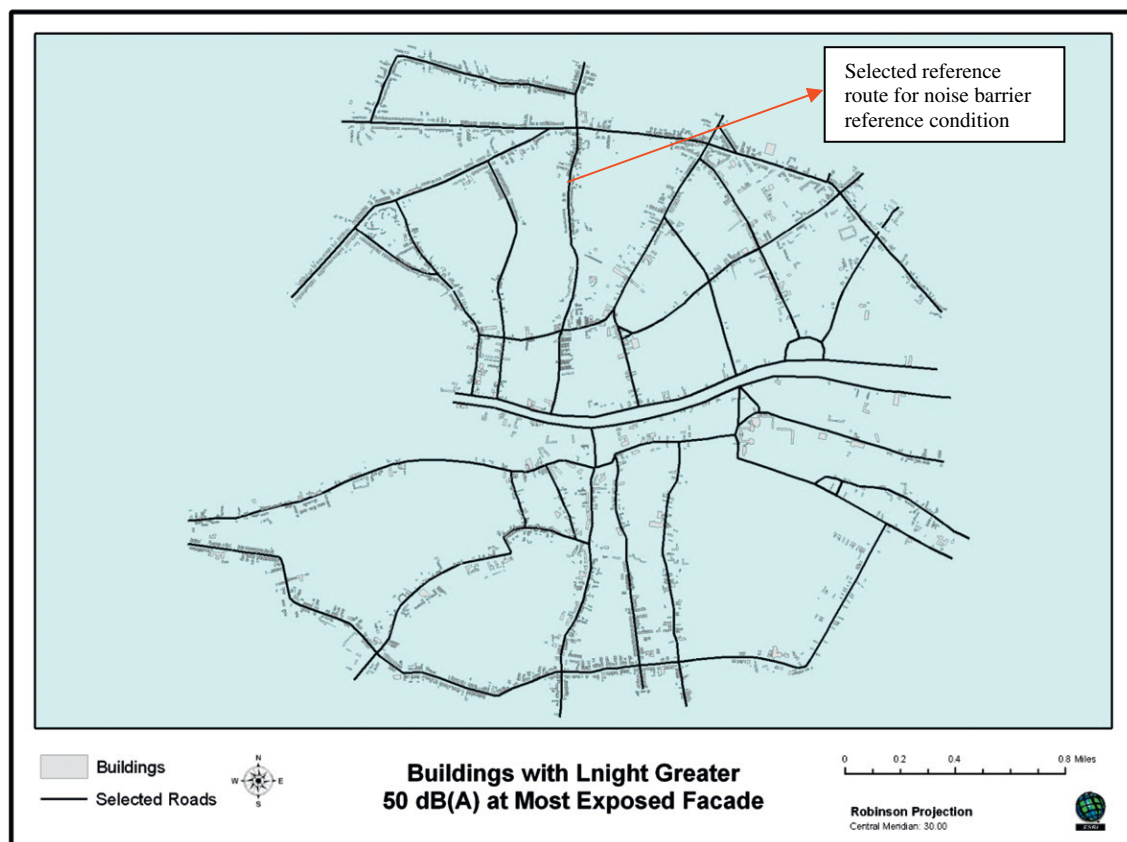


Fig. 3. Buildings with a value greater than 50 dB(A) for L_{night} and selected roads for the base reference condition.

ITEM 11.1.

492

E. Murphy, E.A. King / Applied Acoustics 72 (2011) 487–494

Table 4

Revised population exposure from the base reference condition for 10% and 20% travel demand reductions on roads.

L_{den} (–10%)	<55	55–60	60–65	65–70	70–75	>75
Residents	63,142 (+4.2%)	21,770 (–4.3%)	11,301 (–6.3%)	5690 (–7.4%)	25,672 (–7.5%)	5464 (–27.8%)
L_{den} (–20%)	<55	55–60	60–65	65–70	70–75	>75
Residents	64,899 (+7.1%)	21,841 (–4.2%)	10,167 (–15.7%)	6331 (+3.1%)	27,117 (+13.5%)	2684 (–64.5%)
L_{night} (–10%)	45–50	50–55	55–60	60–65	65–70	>70
Residents	21,132 (–3.5%)	11,729 (–6.8%)	5425 (–7.9%)	16,452 (+16.2%)	16,643 (–12.2%)	115 (–60.5%)
L_{night} (–20%)	45–50	50–55	55–60	60–65	65–70	>70
Residents	19,630 (–10.3%)	11,347 (–9.8%)	6236 (+6.5%)	17,354 (+22.6%)	14,153 (–25.1%)	93 (–68.1%)

Table 5

Revised population exposure from the base reference condition for 10% and 20% speed reductions on roads.

L_{den} (–10%)	<55	55–60	60–65	65–70	70–75	>75
Residents	61,872 (+2.1%)	22,443 (–1.4%)	11,505 (–4.6%)	5843 (–5.2%)	25,246 (+5.7%)	6130–23.4%)
L_{den} (–20%)	<55	55–60	60–65	65–70	70–75	>75
Residents	64,560 (+6.5%)	21,572 (–4.4%)	11,111 (–7.9%)	5863 (–8.6%)	25,927 (+8.5%)	4006 (–47.1%)
L_{night} (–10%)	45–50	50–55	55–60	60–65	65–70	>70
Residents	21,055 (–3.8%)	12,124 (–3.6%)	5623 (–4.0%)	15,862 (+12.0%)	17,418 (–8.5%)	123–57.7%)
L_{night} (–20%)	45–50	50–55	55–60	60–65	65–70	>70
Residents	21,009 (–4.1%)	11,552 (–8.2%)	5377 (–8.2%)	16,911 (+19.5%)	16,111 (+14.8%)	108–169.4%)

65 dB(A) for L_{night} . The reductions achieved in the higher noise categories are considerably greater for L_{night} than for L_{den} . This suggests that this mitigation measure has the potential to affect significant reduction in exposure during the period when dose–effect relationships are greatest for public health concerns.

It is also clear that the reductions achieved by implementing speed reductions are much less than those for travel demand reduction. This suggests that travel demand reduction is a more desirable acoustical planning mitigation measure for curbing human exposure to road traffic noise in urban areas. Taken together, the foregoing results demonstrate convincingly that significant reductions in population exposure can be achieved through careful consideration of traffic flows and associated traffic speeds in the study area. Indeed, on a broader policy level, the results highlight the potential role that traffic management and transportation planning can play in ‘acoustical planning’ in the future.

3.2.3. Scenario three: Combined noise mitigation measures

Table 6 shows the revised population exposure statistics for a 10% travel demand and speed reduction for L_{den} and L_{night} . The logic here is that it may be necessary to implement more than one mea-

sure for adequate noise mitigation. Here, the results show that for a 10% speed reduction, the proportion of people exposed to values above 70 dB(A) for L_{den} is reduced by 1.8%, compared to the values of 1.0% and 0.2% respectively for 10% travel demand and travel speed reduction. The corresponding reduction for people exposed to values above 40 dB(A) for L_{night} is 5.0% compared to the values of 2.9% and 2.0% respectively for 10% travel demand and travel speed reduction. The impact of implementing the two noise mitigation measures simultaneously appears to confer little additional benefit in terms of reducing population exposure than applying the measures separately.

3.2.4. Scenario four: Noise barrier implementation

For this scenario, three models were computed: (1) a base reference condition with no barrier along the selected route, (2) a 2 m barrier erected along both sides of the roadway, and (3) a 3 m barrier erected along the roadway. The route selected for the base reference condition is shown in Fig. 3. Table 7 displays the results of this analysis on population exposure for the entire study area; however, the impact of barriers erected for noise mitigation is relatively localised and the differences in exposure rates are reflective

Table 6

Revised population exposure from the base reference condition for the combined implementation of two ‘acoustical planning’ mitigation measures.

L_{den} (–10%)	<55	55–60	60–65	65–70	70–75	>75
Residents	64,110 (+5.8%)	21,863 (–3.1%)	10,265 (–14.9%)	5907 (–4.3%)	27,147 (+13.6%)	3747 (–50.5%)
L_{night} (–10%)	45–50	50–55	55–60	60–65	65–70	>70
Residents	20,418 (–6.7%)	11,466 (–8.9%)	5453 (–6.9%)	16,604 (+17.3%)	15,200 (–20.0%)	93 (–68.0%)

Table 7

Revised population exposure from the base barrier reference condition for noise barrier implementation.

L_{den} no barrier	<55	55–60	60–65	65–70	70–75	>75
Residents	119,582	5908	3798	1227	970	1554
L_{den} 2 m barrier	<55	55–60	60–65	65–70	70–75	>75
Residents	119,649 (+0.1%)	5967 (+1.0%)	3788 (–0.3%)	1262 (+2.9%)	931–4.0%)	1442–7.2%)
L_{den} 3.5 m barrier	<55	55–60	60–65	65–70	70–75	>75
Residents	119,670 (+0.1%)	6060 (+2.6%)	3715 (–2.2%)	1256 (+3.2%)	931 (–4.0%)	1407–9.5%)
L_{night} no barrier	45–50	50–55	55–60	60–65	65–70	>70
Residents	4993	4223	1076	1273	529	1234
L_{night} 2 m barrier	45–50	50–55	55–60	60–65	65–70	>70
Residents	5024 (+0.6%)	4325 (+2.4%)	1026 (–4.7%)	1292 (+1.5%)	502 (–5.1%)	1185–4.0%)
L_{night} 3.5 m barrier	45–50	50–55	55–60	60–65	65–70	>70
Residents	5086 (+1.9%)	4309 (+2.0%)	1041 (–3.3%)	1286 (+1.0%)	502 (–5.1%)	1131–8.4%)

ITEM 11.1.

of the local impact of the measures on exposure at surrounding buildings. The results demonstrate that significant reduction can be achieved with the erection of both a 2 and 3 m barrier and that the most significant reductions can be achieved in the upper noise categories for both L_{den} and L_{night} . While the erection of barriers are unlikely to be suitable in the urban environment, the analysis demonstrates the potential impact that this mitigation measure may have on reducing population exposure in cases where a barrier may be deemed the most appropriate solution.

4. Discussion and conclusions

One of the grey areas surrounding the END relates to the fact that it fails to stipulate guideline limit values that should not be exceeded for L_{den} and L_{night} . For the current analysis we have used guideline limit values outlined by the WHO [22,31]. However, other guidelines exist. The US Department of Housing and Urban Development classifies noise levels in residential environments into the following four categories [39,28]:

- (1) Clearly acceptable: $L_{eq} \leq 49$ dB(A).
- (2) Normally acceptable: $49 < L_{eq} \leq 62$ dB(A).
- (3) Normally unacceptable: $62 < L_{eq} \leq 76$ dB(A).
- (4) Clearly unacceptable: $L_{eq} > 76$ dB(A).

Bearing the foregoing results in mind, it is evident that whether population exposure is judged from the viewpoint of the WHO or that of the US Department of Housing and Urban Development, Dublin's exposure levels are unacceptable. Of course, the question then arises about the full extent of the dose–effect relationships in Dublin? While it is impossible to provide a definitive answer, the research alluded to at the outset suggests that the impacts of this exposure on public health are likely to be considerable. Undoubtedly, this is an area where further research is needed as a matter of priority.

To summarise, a number of conclusions can be drawn from the analysis. First, the population exposure analysis highlighted the scale of exposure to environmental noise. According to our estimates, more than 27% of the resident population are exposed to L_{den} values above 70 dB(A) while almost 85% are exposed to L_{night} values above 40 dB(A). These are the guideline limits above which the WHO recommends that prolonged exposure is detrimental to human health. However, there are some caveats. Murphy and King [5] have pointed out that many residences do not have bedrooms at the most exposed building façade. They also suggest that exposure estimates ignores the mobility of urban populations to and from rural areas at weekends. Bearing these issues in mind, it is likely that our analysis overestimates population exposure in urban areas but to what extent it is impossible to tell using existing data and information. Nevertheless, even taking these issues into account, there is little doubt that the scale of exposure is considerable and thus highlights a problem of significant environmental concern.

Second, the results demonstrate that in terms of noise action planning, significant reductions can be achieved by implementing traffic management noise mitigation measures in urban areas. Indeed, reducing travel demand leads to the most significant reduction in population exposure for L_{den} and L_{night} while considerable reductions can also be achieved by reducing travel speeds. The research has also highlighted the potential reduction that can be achieved by using acoustical noise barriers in areas that may have unusually high levels of noise exposure and are not visually sensitive. The results echo those of other scholars who have suggested that noise barriers could be used strategically in urban areas as a noise mitigation measure [40].

Finally, tackling the problem of environmental noise adequately is likely to require the implementation of more than one noise mitigation measure. Indeed, it seems that the problem of environmental noise and associated levels of exposure is significant enough to ensure that one mitigation measure will not be enough on its own to bring levels of exposure in line with the guideline limits recommended by the WHO. Undoubtedly, a more concerted approach is needed if levels of exposure are to be reduced and areas of good sound quality are to be protected.

Acknowledgements

We would like to thank the Traffic Noise and Air Quality Unit, Dublin City Council for the provision of much of the data used in this research.

References

- [1] CALM Network. Research for a quieter Europe in 2020. Strategy paper of the CALM II network; 2007.
- [2] Babisch W. Transportation noise and cardiovascular risk: updated review and synthesis of epidemiological studies indicate that the evidence has increased. *Noise Health* 2006;8:1–29.
- [3] Leon Bluhm G, Berglund N, Nordling E, Rosenlund M. Road traffic noise and hypertension. *Occup Environ Med* 2007;64:122–6.
- [4] Jakovljevic B, Paunovic K, Belojevic G. Road-traffic noise and factors influencing noise annoyance in an urban population. *Environ Int* 2009;35:552–6.
- [5] Murphy E, King EA. Strategic environmental noise mapping: methodological issues concerning the implementation of the EU environmental noise directive and their policy implications. *Environ Int* 2010;36:290–8.
- [6] Fidell S, Barber DS, Schultz TJ. Updating dosage–effect relationship for the prevalence of annoyance due to general transportation noise. *J Acoust Soc Am* 1991;89:221–33.
- [7] Fields JM. Reactions to environmental noise in an ambient noise context in residential areas. *J Acoust Soc Am* 1998;104:2245–60.
- [8] Miedema ME. Relationship between exposure to single or multiple transportation noise sources and noise annoyance. In: World Health Organisation and European centre for environment and health report on the technical meeting of exposure–response relationships of noise on health. Bonn, Germany: 2003; 17–19 September 2002.
- [9] Michaud DS, Keith SE, McMurchy D. Noise annoyance in Canada. *Noise Health* 2005;7:39–47.
- [10] Ohrstrom E, Skanberg A. Sleep disturbances from road traffic and ventilation noise – laboratory and field experiments. *J Sound Vib* 2004;271:279–96.
- [11] Carter NL. Transportation noise, sleep, and possible after-effects. *Environ Int* 1996;22:105–16.
- [12] Naitoh P, Muzet A, Lienhard JP. Effects of noise and elevated temperature on sleep cycle. In: 2nd International congress of sleep research, vol. 4. Sleep Research, Edinburgh, 1975. p. 174.
- [13] Thiessen GJ. Effect of traffic noise on the cyclical nature of sleep. *J Acoust Soc Am* 1988;84:1741–3.
- [14] Ohrstrom E, Skanberg A, Svensson H, Gidlof-Gunnarsson A. Effects of road traffic noise and the benefit of access to quietness. *J Sound Vib* 2006;295:40–59.
- [15] Babisch W, Fromme H, Beyer A, Ising H. Increased catecholamine levels in urine in subjects exposed to road traffic noise: the role of stress hormones in noise research. *Environ Int* 2002;26:475–81.
- [16] Belojevic G, Jakovljevic B, Stojanov V, Paunovic K, Ilic J. Urban road-traffic noise and blood pressure and heart rate in preschool children. *Environ Int* 2008;34:226–31.
- [17] de Kluizenaar Y, Gansevoort RT, Miedema HM, de Jong PE. Hypertension and road traffic noise exposure. *J Occup Environ Med* 2007;49:484–92.
- [18] Eriksson C, Rosenlund M, Pershagen G, Hilding A, Ostenson CG, Bluhm G. Aircraft noise and incidence of hypertension. *Epidemiology* 2007;18:716–21.
- [19] Selander J, Nilsson ME, Bluhm G, Rosenlund M, Lindqvist M, Nise G, et al. Long-term exposure to road traffic noise and myocardial infarction. *Epidemiology* 2009;20:272–9.
- [20] Babisch W, Ising H, Gallacher JEJ. Health status as a potential effect modifier of the relation between noise annoyance and incidence of ischaemic heart disease. *Occup Environ Med* 2003;60:739–45.
- [21] Babisch W, Beule B, Schust M, Kersten N, Ising H. Traffic noise and risk of myocardial infarction. *Epidemiology* 2005;16:33–40.
- [22] Berglund B, Lindvall T, Schwela DH. Guidelines for community noise. Geneva: World Health Organisation; 1999.
- [23] European Community. The fifth environmental action programme of the EU. *Off J Eur Commun* 1993;C138.
- [24] European Commission. Green paper of the European Commission: future noise policy. COM 1996; 540(96).
- [25] Directive 2002/49/EC of the European parliament and the council of June 2002. *Off J Eur Commun*; 2002.

ITEM 11.1.

494

E. Murphy, E.A. King / *Applied Acoustics* 72 (2011) 487–494

- [26] Ausejo M, Recuero M, Asensio C, Pavón I, López JM. Study of precision, deviations and uncertainty in the design of the strategic noise map of the macrocenter of the city of Buenos Aires, Argentina. *Environmental Modeling and Assessment* 2009; doi 10.1007/s10666-009-9191-9.
- [27] La Torre G, Moscato U, La Torre F, Ballini P, Marchi S, Ricciardi W. Environmental noise exposure and population health: A cross-sectional study in the Province of Rome. *J Public health* 2007;15:339–44.
- [28] Tsai K-T, Lin M-D, Chen Y-H. Noise mapping in urban environments: a Taiwan study. *Appl Acoust* 2009;70:964–72.
- [29] Yilmaz G, Hocañli Y. Mapping of noise by using GIS in Sanliurfa. *Environ Monit Assess* 2006;121:103–8.
- [30] Murphy E, King EA, Rice HJ. Estimating human exposure to transport noise in central Dublin, Ireland. *Environ Int* 2009;35:298–302.
- [31] World Health Organisation. Night noise guidelines for Europe. Copenhagen: World Health Organisation; 2009.
- [32] Working Group on Assessment of Exposure to Noise (WGAEN). Good practice guide for strategic noise mapping and the prediction of associated data on noise exposure. European Commission Working Group; 2006.
- [33] Department of Transport and the Welsh Office. Calculation of road traffic noise (CRTN). London: HMSO; 1988.
- [34] Steele C. A critical review of some traffic noise prediction models. *Appl Acoust* 2001;62:271–87.
- [35] Abbott PG, Nelson PM. Converting the UK traffic noise index LA10, 18 h to EU noise indices for the purposes of noise mapping. UK: TRL Limited; 2002.
- [36] O'Malley V, King E, Kenny L, Dilworth C. Assessing methodologies for calculating road traffic noise levels in Ireland – converting CRTN indicators to the EU indicators (L_{den} , L_{night}). *Appl Acoust* 2009;70:284–96.
- [37] King EA, Rice HJ. The development of a practical framework for strategic noise mapping. *Appl Acoust* 2009;70:1116–27.
- [38] Government of Ireland. Environmental noise regulations 2006. Stationary office, Dublin. Statutory instrument no. 140 of 2006; 2006.
- [39] Zannin PHT, Diniz FB, Barbosa WA. Environmental noise pollution in the city of Curitiba, Brazil. *Appl Acoust* 2002;63:351–8.
- [40] King EA, Murphy E, McNabola A. Reducing pedestrian exposure to environmental pollutants: a combined noise exposure and air quality analysis approach. *Transport Res D* 2009;14:309–16.

ITEM 11.1.

From: [Erik R](#)
To: [Darcy Goulart](#)
Subject: Re: CNU Dormitory Project PRA
Date: Thursday, May 21, 2020 10:12:15 PM

Hi Darcy,

I can't find any response to these questions in my email. Please resend if I've missed them.

I need a response to the questions so that I can prepare my comments for the City Council.

None of my concerns regarding current noise impacts for the project on White Rock were even discussed in your response. This lack of responsiveness on noise abatement, and what I see as a chronic failure of the City to follow up on citizen complaints the fundamental process issue I have brought forward. The lack of responsiveness simply reinforces my concerns about the CNU build-out and the City's ability to follow and enforce CEQA, and its own ordinances.

Since I haven't heard back in a timely manner, please consider this email as a formal public records act request to the City of Rancho Cordova and any of its staff, consultants, or council members for all communications (electronic, written or text) regarding the CNU dormitory project, the subject properties (both the CNU and White Rock office building rehabilitation project described in my email), or any associated project feature, council action, or consideration, from (or between if in your possession) the project proponents, their consultant or advocates, concerned citizens, council members, staff, consultants, or otherwise.

If you take the position that one or more of these items is covered under privilege, please advise me which property, which topic, which communication media, and which party you are claiming this for.

I would consider a failure to timely respond to this public records act request a deliberate obfuscation of the material issues that I have brought forward related to CEQA, and a failure under the PRA.

Thank you for your consideration.

Erik

From: Erik R <eringelberg@hotmail.com>
Sent: Sunday, May 17, 2020 9:02 PM
To: Darcy Goulart <dgoulart@cityofranhocordova.org>
Subject: Re: CNU Dormitory Project

ITEM 11.1.

Thanks Darcy,

Did you give my contact information to the project proponent? If so was this through a PRA? He contacted me just a few hours after your email.

I saw the attachment that you provided in your email. Your comments in no way address my the fundamentals of my concerns and lack any technical substantiations. The City's analysis seems to be based on speculation. Forevermore the response format does not follow any kind of structure. I made comments on the following:

1. *Construction sound impacts with the potential to harm human health and wildlife, Partly responsive.*
2. *Construction traffic impacts, Partly responsive.*
3. *New construction idling impacts, Partly responsive.*
4. *New construction GHG from equipment, Partly responsive.*
5. *New construction air quality dust and TAC impacts, UNRESPONSIVE*
6. *Potential impacts from failure to follow Stormwater management plans, UNRESPONSIVE*
7. *Operational GHG impacts from project traffic, Partly responsive.*
8. *New lighting impacts with the potential to harm wildlife, UNRESPONSIVE (Comments added.)*
9. *New aesthetic impacts given the visual dissimilarity to the immediate location, Partly responsive.*
10. *Cumulative traffic impacts to this area, and, UNRESPONSIVE*
11. *New water demands in an area reliant on groundwater. Partly responsive.*

I have addressed the following that you were partly responsive to. I did not add to those that I considered you unresponsive to with the exception of lighting.

1. Building sound attenuation. You provide no engineering analysis of peak and continuous sound, and instead point to some nebulous attenuation factor. What is your expertise and basis by which to make that statement? What is the baseline, expected project construction and long-term sound impacts? 1a. My comments on sound were based on my actual measurements and defined by my experience monitoring the unabated project noise from a nearby project. 1b. Do you have any staff going to construction sites and measuring sound, if so, when and how? My experience is that it is nearly impossible to get any follow-up by the City on the "Mitigation monitoring and Reporting Program," and so you make unsubstantiated claims about noise reduction without a technical basis, and the do not enforce what restrictions you have. 1c. You provided no responses to my concerns that the City has failed in my experience to meet its basic

ITEM 11.1.

standards during construction.

2. Species' Use. The project area has several important bird species. There are owls that actively nest in the area, a variety of raptors, including sharp-shinned hawks, and occasional Swanson's hawks use the project area. I have personally rescued baby killdeer in the storm drain near the project area. Please provide your field surveys and the current California Natural Diversity Database results for 1/2 mile around the project footprint that substantiate your opinion on wildlife use.
3. Lighting. Lighting is a distraction to drivers on the freeway and induce wildlife use or discourage wildlife use. Lighting can confuse migratory birds and change their behavioral patterns. As any resident in the area can tell you, there are excessive night lights, and numerous strobing lights in the business complexes.
4. VMT. What is the basis for the VMT identified in your email? How many would have commuted by car, light rail or bus-what is the foundation for your analysis?
5. Traffic and GHG. How do you know what the congestion will be? I cannot even identify how many students will use the dorm, is it 400? Or, up to 800? What are the daily trip basis assumptions? What is the occupancy rate, and will they park there or on the street, or in the neighboring parking lots? The City has not provided any short- or long-term traffic analysis to base your statements on. 3a. My concern is that the City will not have the applicant follow the rules for idling. I never saw any restrictions actually applied to BDX. You claim to follow the law, have you ever issued a single notice on construction idling or traffic or public parking blockage? 3b. What are your cumulative GHG impacts from construction, or, new NOx? How is the project actually compliant with the requirements? 3c. How many diesel truck trips will be needed for supplies to the school and to its cafeteria? How many truck trips and what class of vehicle will be needed for cleaning supplies and building maintenance? You claim without analysis that the project is consistent, yet how can I compare this to the GP? Particulates and NOx are much higher from diesel trucks than student's cars, yet there is no analysis. How about the emissions from the food preparation, are all of these fully considered and consistent with the GP? You provide no basis by which to tell.
6. Aesthetics. You have no aesthetic analysis. How much shading will occur, what are the wind impacts, where is the visual analysis for consistency?
7. Water Demands. So you are saying that the project is compliant with SGMA? How is the project meeting the variety of requirements to show that it is not going to impact the subbasin? Was a will serve letter issued by Golden State Water or is that simply an assumption on the part of the City?

Thank you.

From: Darcy Goulart <dgoulart@cityofranchocordova.org>

Sent: Thursday, May 14, 2020 3:14 PM

ITEM 11.1.

To: Erik R <eringelberg@hotmail.com>

Subject: RE: CNU Dormitory Project

Good Afternoon Erik,

We've have provided a response to your May 4th email in the upcoming May 18th staff report. I have attached that response to this email for your ease. If you have any additional questions or comments, please let me know.

Thank you!

Darcy Goulart
Planning Manager
City of Rancho Cordova
2729 Prospect Park Drive
Rancho Cordova, CA 95670
(916) 851-8784
www.cityofranchocordova.org

From: Erik R <eringelberg@hotmail.com>

Sent: Monday, May 4, 2020 6:30 PM

To: PlanningServices <planningservices@cityofranchocordova.org>

Subject: CNU Dormitory Project

Dear Darcy Goulart, Rancho Cordova Planning Manager,

I am writing to raise concerns about the CNU Dormitory Project. But I could not find the public comment access route. I understood that the meeting was not open to the public, but discovered today that I could come in. So I may take advantage of your process at the next meeting.

I discovered this project by accident when I was walking and saw the sign. I did not receive any notices, but I believe that I am one of the closest residences to this project.

I had previously raised objections to the BDX project at Capitol Village. My concerns included the building being taller than we had been told, increased parking putting pressure on the neighborhood, construction noise, dust and water quality impacts. During construction we had significant noise, parking, traffic and dust problems. I documented the specific problems around construction vehicles parking on residential streets, including Disk and Bridgeway; trucks blocking Data Dr, continuous vehicle idling; and, clear violations of the Stormwater Best Management Practices. I brought these to the attention of the Planning Department who claimed that they could not do anything about these environmental impacts. When I asked about the Mitigation Monitoring and Reporting Plan they did not have any answers about what was being followed. After multiple calls, they gave me the name of a code enforcement officer who said he could not do anything about these problems unless he personally observed the issues and he

ITEM 11.1.

was 'too busy' to come out.

Most recently, the rehabilitation of the building on White Rock and Data has started. While I am supportive of the reuse of this building, this morning at 5:50, they started a circular saw and what could be a compressor. I was able to set up a sound meter compliant with 6.68.050, at 8:35. With the readings >56.1 dB with Peaks at or over 76.0 dB, measured pursuant to 6.68.080 Interior noise standards, and exceeding both indoor and outdoor standards. The City needs to take construction-related environmental impacts much more seriously.

All of these issues relate to the proposal to build CNU Dormitory Project, a residential facility in the middle of a business park: The project is a 61' tall complex, over 100,000/sq/ft just for the 400 dorms and a commercial kitchen! In no way is this consistent with the zoning and the adjacent uses.

There will be significant construction and operational impacts as related to the massive new building, given my experience and the City's recent track record:

1. Construction sound impacts with the potential to harm human health and wildlife,
2. Construction traffic impacts,
3. New construction idling impacts,
4. New construction GHG from equipment,
5. New construction air quality dust and TAC impacts,
6. Potential impacts from failure to follow Stormwater management plans,
7. Operational GHG impacts from project traffic,
8. New lighting impacts with the potential to harm wildlife,
9. New aesthetic impacts given the visual dissimilarity to the immediate location,
10. Cumulative traffic impacts to this area, and,
11. New water demands in an area reliant on groundwater.

Thank you for your consideration,

Erik Ringelberg

ITEM 11.1.

From: [Erik R](#)
To: [PlanningServices](#)
Subject: CNU Dormitory Project
Date: Monday, May 4, 2020 6:30:20 PM

Dear Darcy Goulart, Rancho Cordova Planning Manager,
I am writing to raise concerns about the CNU Dormitory Project. But I could not find the public comment access route. I understood that the meeting was not open to the public, but discovered today that I could come in. So I may take advantage of your process at the next meeting.

I discovered this project by accident when I was walking and saw the sign. I did not receive any notices, but I believe that I am one of the closest residences to this project.

I had previously raised objections to the BDX project at Capitol Village. My concerns included the building being taller than we had been told, increased parking putting pressure on the neighborhood, construction noise, dust and water quality impacts. During construction we had significant noise, parking, traffic and dust problems. I documented the specific problems around construction vehicles parking on residential streets, including Disk and Bridgeway; trucks blocking Data Dr, continuous vehicle idling; and, clear violations of the Stormwater Best Management Practices. I brought these to the attention of the Planning Department who claimed that they could not do anything about these environmental impacts. When I asked about the Mitigation Monitoring and Reporting Plan they did not have any answers about what was being followed. After multiple calls, they gave me the name of a code enforcement officer who said he could not do anything about these problems unless he personally observed the issues and he was 'too busy' to come out.

Most recently, the rehabilitation of the building on White Rock and Data has started. While I am supportive of the reuse of this building, this morning at 5:50, they started a circular saw and what could be a compressor. I was able to set up a sound meter compliant with 6.68.050, at 8:35. With the readings >56.1 dB with Peaks at or over 76.0 dB, measured pursuant to 6.68.080 Interior noise standards, and exceeding both indoor and outdoor standards. The City needs to take construction-related environmental impacts much more seriously.

All of these issues relate to the proposal to build CNU Dormitory Project, a residential facility in the middle of a business park: The project is a 61' tall complex, over 100,000/sq/ft just for the 400 dorms and a commercial kitchen! In no way is this

ITEM 11.1.

consistent with the zoning and the adjacent uses.

There will be significant construction and operational impacts as related to the massive new building, given my experience and the City's recent track record:

1. Construction sound impacts with the potential to harm human health and wildlife,
2. Construction traffic impacts,
3. New construction idling impacts,
4. New construction GHG from equipment,
5. New construction air quality dust and TAC impacts,
6. Potential impacts from failure to follow Stormwater management plans,
7. Operational GHG impacts from project traffic,
8. New lighting impacts with the potential to harm wildlife,
9. New aesthetic impacts given the visual dissimilarity to the immediate location,
10. Cumulative traffic impacts to this area, and,
11. New water demands in an area reliant on groundwater.

Thank you for your consideration,

Erik Ringelberg

ITEM 11.1.

May 15, 2020

Mayor David Sander dsander@cityofranchocordova.org Vice Mayor Garret Gatewood
ggatewood@cityofranchocordova.org Council member Donald Terry
dterry@cityofranchocordova.org Council Member Linda Budge lbudge@cityofranchocordova.org Council
Member Robert McGarvey rmegarvey@cityofranchocordova.org

Mayor Sander and Council Members

City of Rancho Cordova

2720 Prospect Park Drive

Rancho Cordova, California 95670

RE: Opposition to California Northstate University Dormitory Project

Dear Mayor Sander and Council Members,

We, as neighbor of California Northstate University College of Health Sciences (CNU), submit comment on its Dormitory Project (project). Our businesses have brought hundreds of jobs to Rancho Cordova and contributed significantly to the local economy. We expect the City to take our investments in Rancho Cordova into account when considering new development applications, including the dorm Project. As an initial matter, we object to consideration and approval of this project without further input from the affected businesses. The minimal mailing of a postcard notice addressed to the "current resident" to buildings within 500 feet of the project is insufficient. I never actually received the postcard, and only learned of the project from a neighboring landowner who actually did receive the postcard. In addition to difficulties receiving mail addressed to a large building, the current scaling back or shutdowns of offices due to the COVID-19 pandemic have made it even more difficult for building managers to stay up to date on local planning issues. Rather than increase outreach to make sure local businesses are informed, it appears the City is using the communication difficulties of the pandemic to push this controversial project through. Regarding the substance of the proposal, two large five-story dormitory buildings in this location would be incompatible and out of scale with the surrounding established commercial uses. Among other issues, we are concerned about where the 400 dormitory residents would park. While there is currently adequate parking in the area, bringing in 400 new student residents with only 147 new parking spaces (1 space for every three residents) would change the situation dramatically. We anticipate that CNU students and residents would end up parking both on the street, as well as illegally parking in our lots when these foreseeable parking shortages occur. Yet these lots and street spaces are needed for our tenants and their customers. One of the primary benefits of doing business in Rancho Cordova – adequate, no-stress parking – would be lost. In this tough leasing

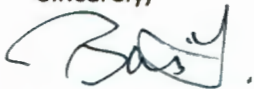
ITEM 11.1.

environment that is likely to deteriorate further due to the COVID-19 pandemic, we object to the City saddling us with this disadvantage.

We also think that the area does not provide the amenities that would be needed by 400 dormitory residents. Unlike other areas of Rancho Cordova, we have very few eating establishments that are open in the evening, as well as few shopping options in the vicinity. Especially if students do not each have access to a vehicle (as the City must be assuming with the 3:1 parking ratio), this dearth of amenities would make the area inhospitable to student life. Thus, in addition to straining our business operations, the dormitories would not ideal for prospective students.

We see from the April 20 staff report that the City intends to issue a CUP for the dormitories as an accessory use. With the existing school footprint being relatively small, we cannot see how two much larger large dormitories and a cafeteria would be "accessory" uses. In addition, to issue a CUP, the City must find that "The negative impacts of the proposed use on adjacent properties and on the public can be mitigated through application of other code standards or other reasonable conditions of approval." (Zoning Code, 23.134.070B.) Yet we do not see any attempt to address negative impacts on adjacent properties and do not believe this finding can be made in good faith. It is especially concerning that the City proposes to rely on environmental review of the City's General Plan approved 15 years ago, and there are no new mitigation measures or conditions proposed specifically to protect adjacent properties. Given the significant negative impacts of this project on our area and businesses, as well as on the environment, the City should delay further consideration of the project at least until an open and transparent discussion can occur. As it stands, the public has not had an opportunity to review and understand the Project, as the public is under the most severe restrictions in movement that have been imposed in most people's lifetimes due to the COVID-19 pandemic. It is unconscionable to move forward until these restrictions on movement are lessened, and the public can meaningfully participate in the City's review of this proposed large-scale change of this part of the City.

Sincerely,



Brent Lee, Managing Member

2868 Prospect Drive and 10901 Gold Center Drive, Rancho Cordova

cc: Stacy Leitner, City Clerk, sleitner@cityofranchocordova.org

Darcy Goulart, Planning Manager, dgoulart@cityofranchocordova.org

ITEM 11.1.



May 15, 2020

Mayor Sander and Council Members
City of Rancho Cordova
2720 Prospect Park Drive
Rancho Cordova, Ca 95670

RE: Opposition to California Northstate University Dormitory Project

Dear Mayor & Council Members:

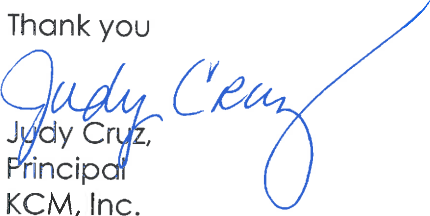
Please allow this letter to serve as my opposition to the proposed planning of the California Northstate University Dormitory Project planned for 2910 Prospect Park Drive. I have been a commercial property manager in the Prospect Park area for approximately 25 years. I have owned KCM Commercial Property Management for 15 years, managed several buildings in the area and have personally leased office space at 3140 Gold Camp Drive for 15 years. I love how the park has grown and changed with many different tenants over the years, but continued with fundamental long-range strategic development planning.

My more specific concerns include traffic, parking and trash. Currently, traffic is already become a large issue. As you know, we have some large tenants, including EDD, State of California Water Resources, TriWest, etc. I cannot imagine this office park holding an additional 400 dormitory residents. That would have a horrendous impact on the current tenants of the area as well as potential growth for future like zoned development projects.

This office park has one full service restaurant - casino/ card room, and a couple other smaller cafes. This is not the correct environment for 400, early 20's aged residents. Parking would be another huge concern. There are times when some of the existing offices have to park on the street and surrounding areas. I cannot imagine the streets being full of cars at all times, especially with how many employees use the sidewalks for walking breaks. In addition, this project would increase trash. This would cause the office park to deteriorate quickly, which would hurt all the property owners trying to bring major tenants into their buildings and the City of Rancho Cordova as a whole.

From my experience as a developer, property manager and business owner in this area, I feel the negative impact of this project could be huge for the future of Prospect Park Office Park and the City of Rancho Cordova. It is my sincere hope that you reconsider the location this project.

Thank you


Judy Cruz,
Principal
KCM, Inc.

ITEM 11.1.



Email Cc:

David Sander, Mayor, dsander@cityofranchocordova.org

Garret Gatewood, Vice Mayor, ggatewood@cityofranchocordova.org

Donald Terry, Council Member, dterry@cityofranchocordova.org

Linda Budge, Council Member, lbudge@cityofranchocordova.org

Robert McGarvey, Council Member, rmcgarvey@cityofranchocordova.org

Stacy Leitner, City Clerk, sleitner@cityofranchocordova.org

Darcy Goulart, Planning Manager, dgoulart@cityofranchocordova.org

ITEM 11.1.

May 14, 2020

Mayor David Sander dsander@cityofranchocordova.org
Vice Mayor Garret Gatewood ggatewood@cityofranchocordova.org
Council member Donald Terry dterry@cityofranchocordova.org
Council Member Linda Budge lbudge@cityofranchocordova.org
Council Member Robert McGarvey rmcgarvey@cityofranchocordova.org

Mayor Sander and Council Members
City of Rancho Cordova
2720 Prospect Park Drive
Rancho Cordova, California 95670

RE: Opposition to California Northstate University Dormitory Project

Dear Mayor Sander and Council Members,

I submit these comments on the California Northstate University College of Health Sciences (CNU) Dormitory Project (project). I am the current owner of the 10995 Gold Center buildings (68,000 square feet) located adjacent to the proposed project. Our building brings hundreds of jobs to Rancho Cordova and contributes significantly to the local economy. We expect the City to take our investment in Rancho Cordova into account when considering new development applications, including the dorm Project.

As an initial matter, we object to consideration and approval of this project without further input from the affected businesses. The minimal mailing of a postcard notice addressed to the "current resident" to buildings within 500 feet of the project is insufficient. I never actually received the postcard, and only learned of the project this past Wednesday from a neighboring owner. In addition to difficulties receiving mail addressed to a large building, the current scaling back or shutdowns of offices due to the COVID-19 pandemic have made it even more difficult for building managers to stay up to date on local planning issues.

Regarding the substance of the proposal, two large five-story dormitory buildings in this location would be incompatible and out of scale with the surrounding established commercial office uses. Among other issues, we are concerned about where the 400 dormitory residents would park. While there is currently adequate parking in the area, bringing in 400 new student residents with only 147 new parking spaces (1 space for every three residents) would change the situation dramatically. We anticipate that CNU students and residents would end up parking both on the street, as well as illegally parking in our lots when these foreseeable parking shortages occur. Yet these lots and street spaces are needed for our tenants and their customers. One of the primary benefits of doing business in Rancho Cordova – adequate, no-stress parking – would be lost. In this tough leasing environment that is likely to deteriorate further due to the COVID-19 pandemic, we object to the City saddling us with this disadvantage.

ITEM 11.1.

When Heald College previously occupied one the existing buildings we experienced students parking in our lots, leaving trash and loitering. With students living on site 24/7 I would expect many more impacts.

We also think that the area does not provide the amenities that would be needed by 400 dormitory residents. Unlike other areas of Rancho Cordova, we have very few eating establishments that are open in the evening, as well as few shopping options in the vicinity. Especially if students *do not* each have access to a vehicle (as the City must be assuming with the 3:1 parking ratio), this dearth of amenities would make the area inhospitable to student life. Thus, in addition to straining our business operations, the dormitories would not be ideal for prospective students.

We see from the April 20 staff report that the City intends to issue a CUP for the dormitories as an accessory use. With the existing school footprint being relatively small, we cannot see how two much larger dormitories and a cafeteria would be "accessory". In addition, to issue a CUP, the City must find that "The negative impacts of the proposed use on adjacent properties and on the public can be mitigated through application of other code standards or other reasonable conditions of approval." (Zoning Code, 23.134.070B.) Yet we do not see any attempt to address negative impacts on adjacent properties and do not believe this finding can be made in good faith. It is especially concerning that the City proposes to rely on environmental review of the City's General Plan approved 15 years ago, and there are no new mitigation measures or conditions proposed specifically to protect adjacent properties.

Given the significant negative impacts of this project on our area and businesses, as well as on the environment, the City should delay further consideration of the project at least until an open and transparent discussion can occur. As it stands, the public has not had an opportunity to review and understand the Project, as the public is under the most severe restrictions in movement that have been imposed in most people's lifetimes. It is unconscionable to move forward until these restrictions on movement are lessened, and the public can meaningfully participate in the City's review of this proposed large-scale change of this part of the City.

Sincerely,



Pierre H. Perret
Main Stone Corporation

cc: Stacy Leitner, City Clerk, sleitner@cityofranchocordova.org
Darcy Goulart, Planning Manager, dgoulart@cityofranchocordova.org

Consolidated Response to letters**The City Should Not Rush Approval of this Controversial Project During the COVID-19 Pandemic (SoluriMeserve, Lee and Perret letter)**

The comments argue that the City should not decide the project during COVID-19 as the public has allegedly had less notice and ability to participate. There has been no state law or order passed which has limited or prohibited California cities from holding public hearings on land use entitlements during COVID-19. To the contrary, since mid-March, state orders (Executive Order N-29-20 and its predecessor N-25-20), have explicitly allowed all public meetings and public hearings held under the Brown Act to be convened “telephonically or otherwise electronically.” If such electronic methods are used, the current Order only requires that the agenda must provide notice of the means by which the public may observe the meeting and offer public comment. It does not prescribe or proscribe those means. The Order also makes clear that local agencies “need not make available any physical location from which members of the public” may observe and offer public comment. The City has both specified the means by which the public may observe and offer public comment at the electronic meeting. The City allows written comments and promptly provides to the City Council copies of all written comments it receives. The City has even continued to keep the chambers and land use proceedings open to the public to provide in-person comments, as well as allowing public participation by video teleconferencing. The City has, in short, far exceeded the minimum requirements under the current state Order, by providing notice of the means by which the public may participate electronically while still also allowing physical participation for those that choose to do so.

On May 25, 2020, the Governor also significantly relaxed restrictions on gatherings for first amendment activities, making it clear to all interested parties that they can safely come to City Hall to participate in governmental proceedings like the consideration of this project. The City even further facilitates in-person public comment during the COVID-19 pandemic by offering those who may wish to speak in-person complementary face masks, hand sanitizer and ample seating with social distancing.

The Scope of the Project is Not Defined (SoluriMeserve letter)

The comment suggests that the dormitory project might be part of a larger expansion of school enrollment, and therefore the scope of the project is not defined to include the whole of the action proposed. While the project will allow CNU to expand the type of students it serves to include international students, the project will not result in an expansion of enrollment beyond its current capacity. The existing campus education space is approximately 91,600 square feet, including 45,816 sf at 2910 Prospect Park Drive and 45,816 sf at 2920 Prospect Park Drive. As stated in the trip generation estimate prepared by KD Anderson and Associates, current enrollment is around 200 students and is anticipated to grow to 420 students. Enrollment is anticipated to grow with or without the proposed dormitory project and will remain well within the capacity of the current campus facilities as currently entitled. CNU has confirmed it has no plans to expand enrollment beyond its current capacity and no campus expansion is anticipated.

Although CNU has no plans to increase enrollment beyond current projections at this time, such an action would not be subject to CEQA because the current facilities could support increased enrollment. No additional or expanded facilities would be required. Increased enrollment would not require any discretionary permit that would in turn trigger further CEQA review. Therefore, there is no possibility of a future CEQA project that has been piecemealed from the current project.

In *Laurel Heights Improvement Association v. Regents of the University of California* (1988) 47 Cal.3d 376, 396, the California Supreme Court held that an analysis of the environmental effects of future expansion or other action is required “if: (1) it is a reasonably foreseeable consequence of the initial project; and (2) the future expansion or action will be significant in that it will likely change the scope or nature of the initial project or its environmental effects.” As applied here, it is not reasonably foreseeable that the dormitory project, which will have capacity to house 416 students, will result in the expansion of the CNU campus, or otherwise affect enrollment to require additional capacity. The existing campus has capacity to serve projected enrollment, and the dormitory project will allow a significant number of those students to live directly on campus. The comment provides no evidence to suggest otherwise.

The Project is Not an Accessory Use and is Incompatible with the Zoning Code, Precluding Conditional Use Permit Issuance (SoluriMeserve, Lee, and Perret letter)

The Rancho Cordova Municipal Code (RCMC), Section 23.313.030, Table 23.313-1 Allowed Use and Permit Requirements for Mixed-Use Districts, footnote 31, states that dormitories are permitted as an accessory use to a public or private school upon approval of a Conditional Use Permit. While an accessory use is not defined in Article 11, Section 23.1104 of the RCMC, as interpreted by the City, an accessory use is one that supports a primary use. As defined by Merriam-Webster, accessory is an object or device that is not essential in itself but adds to the beauty, convenience or effectiveness of something else. As a standalone project, unaffiliated with any other use, the dorms would not be a necessity. However, the proposed project would provide a housing opportunity for students currently enrolled at the university, as well as perspective students, thereby providing an accessory use to the university. It is very typical for higher education institutions to provide various on-campus housing and dining options to make both learning and teaching easier, more convenient and more effective for the existing and prospective student population.

In the case of the project site, the proposed dormitories would be constructed on the same property, immediately adjacent to existing CA Northstate University Rancho Cordova campus. The applicant for the dorm project recently received approval of an application for a lot merger to reconfigure the parcels on the campus such that all the buildings on the campus are on a single parcel. The merged parcels where the proposed dormitory would be constructed and where the existing university building is located, as well as an adjacent parcel are all owned by the university. All the parcels are zoned Office Park Mixed Use (OPMU). The existing classroom building and the new dorms and dining facilities will be operated as a single campus, that shares common parking, drive aisles and ingress and egress points from Prospect Park Drive. Students that are currently enrolled at the university, as well as potential new students would have the ability to utilize the dorms as their permanent living arrangements while attending this campus.

The proposed dormitory buildings are well within the development standards for the OPMU zoning district. The new buildings do not violate the minimum setback requirements and are under the maximum height of 65 feet. The total square footage of the buildings in relation to the size of the parcel has a floor area ratio (FAR) of 0.63, which is within the allowable range of 0.25 to 2.0. If the site were to be constructed in a manner to support office uses, the maximum FAR could support around 250,000 square feet of building space. This would likely be in the form of more than one multi-story building, at the maximum height of 65 feet with supporting parking.

Additionally, there is no requirement in the RCMC that prohibits an accessory use in a commercial or mixed-use campus from being on a second or multiple adjoining properties, as implied is the letter. Nevertheless, and although not required, the applicant for the dorm project recently received approval of an application for a lot merger to reconfigure the parcels on the campus such

that all the buildings on the campus are on a single parcel. Approval of the lot merger moots this sub issue.

Operational and Construction Related Impacts (SoluriMeserve, Ringelberg, Lee, Cruz and Perret letter)

1. Greenhouse Gas Emissions

In response to comments regarding the project's greenhouse gas (GHG) emissions, a quantitative analysis was prepared to determine whether the project's emissions would exceed the thresholds recommended by the Sacramento Metropolitan Air Quality Management District (SMAQMD).

As described in the analysis, maximum annual emissions for construction of the project are 651 MT CO₂e/year, which would not exceed SMAQMD's threshold of 1,100 MT CO₂e/year for GHG construction emissions (SMAQMD 2020a). Given that emissions of GHGs during construction are short-term, temporary, and below SMAQMD thresholds, construction of the Project would not generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.

Long-term operational GHG emissions were calculated and evaluated against SMAQMD-recommended threshold of significance for land use development projects. SMAQMD's threshold justification report states that projects that fall under the screening threshold level of 1,100 MT CO₂e/year are anticipated to only account for less than two percent of annual emissions in the county. Based on modeling conducted, the project would emit 1,051 MT CO₂e/year during operations, which does not exceed SMAQMD's operational screening threshold of 1,100 MT CO₂e (SMAQMD 2020b). Because project emissions are below the SMAQMD threshold, operation of the project would not generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.

Further, the modeled emissions for construction and operation of the project are conservative estimates that would be further reduced by project characteristics that were not included in the model. For example, the Project is proposed to be constructed using modular construction which would likely result in fewer construction haul trips and worker trips than traditional construction. However, CalEEMod default values for construction inputs typical of traditional construction were used in order to ensure a conservative approach. Because the analysis does not account for the trip reductions associated with modular construction, the Project would likely result GHG emissions lower than were modeled and presented in the memorandum.

In addition, while the analysis relied on trip generation from KD Anderson's study done for the purposes of analyzing level of service (LOS), the trip generation study did not address vehicle miles traveled (VMT). Due to the fundamental differences in the LOS and VMT transportation analysis metrics, the KD Anderson & Associates study did not address how the Project would affect existing travel patterns for the college as it relates to VMT. By locating student housing in close proximity to the existing classroom facilities, it is likely that the number of existing student trips would decrease, and trips and associated length of travel generated by both existing and new students would be shorter than if the Project were not to occur. Additionally, the Project would be located along Regional Transit's

Rancho Cordova Route 177 and is within one-half mile of an existing major transit stop (i.e., Regional Transit Cordova Town Center Light-rail Station). In addition, the Project is located in an area identified by the Sacramento Area Council of Governments (SACOG) in the 2020 Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS) as a High Frequency Transit Area (HFTA) for Sacramento County. These are areas located within one-half mile of a major transit stop (including an existing or planned light rail, streetcar, or train station) or an existing or planned high-quality transit corridor. Therefore, the Project would likely be more VMT efficient based on its proximity to transit. Nonetheless, in the interest of providing a conservative analysis, vehicle trip data obtained from the KD Anderson & Associates trip generation study was used to determine operational mobile source emissions described above (KD Anderson & Associates 2020). However, the operational mobile source emissions of the Project would likely be lower than presented in the GHG analysis due to the conservative approach of the modeling.

2. Energy Consumption

The comment states that, since the City did not evaluate energy consumption impacts in the General Plan, it must analyze the energy impacts of the project. In response to this comment, a quantitative analysis was prepared, which concluded that, while implementation of the Project is anticipated to increase the consumption of electricity, natural gas, and fossil fuels during construction and operation, the Project is an infill development located in close proximity to transit and would reduce mobile fuel on a regional basis by reducing total student generated VMT. Housing students on the campus would reduce vehicle miles traveled compared to students commuting from various locations in the region, thereby reducing fuel consumption and greenhouse gas emissions. In addition, housing options available to students off campus would likely be less energy efficient than the dormitories, resulting in less energy demand per capita for those students

In addition, the new buildings would be required to comply with the Titles 20 and 24 of the California Code of Regulations, which serve to reduce demand for electrical energy by implementing energy-efficient standards for residential and non-residential buildings. In addition, the Project would comply with the City's General Plan includes Policies LU.2.7, H.4.1, NR.7.1, NR.7.2, NR.7.3, and NR.7.4 to encourage the development of more energy efficient structures, increase overall energy conservation citywide, and reduce the consumption spread of energy-efficient technology by offering rebates and other incentives to commercial and residential developers. Compliance with these standards, which are intended to promote energy efficiency, would ensure that the increase would not be "wasteful, inefficient, or unnecessary." Implementation of these standards would significantly reduce energy usage from the project. Further, at least 45 percent of the electricity provided by SMUD would be from renewable sources. In addition, SACOG's 2020 MTP/SCS concluded that per capita energy consumption will decrease as a result of implementation of the plan. As discussed above, the proposed Project is consistent with the MTP/SCS in that it locates housing in an area designated as a High Frequency Transit Area for Sacramento County.

Further, as noted in the comment, the dormitories would be of modular construction, which provides for efficiency of construction and reduced waste. Less waste results in less energy demand for raw materials. Modular construction also results in less construction equipment on the project site compared to typical construction assumed in the General Plan EIR.

The project would not result in any unusual characteristics that would result in excessive operational energy consumption. The proposed project would not place a substantial demand on regional energy supply or require significant additional capacity; significantly increase peak and base period electricity demand; cause wasteful, inefficient, and unnecessary consumption of energy during project construction, operation, and/or maintenance; or preempt future energy development or future energy conservation. Thus, consumption associated with construction and operational energy demand of the project would not be considered inefficient, wasteful, or unnecessary in comparison to other similar developments in the region. No further analysis is required.

3. Health Risk Assessment of Toxic Air Contaminant Emissions and Ultrafine Particulates

The comment provides information on health risks associated with mobile-source toxic air contaminants (TAC) emissions and states that this is new information that was not available or known in 2005 and, therefore, the project would result in more severe impacts than previously analyzed in the 2005 General Plan EIR. Specifically, the comment refers to particulate matter less than 0.1 micron. The commenter references an authority on mobile source TAC emissions based on comments on the Nishi Project by Dr. Thomas A. Cahill. However, the commenter provides no details of the Nishi Project and no information of how the comments on that project relate to the conditions on this project site. In addition, Dr. Cahill's comments on the Nishi Project are purely conclusory: the comment simply states the Nishi site is unsuitable for residential development and notes that he could have provided equipment to test air quality at the Nishi site. Consequently, no comparison can be made between potential TAC effects at the Nishi site and the proposed project site.

Health risks associated with fine particulate matter, such as diesel particulate matter and other constituents of automobile and truck exhaust, which includes particulate matter less than 10 microns and less than 2.5 microns, of which particulates 0.1 micron or less is a subset, was known at the time the General Plan EIR was prepared and certified. There are currently no air quality models that estimate emissions of particulates less than 0.1 microns. Construction-related air pollutant emissions were addressed in Draft EIR Impact 4.6.2 (GP EIR pp. 4.6.2 – 4.6.20), including emissions from grading, building demolition, building construction, and paving, as well as motor vehicle exhaust associated with construction equipment and construction personnel commuter trips, and material transport and delivery. The Draft EIR identified General Plan Policies and Action Items that would provide mitigation for these emissions. However, the EIR determined that policies and action items would not fully offset air pollutant emissions from construction activities, so the impact remained significant and unavoidable. Operational impacts related to toxic air contaminants were addressed in Draft EIR Impact 4.6.4 (GP EIR pp. 4.6.26 – 4.6.31), including stationary sources and mobile sources. Like construction emissions, the EIR determined implementation of policies and action items to reduce impacts would not fully offset TAC source emissions or exposure, and the impact remained significant and unavoidable. However, project design would include ventilation system capable of achieving the protection from particulate matter (PM_{2.5}) equivalent to that of a Minimum Efficiency Reporting Value (MERV) 13 filtration (as defined by American Society of Heating, Refrigerating and Air-Conditioning Engineers [ASHRAE] standard 52.2). According to ASHRAE, particles with a diameter of approximately 0.3 microns are most penetrating, but the efficiency of mechanical filters increases above and below this particle size (<https://www.ashrae.org/technical-resources/filtration-disinfection>). Incorporation of

this filtration standard would ensure the project would not be exposed to particulates beyond those assumed in the General Plan EIR.

CEQA Guidelines Section 15183 states that projects that are consistent with the development density established by existing zoning, community plan, or general plan policies for which an EIR was certified shall not require additional environmental review, except as might be necessary to examine whether there are project-specific significant effects which are peculiar to the project or its site. The project site is designated Office Mixed Use in the General Plan and zoned Office Professional Mixed-Use (OPMU), which allows a minimum floor area ratio of 0.25 and a maximum floor area ratio of 2.0 (RCMC Section 23.313.040). The proposed project's floor area ratio is 0.85, which is less than half of the floor area allowed in the General Plan. Because the project is consistent with the development density established in the General Plan, the operational effects of development of the site would have been considered in the EIR, including vehicle trips on US 50 and the emissions of TAC associated with those trips. Consequently, operational emissions from project vehicle trips would not exceed that assumed in the General Plan EIR. There are no aspects peculiar to the project site or the project that that would result in new or more severe TAC impacts than disclosed in the General Plan EIR. No further analysis related to TAC is required.

4. Vehicle Miles Traveled

The comment states that the City was required to analyze vehicle miles traveled impacts for the project. As acknowledged in the comment letter, CEQA Guidelines section 15064.3 does not require that lead agencies begin analyzing VMT as the metric to determine the significance of transportation projects until July 1, 2020. The City is therefore not required to provide an analysis of the project's potential VMT impacts.

Changes in law are presumed to apply prospectively unless it is clear the Legislature intended a retroactive application. (See *Strauss v. Horton* (2009) 46 Cal.4th 364, 470 ["in the absence of a clear legislative intent to the contrary statutory enactments apply prospectively."], citing *Evangelatos v. Superior Court* (1988) 44 Cal.3d 1188, 1208; *Residents Ad Hoc Stadium Com. v. Board of Trustees* (1979) 89 Cal.App.3d 274, 282 ["As section 21081 does not by its terms provide for retroactive application, it may only be considered prospectively."].) Here, section 15064.3 clearly and explicitly states that it applies prospectively. (CEQA Guidelines, section 15064.3, subd. (c); see also section 15007 [mandating that changes to the Guidelines act prospectively only]; *Laurel Heights Improvement Assn. v. Regents of University of California* (1993) 6 Cal.4th 1112, 1126, fn. 10.)

The case cited in the comment letter does not require the City to perform a VMT analysis as the comment suggests. In *Citizens for Positive Growth & Preservation v. City of Sacramento* (2019) 43 Cal.App.5th 609, the court considered whether Public Resources Code section 21099 rendered moot the petitioners' challenge to a traffic analysis for failure to analyze level of service impacts. Public Resources Code section 21099 states that, upon certification of the Guidelines addressing VMT, level of service will no longer be used

as the metric to determine environmental impacts. The court's statement that it will apply the law as it exists at the time of judgment on appeal to find that a cause of action is moot where the law supporting that claim is no longer in effect cannot be read to effectively overturn a long line of cases cited above upholding prospective application of statutory and regulatory requirements. (See also *National Parks & Conservation Assn. v. County of Riverside* (1999) 71 Cal.App.4th 1341, 1357 [Guidelines subdivision that changed after project approval did not apply on appeal]; see also *King & Gardiner Farms, LLC v. County of Kern* (2020) 45 Cal.App.5th 814, 879, 883 [considering the versions of Guidelines section 15088 and Appendix G in effect when the agency prepared and certified the EIR].)

Further, by providing housing for students in close proximity to the existing campus, the project will reduce VMT for students who would otherwise be commuting from off site to attend classes. The project also includes onsite dining facilities, laundry, indoor recreational facilities and an exercise gym to further reduce the need for automobile trips. By increasing the mix of uses in the project's surrounding area and increasing the housing balance, the project will provide exactly the type of development cited by Office of Planning and Research (OPR) in its Technical Advisory on Evaluating Transportation Impacts in CEQA as likely to reduce VMT. According to OPR's Technical Advisory, a project located within ½ mile of an existing major transit stop that has a floor area ratio above 0.75, reduced parking, and is consistent with the applicable Sustainable Community Strategy (SCS) is presumed to have a less than significant impacts related to VMT. Consistent with this guidance, the project is located in an area identified by the Sacramento Area Council of Governments as a qualifying area for SB 375 Sustainable Communities Projects and as a high frequency transit area in its most recent Metropolitan Transportation Plan/Sustainable Communities Strategy (2020 MTP/SCS). Further, the project's floor area ratio is 0.63 and limits parking to one space per three occupants. Therefore, the project would be presumed to have less than significant impacts related to VMT.

5. Noise and Resulting Health Impacts

The comment states that, while the General Plan EIR addressed impacts of noise, the understanding of the health impact of noise has since developed and that negative health impacts have been attributed to traffic noise. However, the General Plan EIR acknowledges potential negative health effects of noise in the community (GP EIR p.4.7-2). Traffic noise was addressed in Impact 4.7.2 (GP EIR pp. 4.7-22 – 4.7-27) and it was determined that traffic noise would be a significant and unavoidable impact. Non-transportation noise was addressed in Impact 4.7.3 (GP EIR pp. 4.7-28 – 4.7-30) and this impact was found to be significant and unavoidable. As discussed previously, the proposed project is consistent with the density established in the General Plan for the project site and, therefore, trips associated with development on the project site – and the noise generated by those trips – were considered in the General Plan EIR. The assertion that the project would pose an additional significant occupational noise source for nearby workers is not supported by evidence. Residential uses, such as the proposed dormitories, are typically not substantial generators of noise. Further, office buildings are not considered sensitive receptors and the comment provides no evidence that there is anything peculiar about the project or the project site that would result in substantial noise impacts beyond those disclosed in the General Plan EIR. Thus, potential health impacts

of noise are not new information and the project would not result in a more severe noise impact than disclosed in the EIR. No further analysis is required.

One comment questioned sound attenuation and referred to noise measurements conducted for another project in the City. However, the commenter's measurements provide no information on noise levels to indicate how the proposed project might affect sensitive receptors in the vicinity of the project site. Construction noise was addressed in General Plan Draft EIR Impact 4.7-1, which was found to be a significant and unavoidable impact. While noise measurements conducted by the commenter may provide data related to that particular project where measurements were taken, it does not describe conditions for this project site. There are no sensitive receptors within 1,500 feet of the project site; the nearest residential units are approximately 2,000 feet to the north of the project site. Truck trips associated with project construction would access the site via Sunrise Boulevard to White Rock Road or via Zinfandel Drive to White Rock Road. Residential areas would not be affected. In addition, the modular nature of the construction for this project would reduce construction noise compared to typical on-site construction methods that was assumed as part of the General Plan EIR. In addition, construction time may be reduced due to the modular nature of the building construction, further having the potential to reduce construction noise as compared to a typical project. Lastly, Rancho Cordova Municipal Code Section 6.68.090(E) exempts construction noise so long as it takes place during specified hours and days, and those time restrictions will be made a condition of approval for the project. Therefore, there is nothing peculiar about this project or the project site that would result in more construction noise than assumed in the General Plan EIR.

6. Aesthetics/Light

Aesthetic impacts occur when a project site is substantially altered from the existing condition given the context of the site. The project site is currently a parking lot in a developed portion of the City surrounded by multi-story buildings. Development of the project would not substantially change the character of the project vicinity. The comment does not note what physical environmental impacts would occur with respect to wind or shading. No response is possible.

The project site is in an urbanized area that is currently developed with a parking lot with existing lighting and surrounded by other uses that have outdoor lighting. In addition, lighting for the proposed project would not substantially differ from lighting for other uses that would be allowed by right on the project site. Any development on the site, including the proposed project, would be required to comply with the lighting standards in Municipal Code Chapter 23.725, Outdoor Lighting, the purpose of which is to regulate lighting to balance the safety and security needs for lighting with the city's desire to preserve dark skies and to ensure that light trespass and glare would have negligible impact on surrounding property. This would ensure that there is nothing peculiar about the project site or lighting associated with the proposed project that would result in new or more severe impacts than disclosed in the General Plan EIR.

7. Species

One comment noted the potential for birds to nest on the project site and requested the results of field surveys. Field surveys were not conducted for the project site as the migratory nature of the species potentially present on the site makes the timing of surveys imperative. The project will be conditioned to conduct nest surveys prior to any

construction or tree removal activities during typical nesting seasons. If nests are present, appropriate non-disturbance buffer zones will be required as otherwise recommended by a biologist. These protection measures will remain in effect until the young have left the nest and are foraging independently or the nest is no longer active, as determined by the biologist. This would ensure nesting birds are not negatively affected by project construction. The project site is in an urbanized area that is currently developed with a parking lot with existing lighting and surrounded by other uses that have outdoor lighting. Thus, project lighting would not substantially differ from existing conditions on the project site and project vicinity with respect to lighting impacts on birds.

8. **Water**

The comment states that the project will create new water demands in an area that is reliant on groundwater. Golden State Water Company is responsible for providing domestic and fire protection water services to the project site. On June 5, 2020, a letter was issued by Golden State to CA Northstate University stating that they will be able to provide domestic and fire protection water services for the subject project.

9. **Parking**

The comment states that providing 1 parking space for every 3 occupants is not adequate and any overflow will impact adjacent properties and result in street parking. The parking ratio of 1 parking stall for every 3 occupants is in line with the industry standard for parking dormitories. The dormitory project is providing the required necessary parking spaces to meet the industry standard on the overall site. The University has additional parking that exists on the site that is utilized by existing students and staff. There is excess parking provided throughout the site to accommodate any overflow. While on street parking can not be counted towards required parking, it is fairly common for many employees within the general office park area to utilize on street parking as their preferred parking spot. Parking along the street is not prohibited unless No Parking signs or painted red curbs indicate otherwise.

10. **Traffic**

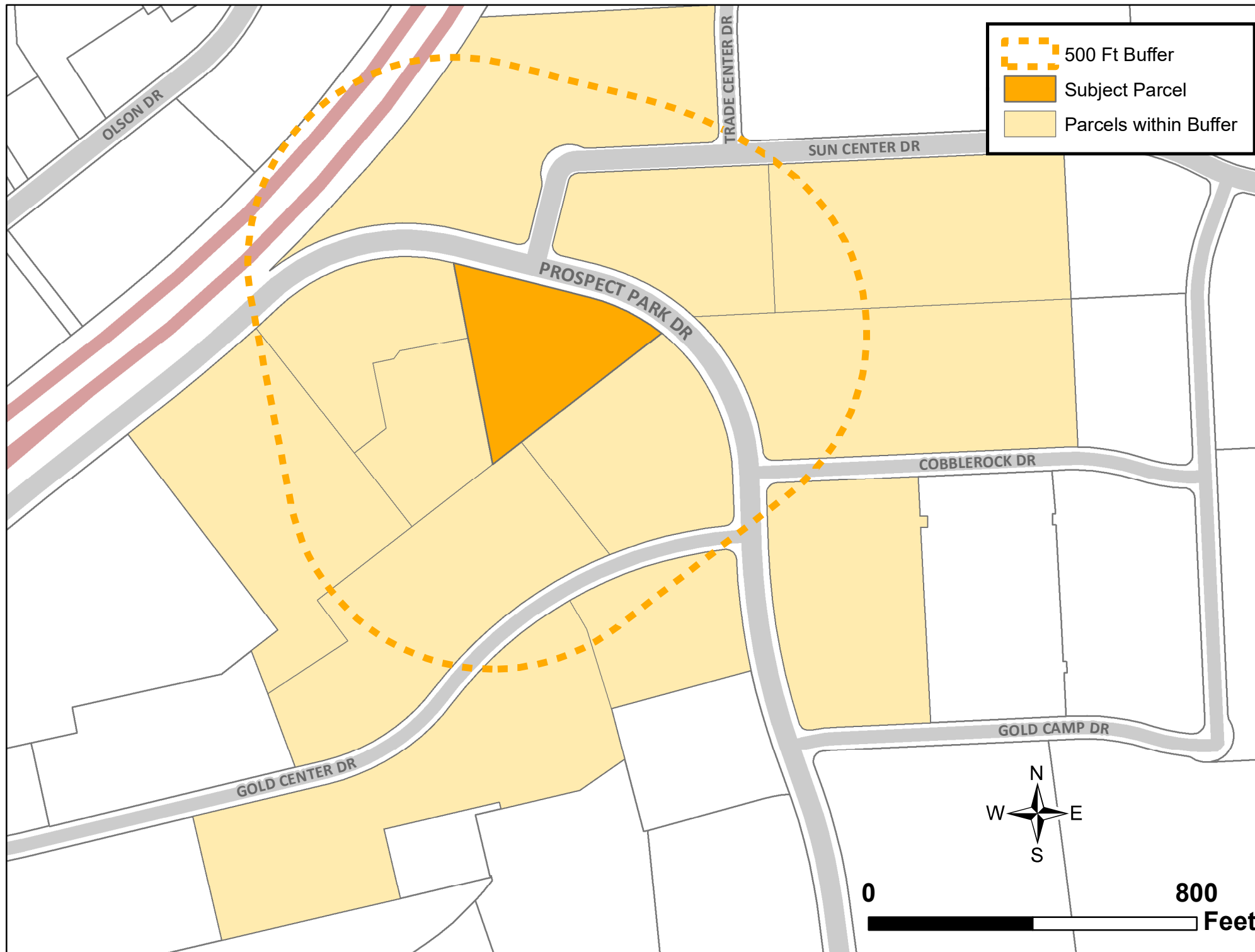
The comment states that traffic is already an issue in the area and in addition to existing large tenants in the project vicinity, the 400 dormitory residents would have a “horrendous impact” on current tenants and future growth. The General Plan EIR considered traffic impacts from existing, proposed, and planned and approved development in the region in Impact 4.5.6, which includes development on the project site and the project vicinity. While the General Plan EIR found that implementation of General Plan policies and action items would assist in reducing the General Plan’s cumulative contribution to regional traffic effects, the impact was considered cumulatively considerable and a significant and unavoidable impact. Because the proposed project is consistent with the density established in the General Plan for the project site, trips associated with development on the project site was considered in the General Plan EIR. (this would benefit from the trip gen/VMT discussion from Ascent)

11. **Trash**

The comment states that the project would increase trash. Trash would be generated by any project that were to be developed on the site. The project is providing the necessary

ITEM 11.1.**ATTACHMENT 9**

trash enclosures for both the dormitory and cafeteria use. Republic Services is the trash hauler for the City and will provide the required weekly trash pick up service for the project site.



ITEM 11.1.**ATTACHMENT 10**

CURRENT OCCUPANT
2969 PROSPECT PARK DR
RANCHO CORDOVA CA 95670

PROSPECT INVESTMENT PARTNERS L P
3140 GOLD CAMP DR 150
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
11020 SUN CENTER DR
RANCHO CORDOVA CA 95670

GPT PROPERTIES TRUST
255 WASHINGTON ST
NEWTON MA 2458

WEST TARON HOLDINGS LLC
9700 W TARON DR
ELK GROVE CA 95757

CURRENT OCCUPANT
10980 GOLD CENTER DR
RANCHO CORDOVA CA 95670

EDGECONNEX SACRAMENTO
HOLDINGS LLC
2201 COOPERATIVE WAY STE 400
HERNDON VA 20171

CURRENT OCCUPANT
2910 PROSPECT PARK DR
RANCHO CORDOVA CA 95670

WEST TARON HOLDINGS LLC
9700 W TARON DR
ELK GROVE CA 95757

CURRENT OCCUPANT
2920 PROSPECT PARK DR
RANCHO CORDOVA CA 95670

WEST TARON HOLDINGS LLC
9700 W TARON DR
ELK GROVE CA 95757

CURRENT OCCUPANT
3164 GOLD CAMP DR
RANCHO CORDOVA CA 95670

DIMENSION PROPS LLC
2930 RAMONA AVE STE 600
SACRAMENTO CA 95826

CURRENT OCCUPANT
11017 COBBLEROCK DR
RANCHO CORDOVA CA 95670

GOLDENBERG ROISEN FAMILY L P
3140 GOLD CAMP DR STE 150
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
10995 GOLD CENTER DR
RANCHO CORDOVA CA 95670

MAIN STONE CORPORATION
2930 WHITEGATE DR
MERCED CA 95340

CURRENT OCCUPANT
10901 GOLD CENTER DR
RANCHO CORDOVA CA 95670

RC ASSET AA LLC
1060 S 3RD ST 185
SAN JOSE CA 95112

CURRENT OCCUPANT
2882 PROSPECT PARK DR
RANCHO CORDOVA CA 95670

PROSPECT PARK DRIVE LLC
1870 SADDLE PARK PL
SAN JOSE CA 95138

CURRENT OCCUPANT
10961 SUN CENTER DR
RANCHO CORDOVA CA 95670

SUN CENTER GPRV PARTNERS 21 LLC
2323 S BASCOM AVE STE 100
CAMPBELL CA 95008

CURRENT OCCUPANT
10860 GOLD CENTER DR # 265
RANCHO CORDOVA CA 95670

RAINTREE REALTY II LLC
316 CALIFORNIA AVE 350
RENO NV 89509

CURRENT OCCUPANT
2995 PROSPECT PARK DR
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
11020 SUN CENTER DR
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
11017 COBBLEROCK DR
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3164 GOLD CAMP DR
RANCHO CORDOVA CA 95670

ITEM 11.1.

ATTACHMENT 10

CURRENT OCCUPANT
3164 GOLD CAMP DR STE 200
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3164 GOLD CAMP DR STE 220
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3164 GOLD CAMP DR STE 230
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3164 GOLD CAMP DR STE 240
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3164 GOLD CAMP DR STE 250
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
2995 PROSPECT PARK DR STE 100
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
2995 PROSPECT PARK DR STE 200
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
11017 COBBLEROCK DR STE 100
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
11020 SUN CENTER DR STE 100
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
11020 SUN CENTER DR STE 200
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 40
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 50
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 60
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 90
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 100
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 120
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 150
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 180
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 190
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 110
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
3035 PROSPECT PARK DR # 160
RANCHO CORDOVA CA 95670

CURRENT OCCUPANT
11017 COBBLEROCK DR STE 150
RANCHO CORDOVA CA 95670

ITEM 11.1.

ATTACHMENT 10

SACRAMENTO SANITATION DISTRICT
10060 GOETHE ROAD
SACRAMENTO CA 95827

SACRAMENTO REGIONAL COUNTY
SANITATION DISTRICT
10060 GOETHE ROAD
SACRAMENTO CA 95827

SACRAMENTO COUNTY WATER
AGENCY
10151 FLORIN ROAD
SACRAMENTO CA 95829

PG&E
2730 GATEWAY OAKS DRIVE
SACRAMENTO CA 95833

PG&E
343 SACRAMENTO STREET
AUBURN CA 95603

SMUD
6301 S STREET MS B304
SACRAMENTO CA 95817

SMUD
6301 S STREET MS B304
SACRAMENTO CA 95817

SMUD
6301 S STREET MS B404
SACRAMENTO CA 95817

SACRAMENTO METROPOLITAN FIRE
10545 ARMSTRONG AVE STE 310
MATHER CA 95655

FOLSOM CORDOVA UNIFIED SCHOOL
DISTRICT
1965 BIRKMNT DRIVE
RANCHO CORDOVA CA 95742

GOLDEN STATE WATER
3005 GOLD CANAL DRIVE
RANCHO CORDOVA CA 95670

CITY OF RANCHO CORDOVA
2729 PROSPECT PARK DR
RANCHO CORDOVA CA 95670

MEMORANDUM



ITEM 12.1.

DATE: July 20, 2020

TO: Honorable Mayor and Council Members

FROM: Micah Runner, Deputy City Manager
Stefan Heisler, Housing Manager
Laura Fickle, Economic Development Analyst

SUBJECT: CIVIC CENTER MASTER DEVELOPER SELECTION

RECOMMENDATION

Adopt the Resolution authorizing the City Manager to execute an Exclusive Negotiating Rights Agreement with Griffin Swinerton.

RESULT OF RECOMMENDED ACTION

Per the direction from the City Council, the City Manager will execute an Exclusive Negotiating Rights Agreement with the selected master developer to negotiate a preferred development alternative and development terms, ultimately returning to the City Council to request approval to execute a Disposition and Development Agreement for the Civic Center Property.

BACKGROUND

In response to the widely held belief that the City lacks a central gathering place, civic, or community center, the City Council directed staff to begin the visioning process to identify a location and determine specific feasible uses for a Civic Center project. The City has conducted an extensive visioning process over the last two years which selected the approximately 10-acre Mills Station site owned by the City as the location for the project. Potential uses of the site have been narrowed down to some combination of arts, culture, event, wellness, retail, recreation, and housing.

The City issued an Offering Memorandum to elicit developer proposals for such uses and select a development team that will finalize the development components of the site and execute the construction of the project. Eight proposals were submitted by qualified development teams. An Evaluation Committee was convened in late 2019 to review the proposals received and recommend a final development team to the City Council for their final selection.

The Evaluation Committee first narrowed down the eight proposals to three finalists. These finalists submitted additional responses to a supplementary questionnaire as well as presented their concepts to the Evaluation Committee, the City Council, and the public at a City Council work session in December 2019. The Evaluation Committee has made a final selection and

recommends the development team of Griffin Swinerton, Related California and Mogavero Architects.

As a final check on the three finalists, staff directed Claggett Wolfe Associates to perform a review on each finalist's team composition, registrations, licenses & restrictions, and financial capacity. This report discovered no real red flags and based on these findings does not lead staff to recommend disqualifying any of the three finalists. Section 3 of this report, attached as Attachment 2, details each team's financial capacity.

DISCUSSION

Staff concurs with the recommendation from the Evaluation Committee. Relative to the other two finalists, the Griffin Swinerton development team exhibits greater financial strength between the individual team members, a stronger ability to leverage a larger diversity of financing mechanisms, including Opportunity Zone funds, and a collectively greater level of experience with the mixed-use kinds of projects and community facilities/amenities that the City is focused on for this project. The Griffin Swinerton team includes local partners, including Swinerton's Sacramento office, and the concept within the Statement of Interest opens the door to discussing the potential redevelopment of adjacent sites to the Civic Center.

Below is a further description and analysis of the three final development teams. Each section includes the list of development team members, an identification of the strengths and financial capacity, and selected relevant project examples drawn from the materials submitted by each team. Each team's proposed land uses and site concepts are included, however each team has acknowledged in their responses to the supplemental questionnaire that these are iterative and still very flexible at this point.

Staff is now requesting Council discussion and selection of a master development team for the Civic Center Project.

DEVELOPMENT TEAMS

Team - Griffin Swinerton

Griffin Swinerton - Industry leading P3 developer of government and community nonprofit facilities.

Related - Affordable housing developer, and as one of the nation's largest real estate firms, possesses extensive breadth, expertise, and financial acumen.

Mogavero Architects - Award-winning architects with extensive local experience, relationships, and track record

Envelope - Award-winning, pioneering placemaking designer-developer; specialist in interim facilities with ground-breaking projects in the Bay Area and beyond.

Project for Public Spaces - Placemaking expert with integrated services spanning engagement, design, programming, and resource sharing; specialty in the mobility-placemaking nexus.

HackerLab - Maker spaces, local operator in Rancho Cordova, Rocklin, and Sacramento.

Citi Bank - California's largest issuer of municipal securities.

Griffin Swinerton Strengths

- The pros of the Griffin Swinerton proposal include having a large development team that can more likely complete a project during a recession.
- The team includes more experience around the amenities to be included on the site and placemaking.
- The proposal includes quickly testing placemaking uses on the site.
- This proposal was the number one selection of the Evaluation Committee.

Griffin Swinerton Financial Capacity

Gathering from Griffin Swinerton's Statement of Interest and responses to the supplemental questionnaire, the following is an overview of the Griffin Swinerton development team's financial capacity. Between the three finalists, Griffin Swinerton provided the most detailed information in their submittal materials. The combined firms have over 40 years of experience, and 170+ years of combined firm experience amongst the leadership of both companies. In 2018, Swinerton builders was the largest general contractor in CA with over \$4 billion in revenues that year. Together Griffin Swinerton have successfully delivered 15 projects in 15 years. Griffin Swinerton has \$600 million in development currently underway all structured as P3 transactions. Leveraging its financial relationships Griffin Swinerton has successfully reached financing close on nearly \$500 million of construction within the past two years including: the Orange County Administration Building North \$200 million (Dec 2018), the Orange County Administration Building South \$188 million (June 2017), the Police Services Headquarters Building, City of Salinas \$55 million (June 2018), and the El Gabilan Library, City of Salinas \$21 million (June 2018).

The Griffin Swinerton proposal included letters from three financial companies expressing interest in financing or insuring the Mills Station project. These included a \$75,000,000 unsecured line of credit through City National Bank. City National Bank asserted that Griffin Swinerton has maintained a cash on deposit balance that consistently averages a mid-eight figure balance and has never returned a check due to insufficiency of funds. The Bank explained that Griffin Swinerton's relationship with the City National Bank has at all times been very satisfactory.

The second letter came from Citigroup Global Markets, Inc. (Citi). Citi is the number one negotiated underwriter 17 of the last 25 years, the number one national availability payment and lease underwriter, and the number one underwriter of California social P3 projects. Citi has worked with Griffin Swinerton on the County of Orange administration buildings. Working with the Griffin Swinerton team, Citi explained that they have developed a unique financing structure which allowed the County of Orange to take advantage of the efficiencies of a P3 structure while utilizing the County's high credit quality to borrow at the lowest cost to fund the project. Citi is also currently engaged as senior managing underwriter by Griffin Swinerton on the financing of the "Riverside Alive" Mixed-Use Development and Convention Center expansion project, which will once again seek to utilize the Citi and Griffin Swinerton modified P3 delivery model to transform downtown Riverside, CA in what is anticipated to be one of the most significant developments in the City's recent history.

Lastly, Griffin Swinerton included a letter from Zurich North America Surety. This letter evidenced that Griffin Swinerton is insured up to \$500,000,000 per project and \$5 billion in aggregate, which evidences Griffin Swinerton's financial capacity to guarantee the completion of construction with performance and completion bonds.

Griffin Swinerton's housing development partner is Related California (Related). Operating on a build and hold model, Related has a 30 year track record, owns over 20,000 units, has completed

over 16,000 units, and has 1,300 affordable and 3,500 market rate housing units currently under development. Backed by The Related Companies L.P., one of the most prominent privately head real estate firms portfolio over \$60 billion, Related asserts its financing capacity, purchasing and negotiating leverage, and unique access to equity and debt providers. With this level of volume Related describes that it has access to substantial purchasing and negotiating power, along with lower construction, operating and marketing costs. When it comes to seeking grant funding, Related has successfully been awarded funding from just about every California State housing funding program (over a dozen different programs) and historically been the largest user of tax-exempt bonds for mixed-income rental housing in California. Highlighting its experience with multiple lenders, Related has recently secured debt financings from Wells Fargo, JP Morgan, Bank of America, Deutsche Bank, Fannie Mae, Freddie Mac, Bank of China and HSBC, among others. In 2007 during the last recession Related was able to close escrow on five deals, and complete seven new developments, totaling 892 units.

Related has raised a total of \$400 million in Opportunity Zone funds to invest in projects. As such, Griffin Swinerton will have direct access to OZ funds and an investment of these funds could be made in the development of this site. Griffin Swinerton will analyze the use of these funds (for either or both the housing and community facilities) in a broader financial analysis of the project, incorporating the many public and private sources of funds that can be layered into the most effective capital stack for this project. For financing projects, Related explains that it generally utilizes low floater tax-exempt debt, supported by an equity letter of credit from a large pension fund, together with low-income housing tax credits to enhance returns on these projects, ultimately providing local agency partners maximum leverage for their investment.

Griffin Swinerton proposes to develop the community facilities in a P3 arrangement with the City, offering a range of financing options and capabilities with their financing partners – from privately-issued tax-exempt bonds to tax credits, State transit oriented development (TOD) funds, private equity, and customized debt instruments. The Griffin Swinerton team will collaboratively work with the City to select a value-added deal structure (e.g. lease-leaseback) and financing approach that best meets the City's programmatic goals while most efficiently leveraging the City's significant investment of land and cash contribution.

Griffin Swinerton Relevant Experience

As mentioned above, Griffin Swinerton has more than \$600 million of P3 transactions currently underway. Related has more than \$60 billion in developments and owns and operates over 20,000 affordable housing units in California. Extensive experience in workforce housing and created new financing models in partnership with cities of New York, Boston and San Francisco. A few examples are featured here, but more can be found in Griffin Swinerton's Statement of Interest, included as Attachment 3.

Examples begin on the next page.

Figure 1: Griffin Swinerton - Yorba Linda Library & Cultural Arts Center



Cost:
\$52M

Size:
45,000 SF Library;
13,500 SF Arts Center

Client:
City of Yorba Linda

Contact:
Carrie Lixey, Library Director
(714) 777-2466

The City of Yorba Linda recently retained Griffin Structures, Inc., as its Construction Manager to work with the City, Library, and Parks and Recreation staff to provide construction management services for the construction of a new two-story, approximately 45,000 square foot Library and 13,500 square foot Arts Center. The project will consist of a design phase (now through Fall of 2018) and a construction phase from Fall of 2018 to early 2020. The City of Yorba Linda has designated the Strawberry Field/Site 13 as the site for the project.

The existing 28,350 square foot Public Library facility, has had over three successive expansions to accommodate the changing needs of the community. Due to the increasing demand for services and materials, the Library facility, once again, needs to grow, but lack of space on the current lot, structural limitations and the complexity of the existing layout deter further expansion, and a new facility is needed. A new Arts Center will be incorporated and will also address needs identified in the Parks and Recreation Master Plan.

Figure 2: Griffin Swinerton - Discover Cube Science Center, Santa Ana, CA



Relevancy:

- Program and Construction Management
- Non-Profit Organization

Cost:
\$12M

Size:
44,000 SF

Project Duration:
2013 - 2015

Client:
Discovery Science Foundation

Contact:
Joe Adams
CEO, Discovery Science Foundation
(866) 552-2823
jadams@discoverycube.org

As the construction manager for the \$12M expansion of the popular Discovery Cube-Orange County Science Center in Santa Ana, Griffin managed the project that enabled the Center to expand its distinctive hands-on experiences for visitors with differing learning styles, whether kinesthetic, auditory or visual.

The 44,000 SF Discovery Pavilion expansion included a flexible black box theater, new exhibit space, a full demonstration kitchen, an educators' resource center, an expanded Launch Pad Science Store, upgraded welcome lobby and ticketing areas, and additional administrative office space. The expansion doubled Discovery Cube's guest capacity

and provided a larger, state-of-the-art exhibits.

Discovery Cube-Orange County programs and interactive features provided a natural extension to school outreach programs and served as a large-scale teaching aids for students, teachers and families, fulfilling the Discovery Science Foundation mission to "*inspire and educate young minds through engaging science-based programs and exhibits to create a meaningful impact on the communities they serve.*"

Figure 3: Related - Five 88, San Francisco, CA

Five 88

Mixed-Use, Transit-oriented, Affordable
Workforce & Family Development

588 Mission Bay Boulevard North
San Francisco, CA 94158



Exterior elevation



Interior courtyard lobby

DEVELOPER

Related California, Chinatown Community Development Center

ARCHITECT

David Baker Architects, Gonzales Architect

GENERAL CONTRACTOR

Nibbi Brothers General Contractors

MUNICIPAL PARTNER

City of San Francisco

PROPERTY MANAGEMENT

Related Management Company

- Surpassed leasing projections
- Current vacancy rate of 1%

Key Features & Awards

2016 POBC Gold Nugget
Award of Merit - Best
Affordable Housing
Community

2018 AIA San Francisco
Design Awards - Architecture
Merit Award + Social/Respon-
sibility Commendation

2018 SFBE Real Estate
Deal of the Year - Real
Estate Deal of the Year

Via a partnership with Chinatown CDC, FIVE 88 is San Francisco's largest 100% affordable housing development in the last decade. Located in San Francisco's Mission Bay Redevelopment Area, Five 88 offers 10,000 sq. ft. of retail space in close proximity to a Muni Metro station. While Five 88 features a modern urban aesthetic, design features encourage residents to connect with their environment via open courtyards, close proximity to Mission Bay Commons Park and the south waterfront of the San Francisco Bay. Residents enjoy a community pavilion with space and amenities for residents to gather, 252 secured bicycle spaces, onsite parking, a fitness center, community room and BBQ area.

- Leasing priority for employees of public healthcare institutions located in San Francisco, in addition to elderly and disabled applicants

Community Feedback: Intensive collaboration between Related, Chinatown CDC, UC Regents, Family House, and San Francisco's Office of Community Investment and Infrastructure led to the successful development of Five 88 – e.g., common pedestrian mews between Family House site and Five 88, expensive façade upgrades (i.e., corten steel) used on corner facing a public park and UCSF hospital, etc. Thoughtful consideration was given to the tenant selection plan due to the UC Regents wanting a preference for local residents working at public educational and healthcare institutions.

LEASE-UP PERIOD

Feb '17 to Oct '17

FINANCING

Tax Credit Equity	\$35,700,000
Citibank Permanent Loan	\$27,700,000
Subordinate Citi Loan	\$3,000,000
Residual Receipts Loan	\$17,000,000
Deferred Developer Fee (MGP Cap. Cont.)	\$500,000
Total Permanent Sources	\$83,900,000

INCOME LEVEL	BEDROOM TYPE		TOTAL UNITS
	1 BR	2 BR	
50% AMI	14	26	40
60% AMI	56	102	158
Manager's	2		2
Total	72	128	200

Team – SKK

SKK Developments - Leading Sacramento developer with extensive experience working with public sector partners to deliver successful projects and transform neighborhoods.

The Hodgson Company - Sacramento-based firm that specializes in the entitlement and development of real estate and land use projects throughout Northern California.

Cunningham Engineering – Sacramento-based engineering firm that has played an integral role in consulting with the public agency and private partners to make P3 delivery method a viable solution.

C2K Architecture - Portland based, the C2K portfolio includes high rises, mixed-use developments, retail centers, entertainment venues, healthcare and fitness facilities and residential projects of all varieties.

AMS Planning and Research - Local planning and research firm, notable projects include Elk Grove Civic Center, Harris Center for the Arts feasibility study, City of Boise Main library event center.

FPI Management - FPI has been providing professional property management services to multi-family housing owners for over 49 years. Currently FPI has in its inventory approximately 110,000 units located in 14 states.

SKK Strengths

- The pros of the SKK proposal include having a local developer as the lead entity may put more effort into the project than a national firm.
- The proposal addressed more of the synergies between the project and light rail.
- The proposal included the largest number of housing units, which was seen by the Evaluation Committee as potentially being the insurance policy for making the project successful from a placemaking standpoint.
- SKK has a history of developing transformative projects in the Sacramento region.

SKK Financial Capacity

Gathering from SKK's Statement of Interest and responses to the supplemental questionnaire, the following is an overview of the SKK development team's financial capacity. Over the last 4 decades, members of the SKK development team have capitalized projects valued at more than \$1.7 billion including more than 7,000 residential home sites, 2,000 single family homes, 2,000 multi-family units and 300,00 square feet of commercial buildings in Northern California, Colorado, Nevada and Oregon..

SKK has a strong record of completing significant projects, particularly in the Sacramento area. Valuations of completed and currently underway projects in Sacramento since 2001 include: \$250,000,000 of completed projects since 2001, \$196,000,000 in projects currently under construction, and \$438,000,000 in projects under development.

The SKK development team anticipates that capitalization of this project will come from a variety of public and private sources, projecting that the housing will be market rate, financed entirely with private capital (both debt and equity). The development team emphasizes that it has built strong investor and lender connections in Sacramento due to its numerous projects over many years in this region. SKK will explore Opportunity Zone funding as SKK recently closed one of the first opportunity zone deals (\$65 million capitalization with \$20 million from an opportunity zone

fund) with Aegon Asset Management for 186 apartments on the site of Sacramento's Mansion Inn/Clarion Hotel.

SKK Relevant Experience

Again as mentioned above, over the last 30 years, SKK Developments has been involved in the development of six master-planned communities, 7,000 residential home sites, 1,500 multifamily units, 2,000 homes, and 300,000 square feet of commercial buildings in four states, valued at over \$1.7 billion. SKK Developments currently has nearly 500 residential units under construction and another 1,700 units in the entitlements and planning process. Together these projects represent nearly \$650 million worth of investment in the Sacramento region. SKK's Letter of Interest is attached as Attachment 4.

Figure 4: SKK – 1801L Mixed Use, Sacramento, CA

- Midtown Sacramento, CA
- Mixed Use/Mixed Income/Urban Infill
- 176 Residential Units, 10,000 SF Retail
- Completed: 2006

After assembling vacant properties between 18th and 19th Streets along L Street in Midtown Sacramento, SKK developed this mixed-use project which includes 11,000 square feet of retail space with restaurants, services and 12 live-work units, 164 mixed income rental apartments, as well as 163 below grade parking spaces.



Examples continue on the next page.

Figure 5: SKK – E16 Apartments, Sacramento, CA

UNDER CONSTRUCTION

	H16	E16	The Press Building	TOTAL
Estimated Completed	Early 2020	Fall 2020	Spring 2020	
Description	Mixed-use, rental apartments	Mixed-use, rental apartments	Mixed-use, rental apartments	
Estimated Current Value	\$ 36,000,000	\$ 35,000,000	\$ 125,000,000	\$196,000,000
Units	95	95	277	467
Retail Sq. Footage			8,600	8,600 sf



E16 APARTMENTS

Team – Civic Partners/SVA Architects

Civic Partners - Development firm recognized for its successful public/private partnerships and experience in the area of infill and redevelopment and creating a unique "sense of place" for each of its projects.

SVA Architects - Recognized as one of California's most innovative and respected architectural firms, SVA's staff of over 50 professionals has decades of experience across a wide range of project types.

Lifescapes International, Inc. - For 60 years, Lifescapes International, Inc. has been a forerunner in landscape architecture and design creating some of the most delightful, memorable and iconic environments in both the U.S. and abroad.

Otto Construction - 72 years in business, family-owned construction firm proud to call Sacramento home with an established history of repeat clients throughout Northern and Coastal California.

Hunt Real Estate Capital - Current loan portfolio of \$15.1 billion, Hunt finances mostly commercial and residential assets.

Civic Partners Strengths

- The pros of the Civic Partners proposal include again having a large national developer may have more resources to complete a project during a recession.
- The proposal focused heavily on creating vibrant people-oriented designs and emphasized outdoor gathering spaces.
- The Civic Partners proposal also included a well-rounded development team able to get the outdoor amenities and placemaking right.

Civic Partners Financial Capacity

Taken from Civic Partner's Statement of Interest and responses to the supplemental questionnaire, the following is an overview of the Civic Partner development team's financial capacity. In its proposal, the Civic Partners Development Team explains that it is experienced, financially capable, and prepared to create an economically viable project which will attract construction financing and long-term debt. Civic Partner's proposal continues to describe that it has a strong history of successfully achieving economically stable developments, many in public/private partnerships and several in a strategic alliance with Hunt Real Estate Capital principals (one of the Development Team's financing partners described below). Civic Partner's resume includes multiple examples of various public facilities all of which were successfully financed and completed with what Civic Partner's believes were optimal public financing techniques.

Civic Partners and their team highlight having established strong personal and professional ties allowing their team to work efficiently and cost effectively together. Past projects include residential, commercial, retail, mixed-use, governmental, and entertainment venues.

The financing team members includes Hunt Real Estate Capital and AFL CIO Housing Investment Trust. Hunt has been in continuous operation since 1972, has a current loan portfolio is \$15.1 billion, and closed approximately \$3.5 billion in originations in 2017. The AFL CIO Housing Investment Trust has approximately \$6.6 billion in net assets and has invested over \$440 million in 27 projects in California. The last five of which included projects in San Francisco, San Jose, and Salinas.

The Civic Partners team anticipates utilizing its varied resources and associations to structure a capitalization program that maximizes financial returns within the parameters of prudent investment asset allocation. The team will simultaneously explore alternative financing options that best fit the needs of both the project's individual components and the project in its entirety. Civic Partners aims to achieve the objectives of optimizing the use of public subsidy and providing an economic program assisting in the long-term financial stabilization of the public facilities.

Civic Partners Relevant Experience

Civic Partners, Inc. has been recognized for its successful public/private partnering and experience in the area of redevelopment. The principals of Civic Partners and its affiliates have been active in real estate development since the 1970's, with several decades of combined specialized experience in partnering with public agencies. Civic Partner's Letter of Interest in included as [Attachment 5](#).

Figure 6: Civic Partners/ SVA Architects – Tenth Street Place, Modesto, CA



Figure 7: Civic Partners/SVA Architects – Civic Plaza, Boise, ID



Staff report continues on the next page.

NEXT STEPS

Per City Council selection, the City Manager will execute an Exclusive Negotiating Rights Agreement (ERN) with the selected master developer in a form substantially in the form attached as Attachment 6 to this report and in a final form acceptable to the City Attorney. Once that agreement is executed, staff will proceed to work with the master developer to formulate several development alternatives. These alternatives will be presented to Council no later than January 2021. If an alternative is selected at that time, staff will negotiate business terms for the development of that alternative to return to Council for approval of a Disposition and Development Agreement (DDA). If an alternative is not selected in January, staff will continue working with the master developer on additional alternatives for Council approval.

Entering into an ERN will not obligate the City to sell or transfer the property to the Developer or provide any financial assistance. The initial term of the ERN will be for one year, providing the City Manager authorization for one six-month extension, and an initial deadline to return to Council with development alternatives no later than January 2021. Therefore, staff anticipates entering into a DDA sometime in mid or late 2021. Predevelopment, environmental, and site preparation activities would begin shortly thereafter with construction beginning sometime in 2022 or 2023.

If negotiations are ultimately unsuccessful with the selected master developer during the term of the ERN, staff will return to the City Council for further direction on next steps. This may include extending the term of the ERN, selecting another master developer from the three finalists included here, or issuing another Memorandum of Offering to gather proposals from additional developers.

FISCAL IMPACT

There is no fiscal impact at this time. It is expected that there will be significant fiscal impact of several million dollars to the General Fund committed to the development of the Civic Center Project once a Disposition and Development Agreement is executed.

ATTACHMENT(S)

1. Resolution
2. Claggett Wolfe Associates Mills Station Master Developer Proposal Assessment, Section Financial Capacity
3. Griffin Swinerton Statement of Interest
4. SKK Letter of Interest
5. Civic Partners Letter of Interest
6. Exclusive Negotiating Rights Agreement
7. Civic Center Master Developer Selection Presentation

CITY OF RANCHO CORDOVA

RESOLUTION NO. XX-2020

**A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA,
STATE OF CALIFORNIA, AUTHORIZING EXECUTION OF AN EXCLUSIVE NEGOTIATING
RIGHTS AGREEMENT WITH GRIFFIN SWINERTON WITH REGARD TO CITY PROPERTY
AT 10153-10179 FOLSOM BLVD**

WHEREAS, the City of Rancho Cordova owns fee simple title in that certain property consisting of approximately 9.85 acres located in the City at 10153-10179 Folsom Blvd (the "Civic Center Property"); and

WHEREAS, the City has conducted an extensive visioning process with community input to determine preliminary use concepts for the Civic Center Property. The City seeks the development of the Civic Center Property consistent with relevant City plans and development standards as a central gathering place with a mix of uses; and

WHEREAS, the City issued an Offering Memorandum for the Property to engage a qualified developer in a public-private partnership; and

WHEREAS, Griffin Swinerton has submitted a statement of interest highlighting its expertise in public-private partnerships, housing and mixed-use development, financial strength and flexibility, among other strengths. The statement of interest included a team of qualified organizations in respective fields needed to execute the development of the Project, and proposed additional use concepts; and

WHEREAS, the City has selected Griffin Swinerton (the "Developer") as a potential developer of the Property for development of the Project on the Property; and

WHEREAS, the City desires to enter into an Exclusive Negotiating Rights Agreement ("ERN") with the Developer and to engage in good faith exclusive negotiations with Developer toward the preparation of Disposition and Development Agreement for development of the Project on the Property and its submission to the City Council for approval.

NOW, THEREFORE, BE IT HEREBY RESOLVED THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA AS FOLLOWS:

Section 1 The City Council hereby finds that the ERN is exempt from CEQA review pursuant to CEQA Guidelines Section 15061(b)(3) in that it is a preliminary agreement and it can be seen with certainty that there is no possibility that the ENA may have a significant impact on the environment. The City has discretionary authority whether any project affecting or making use of the Property will go forward and will not exercise its discretion regarding any future project until such time as the City is satisfied that all necessary or required CEQA review has been

completed.

Section 2 The City Council authorizes the City Manager, on behalf of the City, to execute an ERN with the Developer, substantially in the form on file with the City Clerk, and to execute such other instruments and to take such other actions as necessary to carry out the intent of this Resolution.

Section 3 The above recitals are true and correct. The City Clerk shall certify to the passage and adoption of this Resolution, and the minutes of this meeting shall so reflect the above City Council action.

PASSED AND ADOPTED by the City Council of the City of Rancho Cordova on the 20th day of July, 2020 by following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

ATTEST:

David M. Sander, Mayor

Stacy Leitner, CMC
City Clerk

May 14, 2020

MEMORANDUM

TO: Amanda Norton, Economic Development Manager, City of Rancho Cordova
Laura Fickle, Economic Development Analyst, City of Rancho Cordova

From: Chuck Wolfe, President

RE: Mills Station Master Developer Proposal Assessment

Claggett Wolfe completed a review three proposals submitted in response to the City of Rancho Cordova's RFQ for a Master Developer for the Mills Station Artist District P3 Master Development Opportunity. As per the guidance provided by City staff, no direct contact was made with any of the proposers with all findings based on publicly available information obtained from secondary data sources. Information was collected for the teams lead by the following three proposer that will serve as the prime contractors for the project.

- SKK Developments: Sacramento, CA
- Griffin | Swinerton: San Francisco, CA
- Civic Partners: Huntington Beach, CA

The information that follows is aggregated into the following three section with supporting documents provided in Attachment A.

Section 1: Team Composition

Section 2: Registrations, Licenses & Restrictions

Section 3: Financial Capacity

SECTION 3: FINANCIAL CAPACITY

To assess the financial capacity of each proposer Claggett Wolfe reviewed the information submitted in each proposal and ran a D&B Business Information Report (BIR) Snapshot on each prime contractor. The results of this review are outlined below.

SKK Developments

SKK Developments did not provide any supporting information in its proposal to demonstrate financial capacity. In addition, as SKK Developments operates as a dba under a Fictitious Business Names Statement there was no information available on the D&B Business Credit database. As SKK Developments and CNM Construction are owned by the same individual, Claggett Wolfe ran a D&B BIR Snapshot report on the corporate entity CNM Construction with the following findings.

Overall Business Risk – Low-Moderate

PAYDEX® - 80 out of 100: Risk of Slow Pay – Low

Delinquency Predictor Score – 81 out of 100: Level of Risk – Low-Moderate

Financial Stress Score – 93 (Low Risk – 100, High Risk – 1): Level of Risk – Low-Moderate

Supplier Evaluation Risk Rating – Low Risk

Legal Events: Suits – 0; Judgements – 0; Liens – 0; UCC Filings – 1

Special Events: On February 3, 2012 Kolokotronis, Sotiris filed a voluntary petition in bankruptcy in US Bankruptcy County, Sacramento, CA under Chapter 7 of the US Bankruptcy Act.

Griffin | Swinerton

Griffin | Swinerton provided letters from three separate institutions showing the following financial capacity:

- Operating Line of Credit (LOC) – unsecured LOC of \$75,000,000
- Project Financing Letter of Support – Citigroup Global Markets references previous Griffin | Swinerton project funded. A brief review showed Citigroup with sufficient capacity to finance the project
- Surety Credit Letter of Support – Zurich North America Surety references previous surety credit extended to Griffin | Swinerton for single project to \$500,000,000 in the past and for an aggregate level of \$5,000,000,000. A brief review showed Zurich with sufficient capacity to provide surety credit for the project.

A D&B BIR Snapshot report was run for Griffin Structures with the following findings:

Overall Business Risk – Low-Moderate

PAYDEX® - 72 out of 100: Risk of Slow Pay – Low

Delinquency Predictor Score – 84 out of 100: Level of Risk – Low-Moderate

Financial Stress Score – 39 (Low Risk – 100, High Risk – 1): Level of Risk – Moderate

Supplier Evaluation Risk Rating – Low Risk

Legal Events: Suits – 0; Judgements – 0; Liens – 0; UCC Filings – 0

Special Events: None reported

A D&B BIR Snapshot report was run for Swinerton Builders with the following findings.

Overall Business Risk – Low-Moderate

PAYDEX® - 77 out of 100: Risk of Slow Pay – Low

Delinquency Predictor Score – 67 out of 100: Level of Risk – Moderate

Financial Stress Score – 67 (Low Risk – 100, High Risk – 1): Level of Risk – Moderate

Supplier Evaluation Risk Rating – Low Risk

Legal Events: Suits – 0; Judgements – 0; Liens – 1; UCC Filings – 4

Special Events: None reported

Civic Partners

Civic Partners provided background for three separate institutions that would be involved in providing financial capacity for the project:

- Red Stone Tax Exempt Funding – No project specific reference was provided but the firms partners have closed over \$7 billion in tax-exempt bond financing throughout their careers.
- Hunt Real Estate Capital – No project specific reference was provided. Claggett Wolfe noted in its research the Hunt Real Estate Capital canceled its corporate registration with the CA SOS on 4/7/20.
- AFL-CIO Housing Investment Trust – The Trust has approximately \$6.6 billion in net assets and provides capital for new construction of affordable and market-rate multifamily projection nationwide, using 100% union labor. The Trust has invested over \$440 million in 27 projects in California.

A D&B BIR Snapshot report was run for Civic Partners with the following findings.

Overall Business Risk – Low-Moderate

PAYDEX® - 52 out of 100: Risk of Slow Pay – Moderate

Delinquency Predictor Score – 96 out of 100: Level of Risk – Low

Financial Stress Score – 28 (Low Risk – 100, High Risk – 1): Level of Risk – Moderate

Supplier Evaluation Risk Rating – Low Risk

Legal Events: Suits – 0; Judgements – 0; Liens – 0; UCC Filings – 2

Special Events: None reported



MILLS CROSSING

STATEMENT OF INTEREST | September 20, 2019



MILLS CROSSING

STATEMENT OF INTEREST | September 20, 2019





PROXY, San Francisco CA | Envelope A+D

TABLE OF CONTENTS

COVER LETTER	04
PROJECT IDEAS	07
RELEVANT TEAM EXPERIENCE	29
FINANCIAL CAPACITY	121

September 20, 2019

Laura Fickle
City of Rancho Cordova
2729 Prospect Park Drive
Rancho Cordova, CA 95670

RE: Letter of Interest: Mills Station District – P3 Development Opportunity

Dear Ms. Fickle:

Griffin|Swinerton and its Team Members are pleased to submit our Statement of Qualifications (SOQ) for the opportunity to develop a 9.8-acre City-owned site as a public-private partnership (P3). Griffin|Swinerton fully understands and appreciates how catalytic the development of the Mills Station District site will be for the City of Rancho Cordova (City) in terms of establishing a community hub and center for civic identity, stimulating further economic development, fiscal benefits, and job creation within the District. Our Team is excited about this opportunity to assist the City in bringing its vision into fruition. We believe successful projects are built on close, interactive relationships amongst the development team, project owner, and community stakeholders. Our Statement of Qualifications highlights the following:

Expertise in Public, Private Partnership (P3) Project Delivery

Combining the best of the development and construction industries, Griffin|Swinerton, established in 2009 with ownership interests equally divided between its two partner firms – Griffin Structures and Swinerton Builders, is a highly experienced, recognized expert in the development, financing, construction, and management of public facilities utilizing the P3 development method. We have a well-established, fully integrated and operating platform with over \$600M of P3 transactions currently underway, making Griffin|Swinerton one of the most active P3 developers in the State of California. Our Team Members represent the best in their respective fields, with long and successful track records working with numerous counties and cities through every stage of the development process, including site acquisition/ground lease, facility design, entitlements and permitting, project financing, construction, and facility maintenance. Griffin|Swinerton projects delivered as P3s in California are more fully described in this SOQ and range from the P3 delivery of Orange County's \$200 million County Administration North Building (Building 14) within its civic center to the \$12 million turn-key P3 delivery of the Quartz Hill Library for Los Angeles County.

Housing and Mixed-Use Development

Bringing a range of affordable housing options to this key location is best thought of as investing in civic infrastructure, benefiting not just the residents who will live onsite but also the broader Rancho Cordova community. By bringing new residents to the City, the housing component embeds demand for community uses on the Site. Housing, particularly housing near transit, supports healthy and well-functioning communities and economies.

Backed by one of the most prominent privately-owned real estate firms in the nation, with a portfolio of over \$60 billion in developments, Related has been staunchly committed to affordable housing. Related California owns and operates over 20,000 units in California and has never converted a single unit to market rent. Related also has extensive experience in workforce housing and created new financing models in partnership with the cities of New York, Boston and San Francisco to deliver much needed residences across various income levels. The company has deep relationships with federal, state and local governments to access programs and financing to see these projects through to completion. Related California operates on a 'build and hold' business model which means it invests for the long term.

A Modern Placemaking Approach: Prototype to Permanent

The state of the art of placemaking takes a "prototype to permanent" approach, i.e. applying a human-centered design/development (HCD) approach toward the creation of public spaces. Our Team includes the industry's best placemaking practitioners who have demonstrated how effective HCD-based development can create authentic experiences and community facilities for evolving neighborhoods.

The expanding world of temporary/interim “pop-up” facilities are the built environment’s answer to the need to prototype and test new ideas with the end user, gather feedback/data, and iterate – the key elements of the human-centered design or design thinking as it is often called. The strategic deployment of Interim facilities for food & beverage, retail, entertainment, performances, exhibits, crafts, civic engagement will allow our Team, in collaboration with the City, to rapidly establish temporary places before putting “shovels in the ground” and test what community-oriented uses will attract durable demand and activity on the Site. The use of interim placemaking frameworks could occur during pre-development in parallel with and informing the planning for permanent facilities, adding energy and excitement to the civic engagement process. The process leverages and expands upon more traditional (and risky) approaches that solely focus on writing business plans and performing market studies or surveys.

Local Expertise, Relationships, and Operating Partnerships

Griffin|Swinerton Team Members provide hands-on, real-time value-added services through local offices in the Sacramento area. Mogavero Architects is an award-winning local architect with deep relationships in the area and a long track record of serving Rancho Cordova and the broader Sacramento region. Team member Hacker Lab is a creative operator of maker spaces, co-working facilities, and meeting spaces in the Sacramento area and will lend their expertise toward activating and programming flexible community spaces. The Sacramento office of Swinerton Builders, the largest general contractor by volume in the State of California, is particularly well versed in constructing iconic projects with local trade contractors in the Sacramento region.

Financial Strength, Flexibility, and Creativity

Griffin|Swinerton and Related have assembled a highly experienced, well-qualified Team, including Citigroup (Citi), that brings unmatched versatility and financial expertise, creativity, and flexibility to present the City with a range of options to best meet its fiscal and programmatic goals. We cannot stress enough the importance of collaboration and open communication between the City and its Developer-led Team as the Project is developed over time in a dynamic, shifting marketplace.

Best-in-Class Team

Further described in the following pages, Griffin|Swinerton has assembled a purpose-built team with leaders in their respective fields, where Team members’ skillsets have been customized to implement each project component in a best-in-class fashion.

	Industry leading P3 developer of government and community/non-profit facilities.
	Affordable housing developer and, as one of the nation’s largest real estate firms, possesses unmatched breadth, expertise, and financial acumen
	Award-winning architects with extensive local expertise, relationships, and track record
	Award-winning, pioneering placemaking designer-developer; specialist in interim facilities with ground-breaking projects in the Bay Area and beyond
	Placemaking expert with integrated services spanning engagement, design, programming, and resource sharing; specialty in the mobility-placemaking nexus
	Maker spaces, local operator in Rancho Cordova, Rocklin, and Sacramento
	California’s largest issuer of municipal securities



Selecting the Griffin|Swinerton Team will assure that the City participates continuously and actively in the creative and responsibly designed, cost-effective, and efficient delivery of its planned community facilities. We look forward to an opportunity to further dialogue about the Team's expertise, capabilities, and strategies for maximizing the potential of this important project. Please don't hesitate to contact us via the information provided below.

We recognize and understand that the concepts presented in our Statement of Qualifications have been suggested without the benefit of the necessary input from the City, the community and market influences, and therefore will undoubtedly undergo rigorous demand analytics and validation.

Sincerely,

GRIFFIN|SWINERTON

Roger Torriero
Managing Partner, GriffinSwinerton
rtorriero@griffinholdings.net
Mobile: +1 (949) 412-9000

William A. Witte
CEO, Related California
WWitte@Related.com
Phone: +1 (949) 660-7272

PROJECT IDEAS



SOURCE: Project For Public Spaces

COMMUNITY IDENTITY

EMBEDDED ACTIVITY

INTERIM “POP UP” FACILITIES



Iconic Community
Facilities



Mixed-Income
Housing



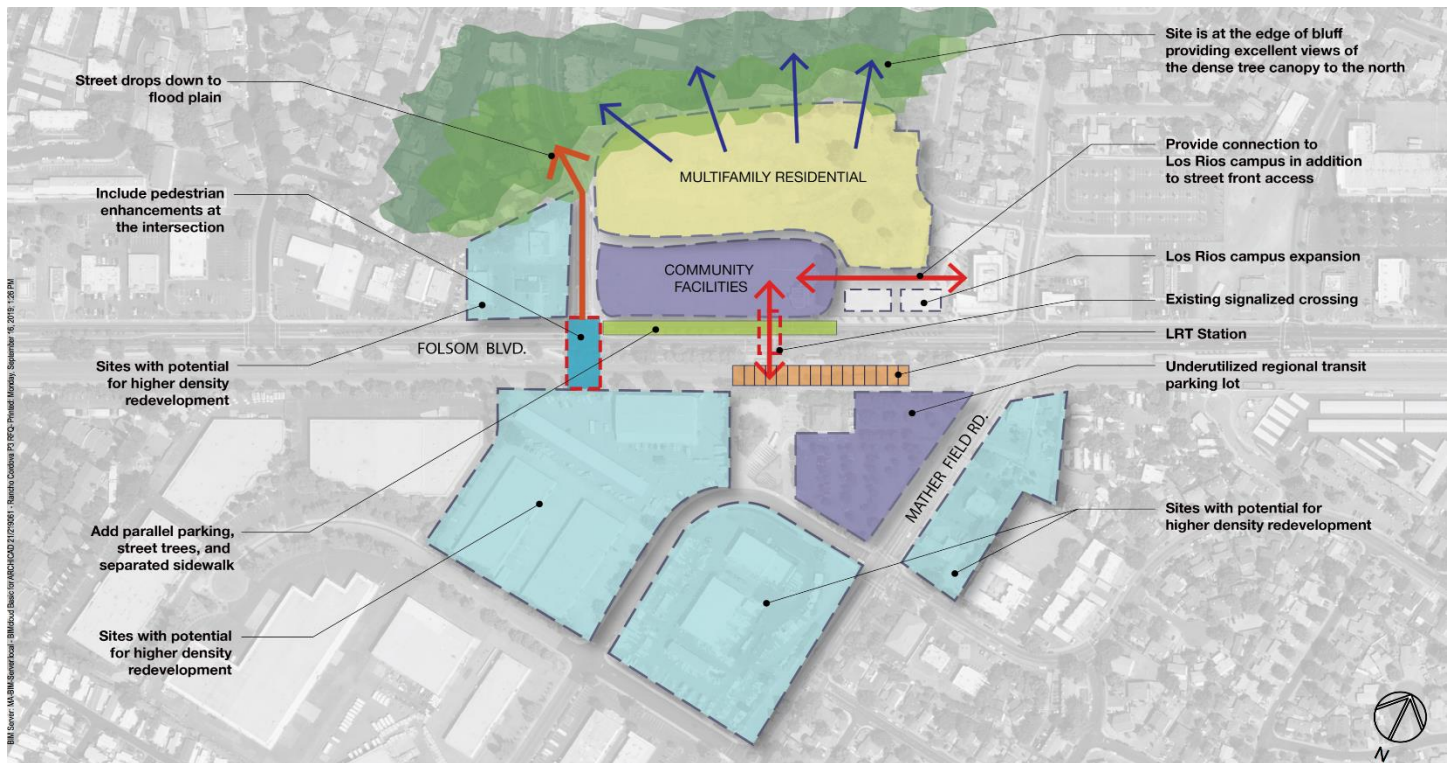
Human Centered
Design-Development

PROJECT IDEAS

crossing

cross-ing \ 'krô - sîŋ \ noun, verb

- Connectivity:** linkages, exchanges (*at transit stops, public spaces, cultural and educational gatherings, etc.*)
- Progression:** catalyzing activity, evolution, capturing growth and opportunity
- Emergence:** a sense of arrival



Mills Station District Conceptual Plan, 2019

HUMAN-CENTERED DESIGN/DEVELOPMENT (HCD) for URBAN PLACEMAKING

Get up from your desk, get out of your building, and get into the environment you're creating

Rancho Cordova is a young City incorporated only 16 years ago with a palpable spirit of innovation. The GriffinSwinerton Team seeks to harness that energy in presenting the following ideas which underpin our project concept, Mills Crossing.

Mills Crossing focuses on **HOW** development occurs in equal parts to **WHAT** is developed, a design and development that provides flexibility in both **TIME** and **SPACE**.

Human-centered design or design thinking is a discovery-driven problem-solving approach at the forefront of many

different industries and disciplines that seek to innovate. As much as any industry or domain, the built environment stands to benefit from utilizing a human-centered design (or "human-centered development") approach to create authentic and active places that serve the unique needs of a local community.

The traditional approach of "if you build it, they will come" has shown that, more often than not, "they" don't come if you don't build what the community needs where it is most needed. Rather than developing ideas from this top-down, hierarchical structure – from "the Market's" mind to the

ITEM 12.1.

ATTACHMENT 3

Community's backyard – HCD is collaborative, community/user-focused, and iterative. It is a learning process that is fueled by users' experiential feedback. The process leverages and expands upon more traditional (and risky) approaches that solely focus on writing business plans and performing market studies or surveys.

Public-private partnerships (P3s) and HCD have natural and powerful synergies.

DEVELOPING A UNIQUE PLACE FOR A YOUNG, EVOLVING CITY

By necessity, the Team's application of a human-centered design/development approach to Mills Crossing must be specifically tailored to the social, economic, and environmental characteristics of Rancho Cordova. Our customized development approach involves the following steps:

1. REFINE PROJECT IDEAS

Housing Development

- By bringing new residents to the City, the housing component embeds demand for community uses on the Site.
- Housing in this key location is best thought of as civic infrastructure benefiting not just to the residents who will live onsite but also the broader community.

Community Facilities



- Drawing from conclusions reached in commissioned market analyses, space programming studies, stakeholder surveys, and council study sessions, the City's program aspirations center on providing flexible multi-purpose community facilities.
- Thoroughly researched, site-specific programming would involve further exploration of partnerships with local operators and stakeholders – for example, Team member Hacker Lab – for unmet demand for space and community programming needs.
- Led by the Team's placemaking experts, generate new ideas, "connect new dots", and further identify gaps and community needs through cross-silo community and civic partner engagement.

2 TEST IDEAS AND ITERATE

Interim ("Pop Up") Facilities



- Prototyping phase (i.e. the Minimum Viable Product, or MVP, in design thinking): no matter how experienced and knowledgeable the team is, ideas are only as good as they are able to be implemented. Pop-up facilities are the built environment's answer to the need to develop an MVP or prototype and test new ideas with the end user, gather feedback/data, and iterate.
- The expanding world of temporary/interim facilities (i.e. pop-up uses) – for food & beverage, retail, entertainment, performances, exhibits, crafts, civic engagement, etc. – allows our Team, in collaboration with the City, to rapidly establish temporary places before putting "shovels in the ground".
- The use of interim placemaking frameworks could occur during pre-development in parallel with and informing the planning for permanent facilities, adding energy and excitement to the civic engagement process.

3 FINALIZE DEVELOPMENT PLAN

Risk-mitigated, Development



- A final development plan will be established with thorough collaboration with the City, community, and the Team
- The strategies above allow for responsible, risk-mitigated project implementation, managing time by breaking up the project into phases as needed while activating the entire Site with an evolving balance of permanent and interim facilities.
- The Team will craft a strategy that keeps the development advancing in its stages in order to achieve the City's aspirations.

INTERPRETING THE VISION

The City offers a compelling case for the development of a mixed-use community hub on the nearly 10-acre Mills Station site, where the interplay of public gathering spaces, community amenities, and cultural, recreational, commercial, and residential uses seek to create a vibrant center of civic identity and catalyze further development within the Mills Station District.



Mills Crossing Annotated Site Plan, 2019

Our concept emphasizes **Connectivity** in terms of linkages to the surrounding neighborhood as well as crossroads or exchanges within the Site, places where planned and unplanned activity and gatherings **Emerge**.



Mills Crossing Conceptual Rendering, 2019

The epicenter of the Site provides a strong pedestrian connection across Folsom Boulevard to Mills Light Rail Station, which arrives at a central public promenade, plaza, and stage, which can be programmed in a variety of ways. The central promenade extends and connects to the Site's residential anterior, inviting residents to partake in the public gathering spaces and community facilities. A permeable pedestrian green street or pathway divides the Site from north to south, where residential use sits to the

north and community facilities to the south. The green paths also draw activity to the easterly side of the Site and create connections to Los Rios Community College, both existing and expansion areas. Bike lanes and pedestrian enhancements at street corners further invite multiple modes of access to the Site. Finally, true to the Site's TOD nature, parking is predominantly accommodated across the street at Mills Station.

Conceptual development program yields are as follows:

Use Type	Program Yield
Housing	130 to 200 Units
Community Flex Facilities	50,000 to 60,000 SF
Commercial/Retail Flex	5,000 to 10,000 SF

Note: the above is illustrative in nature and will be subject to modification as the project evolves

Housing: a critical element of the development program, embedding demand for the community facilities on the Site. New housing development also aligns with the growth trajectory of Rancho Cordova and the region, as the City intentionally **Progresses** from a commuter town to a more diversified population of residents with evening and weekend presence.

ITEM 12.1.

The housing component is planned on the northern half of the Site in a 3-story walkup configuration. The amount and levels of affordability are to be determined in collaboration with the City, as is a portion of potentially unrestricted units to accommodate the progression of market rate demand over time.

Community and Commercial Facilities: activation of public spaces is the lifeblood of the Project, and the vision for the community facilities is to create a community identity through iconic structures fronting Folsom Boulevard in space quantities and configurations that can accommodate flexible cultural and recreational uses. The City's extensive analysis and engagement efforts to date have focused on providing flexible spaces for performance and visual arts, meeting spaces, maker spaces, commercial kitchen, arts studios, museum or exhibit space, and social services such as a clinic.

PROTOTYPE TO PERMANENT: A MODERN APPROACH TO PLACEMAKING

The City should be commended for advancing its vision for the Mills Station District to the point that it has, providing prospective developers and designers much to draw from.

Both the challenge and opportunity presented by this Project are to effectively balance the varied programmatic ideas, affordability goals, and financing opportunities into a cohesive and feasible development plan operated by the appropriate organization(s) that can satisfy demonstrated community needs. Beyond business planning and additional surveys, our view is that success will be greatly enhanced by adopting a "prototype to permanent" approach, i.e. strategic deployment of creative, living laboratories to gauge real demand and viability for the various ideas explored before the full built-out of permanent facilities. This proposed evolutionary placemaking framework i.e. HCD approach – from prototype to permanent – is a critical value-added element missing from the City's process so far, and it can reduce risk and speculation in Project implementation

It doesn't take as long as you might think

Activating the Site and stress testing ideas would be a core part of the Project's pre-development phase – think "placemaking festivals" with pop-up vendors as a form of community development charrettes. The mix of interim facilities and permanent facilities may also prove to be an effective phasing strategy and can elevate the name recognition of the Project throughout the industry and region. In this way, interim uses (1) catalyze development early in the development process, (2) are a risk-mitigation strategy to test community service demand before making long-term commitments to permanent facilities, and (3) can attract private investment in permanent facilities by demonstrating market viability of commercial pop-up uses.

ATTACHMENT 3

Team member Hacker Lab is an ideal partner to plan and program multi-purpose maker spaces, arts studios, STEM laboratories, meeting rooms, and similar cultural uses.



Hacker Lab Global Home, Sacramento CA



ITEM 12.1.

Examples of this work from our pioneering team members are shown below and further detailed in the Relevant Team Experience section.

ENVELOPE A+D

envelope a+d o | a u a

PROXY

San Francisco, CA

Temporary urban activation – retail, food, arts, events

Conceptualized as a placeholder for a more permanent development, PROXY demonstrates how, through minimal means, voids in the city fabric can become thriving centers of ingenuity and fun that positively affect the quality of life in the surrounding neighborhood.



A combination of provisional architecture and thoroughly researched, site-specific programming act as a content machine ... an invitation for artists,

designers, content creators and passers-by to act on PROXY, play around in it and invent it for themselves. These chance collisions between multidisciplinary actors result in a richness of experience that draws in people to engage with each other and with their environment in delightful ways.

NOW_HUNTERS POINT

San Francisco, CA

Interim uses and structures, public park, streetscape + plaza

NOW_Hunters Point is framed around an incremental, community-led approach in which an array of interim uses—job training, mobile health clinics, access to fresh food, youth activities and tutoring—are implemented to support the existing community against the strong currents of change that are already in motion...we crafted a strategy that utilizes live prototyping not only to test objects—like the Listening Booth used to record neighbors' stories—but to establish a way of engaging community members in the design process that is fundamentally reciprocal and respectful.



Along the way, the insights that we take from this constant conversation will create a feedback loop within the design process, shaping the form and content of the permanent public space improvements, and suggesting directions for the long-term development of the land.

PROJECT FOR PUBLIC SPACES



DOWNTOWN DETROIT PUBLIC SPACES

Detroit, MI

Placemaking revival in downtown Detroit

Project for Public Spaces has worked with local partners in downtown Detroit for nearly two decades. As the city fell upon hard times, our placemaking efforts in the heart of downtown provided a beacon of hope for residents and an engine for economic revitalization. ... community-driven improvements to the once unfriendly traffic island

Campus Martius caught the attention first of Compuware and then of Quicken Loans, both of which moved their headquarters next to Campus Martius, and brought jobs and investment back downtown. Today, Campus Martius attracts more than two million people annually, the surrounding district has attracted 20,000 new jobs and over \$2 billion of real estate investment, and since the Detroit declared bankruptcy in 2013, the park has become a symbol of the city's resilience and renewal.



SAN MATEO PENINSULA TRANSIT CORRIDOR PLAN

San Mateo County, CA

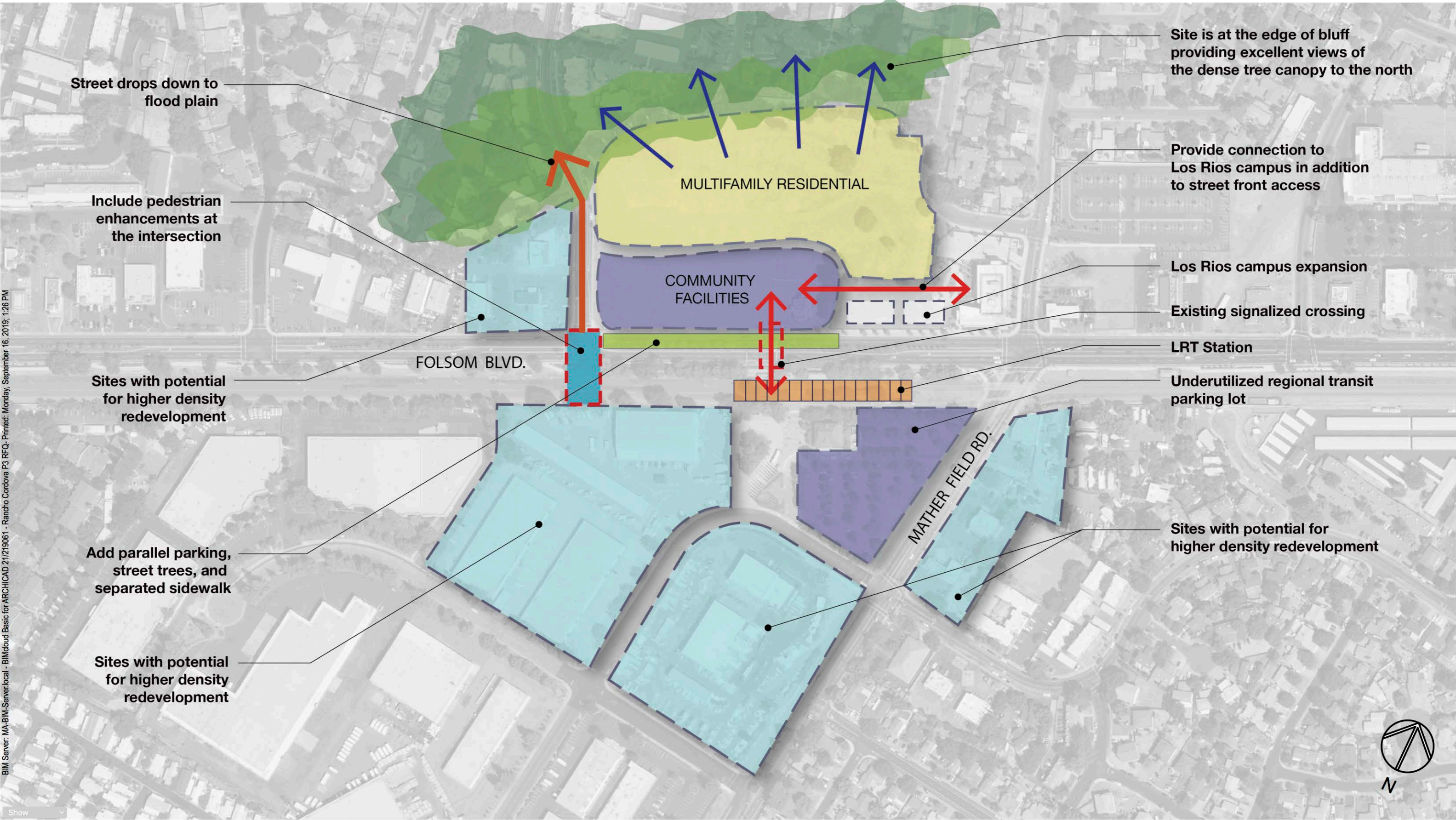
Transit stations as community hubs

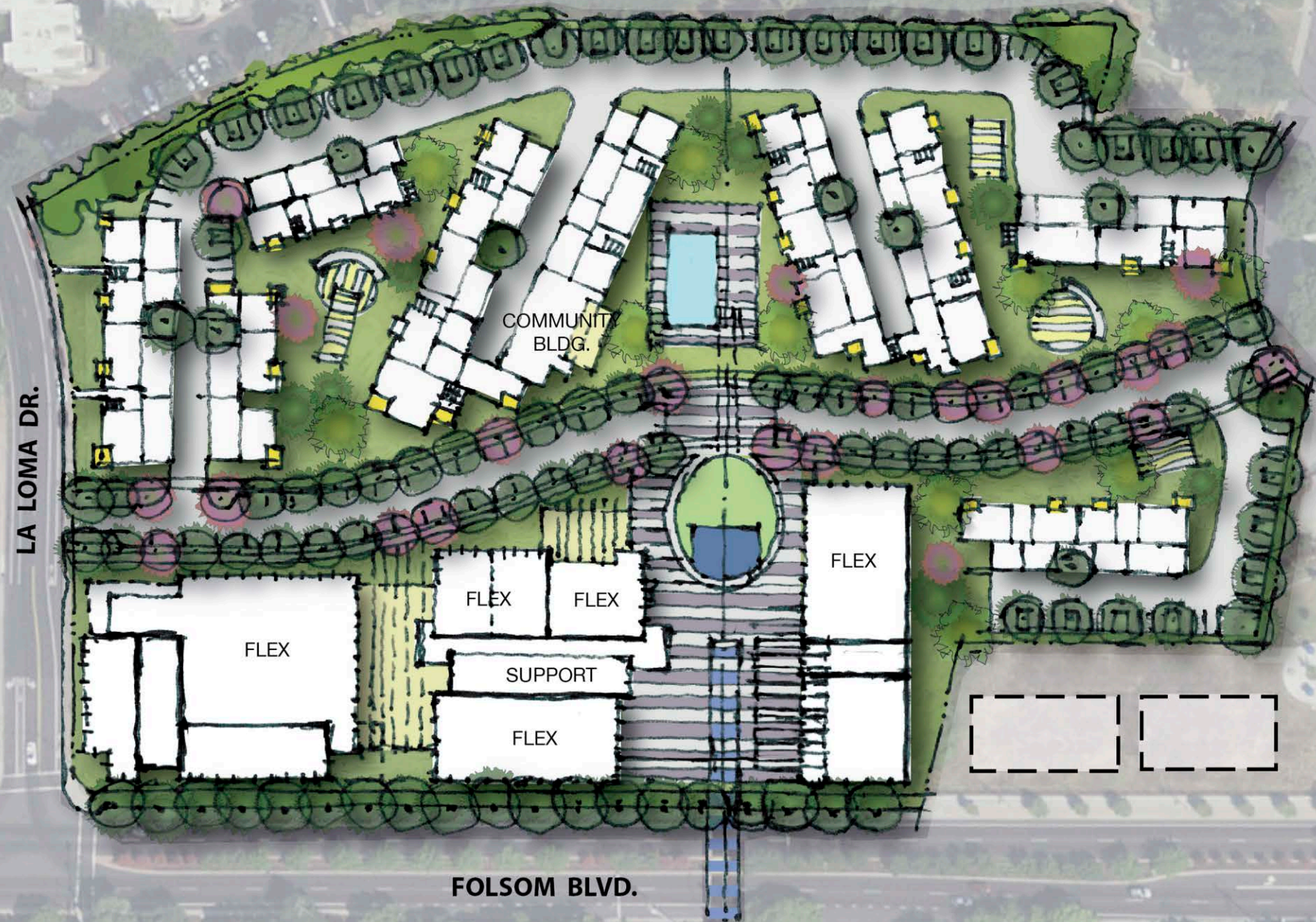
Thinking beyond Stops and Stations to Community Hubs – PPS's Portals to PLACES program

focuses on creating transit facilities that support communities. Transit stops and stations are well integrated into the communities they serve at the local and regional level, meet the needs of passengers through useful amenities, and serve as accessible active, social, and comfortable public spaces.



Through a participatory and interactive planning process, PPS developed conceptual Placemaking plans for seven transit stations along the corridor in order to attract more people to them, along with a plan to transform El Camino Real into a 'Grand Boulevard.' The Plan is based on four related strategies: 1. Turning Transit Stops and Stations into "Places"; 2. Transforming El Camino Real into a Grand Boulevard; 3. Creating Balanced Access to Transit; and 4. Fostering Affordable Housing and a Lively Downtown Development Mix. The seven cities involved are: Belmont, Colma, Daly City, Redwood City, San Bruno, San Carlos, and South San Francisco.





LA LOMA DR.

COMMUNITY
BLDG.

FLEX

FLEX

FLEX

FLEX

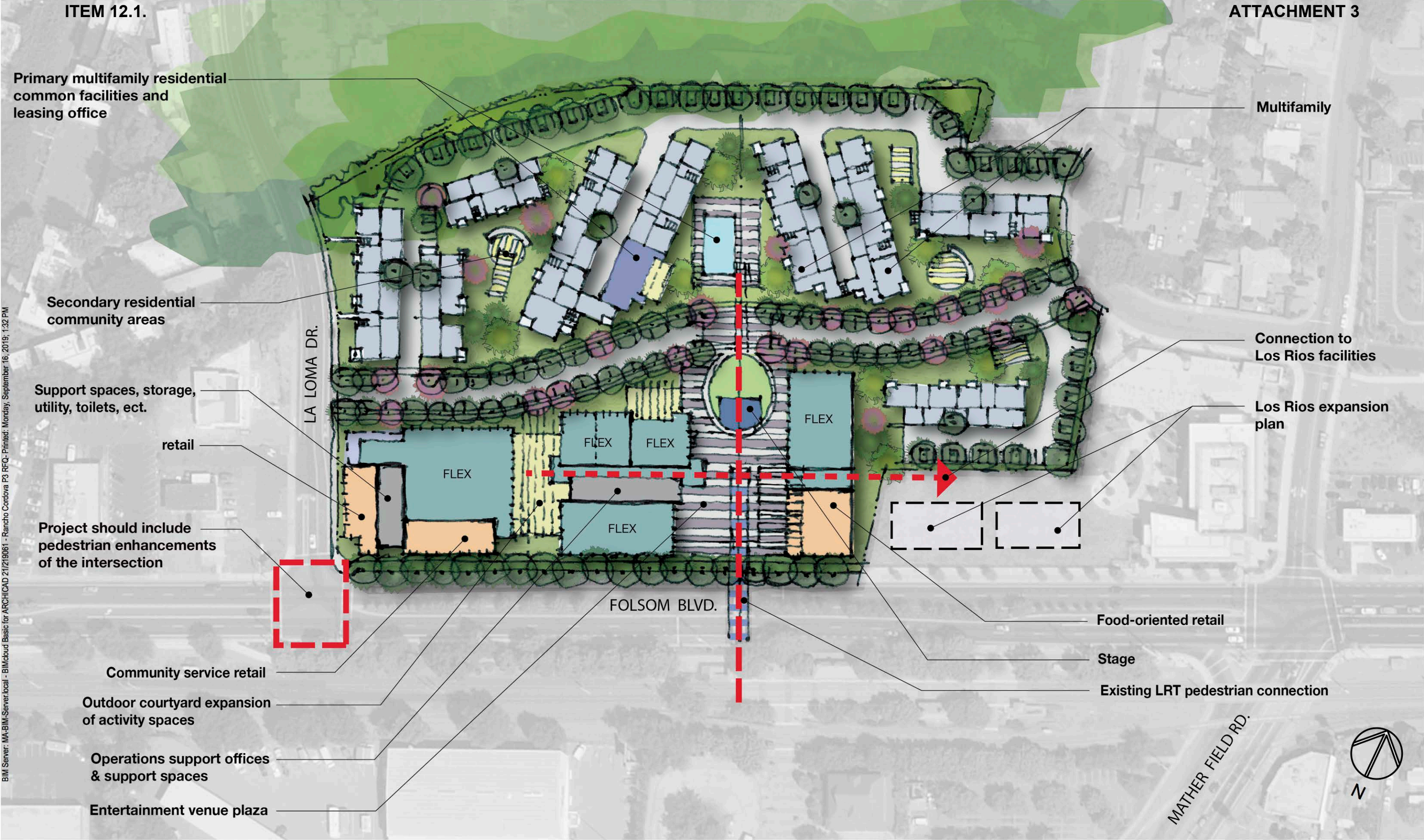
SUPPORT

FLEX

FOLSOM BLVD.

MATHER FIELD RD.

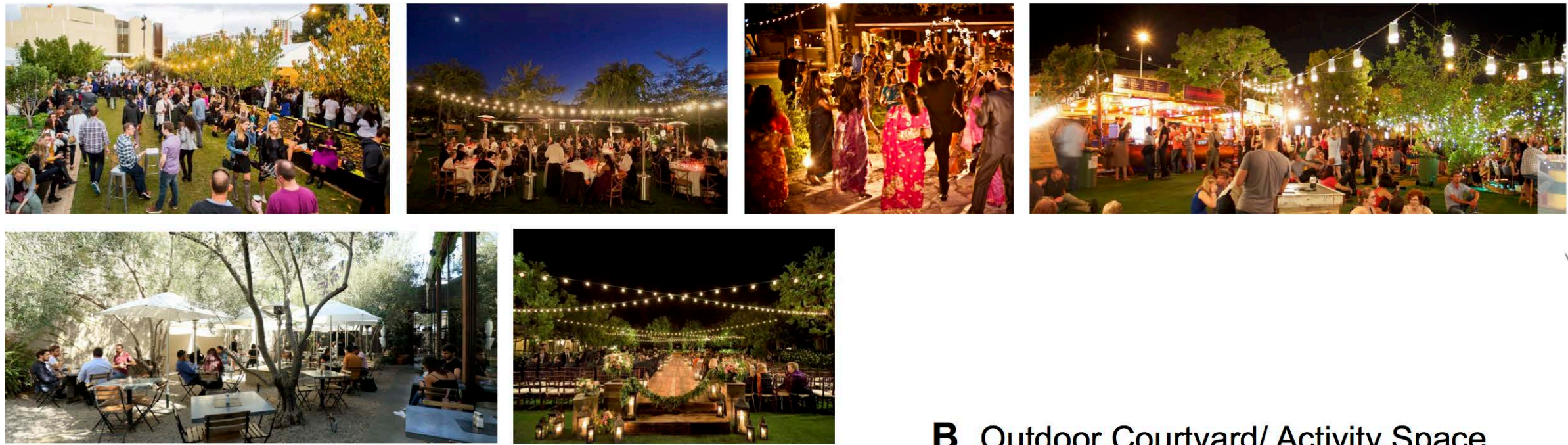




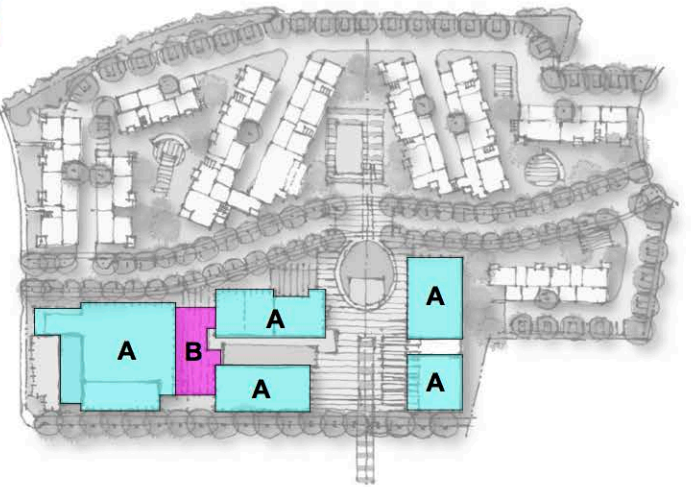
BIM Server: MA-BIM-Server.local - BIMcloud Basic for ARCHICAD 21/219061 - Rancho Cordova P3 RFQ - Printed: Monday, September 16, 2019, 1:32 PM



A Building Form

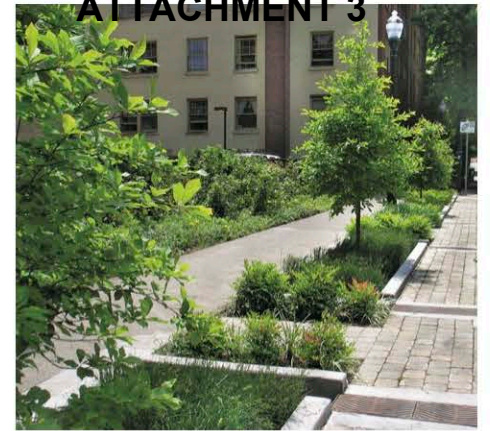
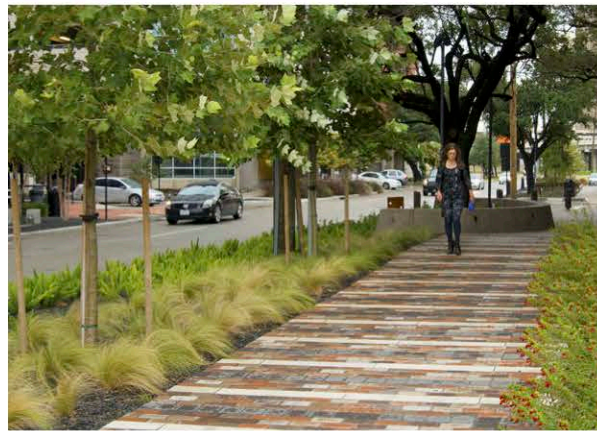
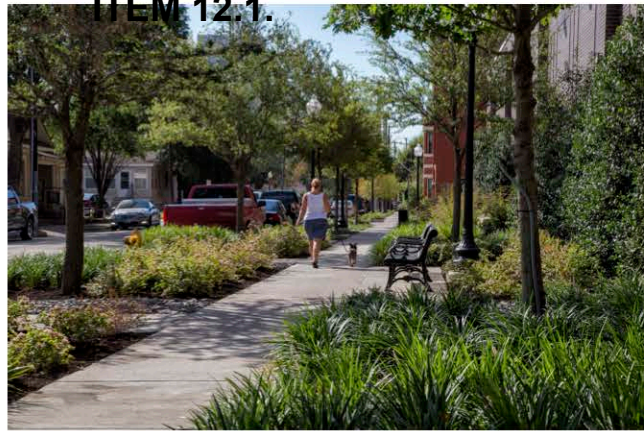


B Outdoor Courtyard/ Activity Space

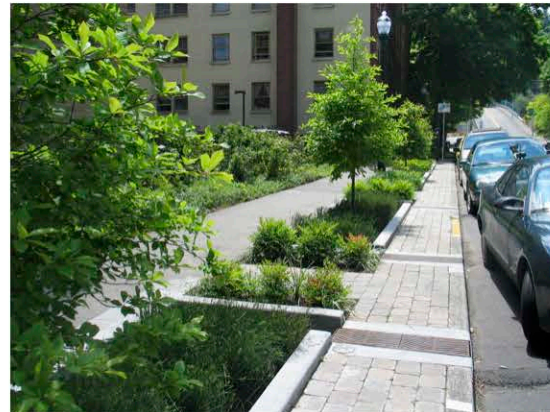


BIM Server: MA-BIM-Server.local - BIMcloud Basic for ARCHICAD 21/219061 - Rancho Cordova P3 RFQ - Printed: Friday, September 13, 2019, 4:21 PM

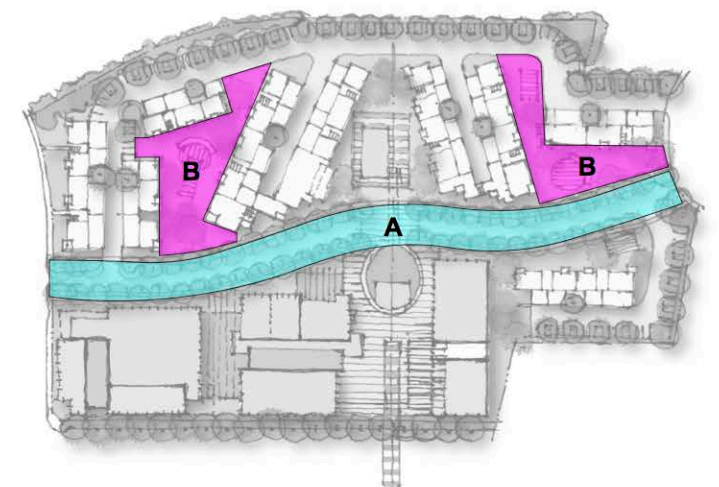
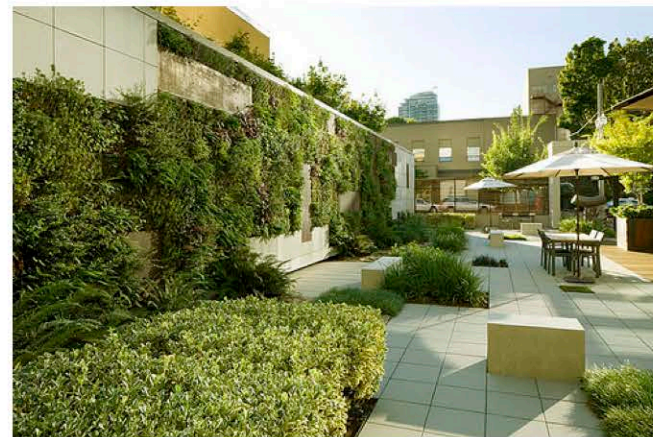
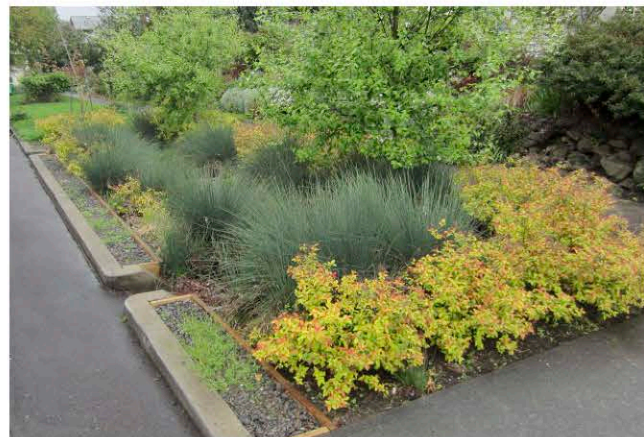
ITEM 12.1.



ATTACHMENT 3



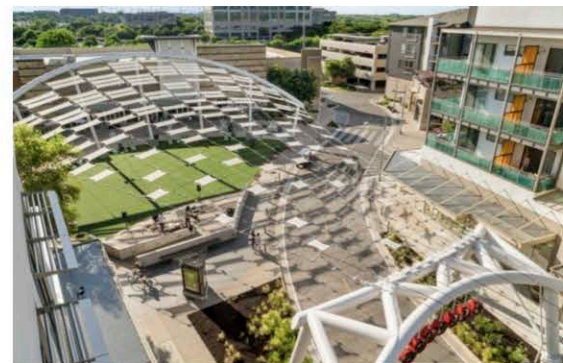
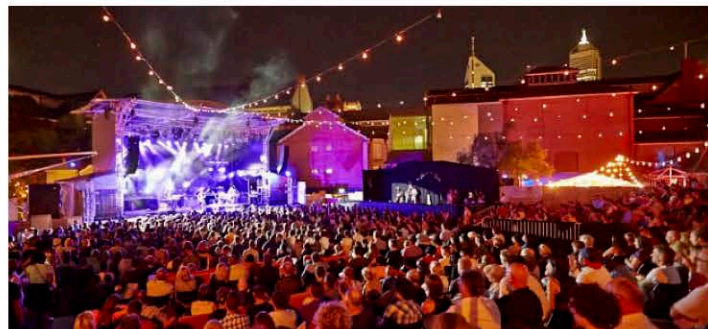
A Green Streets



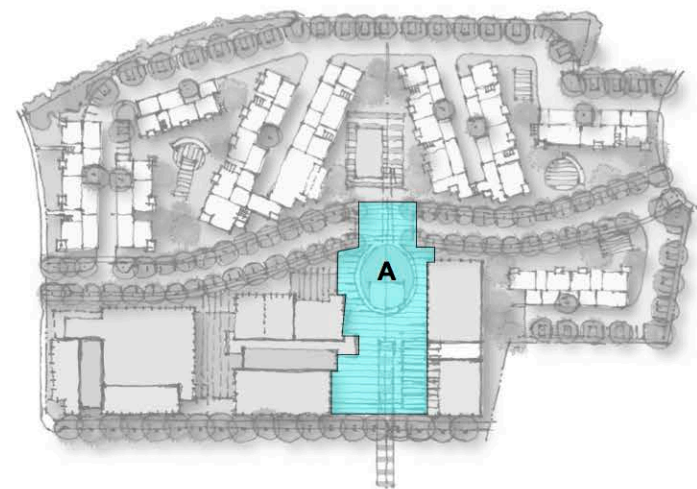
B Residential Courtyard



A Venue Plaza: Food Truck



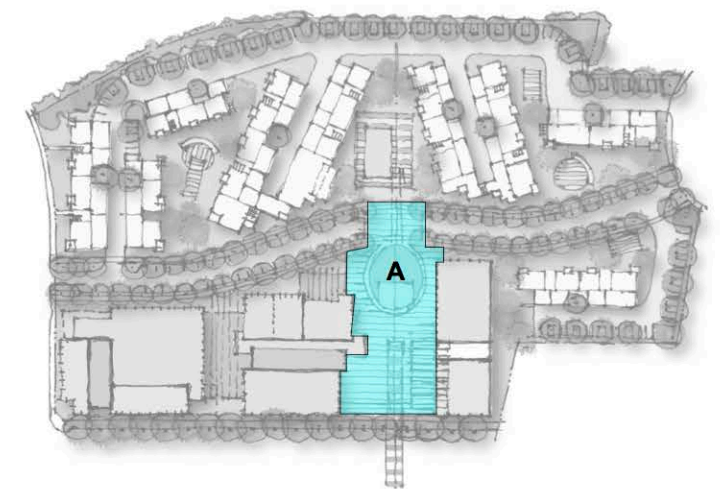
A Venue Plaza: Outdoor Entertainment



ITEM 12.1

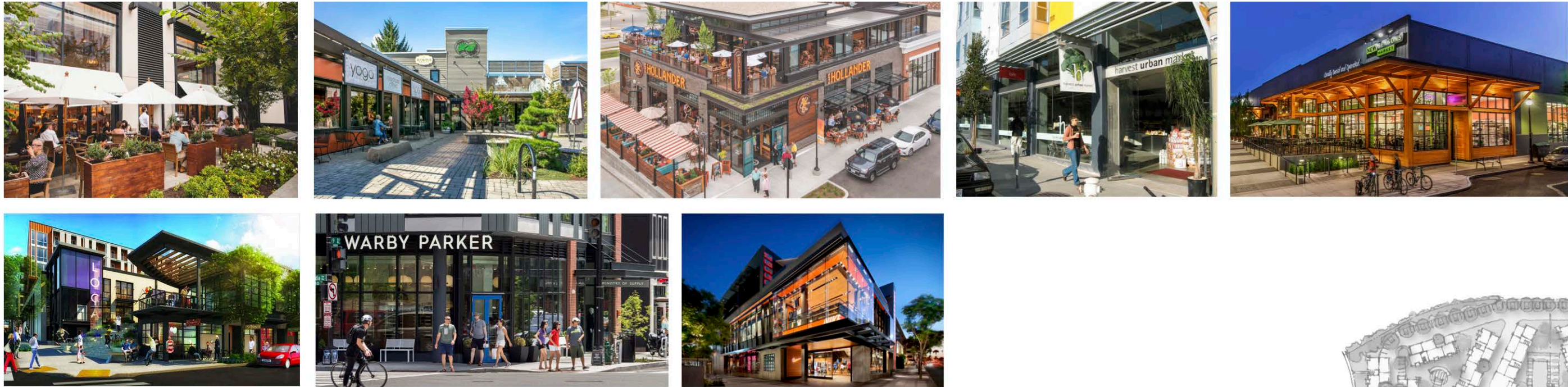


A Venue Plaza: Creative Pop-Ups

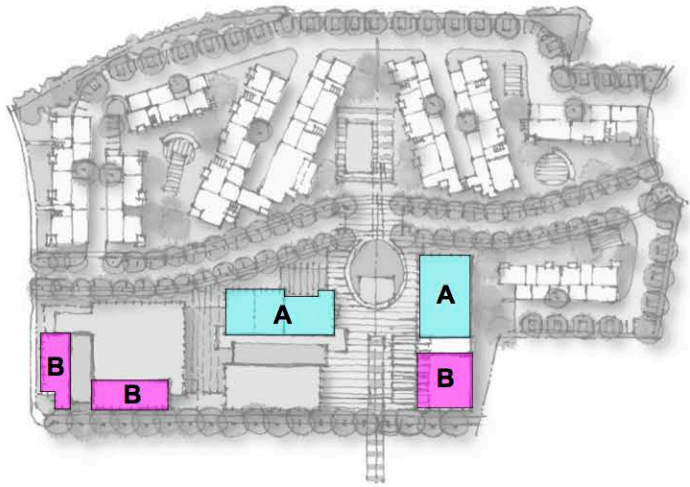




A Maker Space



B Retail





BIM Server: MA-BIM-Server.local - BIMcloud Basic for ARCHICAD 21/210061 - Rancho Cordova P3 RFP - Printed: Friday, September 13, 2019, 6:47 PM



BIM Server: MA-BIM-Server-local - BIMcloud Basic for ARCHICAD 21/219061 - Rancho Cordova P3 RFQ - Printed: Friday, September 13, 2019 6:47 PM



BIM Server: MA-BIM-Server.local - BIMcloud Basic for ARCHICAD 21(19061) - Rancho Cordova P3 RFQ - Printed: Friday, September 13, 2019, 6:47 PM



BIM Server: MA-BIM-Server.local - BIMcloud Basic for AEC-HICAD 21/2/2019 - Rancho Cordova P3 RFQ. Printed: Friday, September 13, 2019, 6:47 PM





Q- Printed: Friday, September 13, 2019, 6:47 PM
CAD 21 10/13





RELEVANT EXPERIENCE



COUNTY ADMINISTRATION SOUTH BUILDING // ORANGE COUNTY CIVIC CENTER P3

THE INDUSTRY'S LEADERS AND PIONEERS

GRIFFIN SWINERTON	30
RELATED CALIFORNIA	55
MOGAVERO ARCHITECTS	67
ENVELOPE A+D	80
PROJECT FOR PUBLIC SPACES	97
HACKER LAB	113
CITIGROUP (CITI)	116



RELEVANT EXPERIENCE

FIRM OVERVIEW

FEATURED PROJECTS & REFERENCES

TEAM RESUMES



Griffin|Swinerton operates as a distinct development company with ownership interest shared between Griffin Structures Inc and Swinerton Builders and leverages the expertise, track record, and resources of its partner firms.

+\$3B

of development
experience over 40 years

+\$600M

In development
currently underway

\$4B/YR

Swinerton: largest general
contractor in CA with +\$4B
of revenue in 2018

15 IN 15

15 successful
projects in 15 years

170+ YEARS

Combined firm experience

Griffin|Swinerton is a recognized leader in the design, planning, entitlements, financing, and development of social infrastructure, community facilities, and real estate using alternative project delivery methods including Public-Private Partnerships (P3), Lease-Leaseback, Design-Build, and Program Management at-Risk. Formed in 2009, Griffin|Swinerton is a fully integrated, well-established organization with more than \$600M of development underway all structured as P3 transactions.

Griffin|Swinerton combines the complementary strengths of its well-respected partner firms, Griffin Structures and Swinerton Builders, established in 1981 and 1888 respectively, each with decades of experience serving public sector clients throughout California and the U.S. Griffin Structures and Swinerton Builders have long and successful track records working with counties and cities in an open book, fully transparent process utilizing multiple alternative forms of project financing and delivery. Over the years we have been recognized for our expertise and innovation in public-private partnerships, land acquisition and development, construction management, and building construction. However, we are most proud of the trusted, committed reputation we have built with our public sector partners, who are often long-term repeat clients.

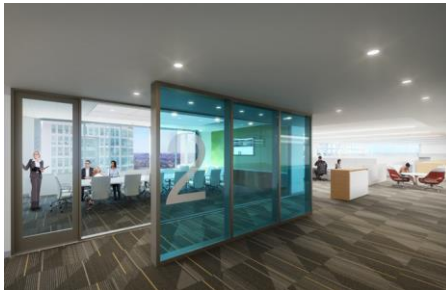
Master Development – Griffin|Swinerton, in collaboration with our partners, will perform integrated technical, financial, and administrative functions as master developer of the Site. Services within this category include master planning, entitlements, attribution of site work, public-private financing, and creation of the separate parcels for development of the housing and community facilities components.

Community Facilities Development via Public-Private Partnership (P3) – Griffin|Swinerton will develop the community facilities in a P3 arrangement with the County, offering a range of financing options and capabilities with our financing partners – from privately-issued tax-exempt bonds to tax credits, State transit oriented development (TOD) funds, private equity, and customized debt instruments. Our Team will collaboratively work with the City to select a value-added deal structure and (e.g. lease-leaseback) and financing approach that best meets its programmatic goals while most efficiently leveraging the City's significant investment of land and \$35 million cash contribution.

Griffin|Swinerton operates as a flat organization with minimal hierarchy. We take an **all-hands-on-deck approach**, seamlessly integrating the staff of both partner firms into project-specific teams. The expertise and commitment of our staff resources along with the industry's best architects, planners, builders and subcontractors will ensure that the Project is carefully planned, executed, and delivered in a fully transparent, open book, and collaborative process.

BUILDING 16 – COUNTY ADMINISTRATION SOUTH

SANTA ANA, CA



DEVELOPMENT: PUBLIC FACILITIES Public-Private Partnership (P3)

Cost
\$188M

Size
250,000 SF

Client
County of Orange

Reference Contact
Frank Kim, CEO
(714) 834-4304
frank.kim@ocgov.com
Executive Assistant:
Nadine Romero
(714) 834-6201

The LEED Silver project known as Building 16 is the first phase of a multiphase master plan for the County of Orange. This phase is comprised of a 250,000 SF, six-story office building over two levels of subterranean parking. The tenants will be Public Works, Waste Management, Treasurer/Tax Collector, as well as a One Stop Shop, providing 'walk up service' to all departments for the County's constituents. The project is estimated to be complete in 2020.

The project is bordered by a future OC Street Car transit stop to the south, service and pedestrian paseo to the east, a central courtyard to the north and a rejuvenated pedestrian-friendly street to the west. Likewise, the project's elevations change with the solar orientation which allows filtered sunlight to enter the east and west facades while the southern exposure shields the interiors from the harsh southern sunlight.

This is a Public-Private Partnership ("P3") project.

BUILDING 14 – COUNTY ADMINISTRATION NORTH

SANTA ANA, CA



DEVELOPMENT: PUBLIC FACILITIES Public-Private Partnership (P3)

Cost

\$200M

Size

250,000 SF

Client

County of Orange

Reference Contact

Frank Kim, CEO
(714) 834-4304
frank.kim@ocgov.com

Executive Assistant:

Nadine Romero
(714) 834-6201

“Building 14” will be a sister building to the County of Orange’s new Building 16 in terms of design and approximate size. The planned occupants include Board of Supervisor offices, the Board of Supervisor hearing chamber, and departments currently occupying Buildings 10 and 12. A new plaza is also planned between and around the newly constructed Buildings 14 and 16.

In December 2018, financing closed for Building 14 in a privately-issued tax-exempt bond offering that achieved excellent spreads and coincided with an ratings upgrade for the County of Orange to AAA. The project is currently in its pre-development phase and is on schedule to commence construction in October 2019.

This is a Public-Private Partnership (“P3”) project.

RIVERSIDE CONVENTION CENTER EXPANSION

RIVERSIDE, CA



DEVELOPMENT: PUBLIC FACILITIES Public-Private Partnership (P3)

Cost

\$130M (est)

Size

120,000 SF (est)

Client

City of Riverside

In Q2 2019, Griffin|Swinerton was awarded a P3 by the Riverside City Council to design, permit, finance, and construct a roughly 100,000 gross square foot expansion of the Riverside Convention Center, adjacent 1,000+ space parking structure, and public events plaza. This project is a part of the Riverside Alive district in the heart of downtown Riverside, adjacent to a concurrently-built mixed-use development of a connected convention hotel, extended stay hotel, apartments, retail, and office building.

The project is currently in an exclusive negotiations phase and is on a preliminary schedule for construction between 2021 to 2023.

SALINAS POLICE SERVICE HEADQUARTERS

SALINAS, CA



DEVELOPMENT: PUBLIC FACILITIES Public-Private Partnership (P3)

Cost
\$55M

Size
74,000 SF

Client
City of Salinas

Reference Contact
Donald Reynolds
Assistant Public Works Director
(831)758-7241
donaldr@ci.salinas.ca.us

The team of Griffin Structures and Swinerton Builders is serving as the Development Team for the design, financing, construction and delivery of this new \$55 million facility.

The new 74,000 square foot building will replace the City's existing police department headquarters, built in 1958. The Police Headquarters will address the space needs identified in the City's 2014 needs assessment study for the Police Department.

Planning and development includes a comprehensive community outreach component to engage residents and businesses. The project closed financing in May 2018 and commenced construction in June 2018.

"The reference check is what really tilted the scale toward [selecting] the Griffin|Swinerton team."

—City of Salinas Council Staff Report (April 18, 2017)

EL GABILAN BRANCH LIBRARY

SALINAS, CA



Interior View – Café

- Internet Access
- Food/Drinks
- View Out (active)



DEVELOPMENT: PUBLIC FACILITIES Public-Private Partnership (P3)

Cost
\$22M

Size
21,000 SF

Client
City of Salinas

Reference Contact
Eric Howard
Librarian, Salinas Public Library
(831)758-7419
erich@ci.salinas.ca.us

The team of Griffin Structures and Swinerton Builders is serving as the Development Team for the new El Gabilan Branch Library in the City of Salinas. This facility will be delivered utilizing a Public-Private Partnership (P3) which will provide for the design, financing, construction, and delivery of the new library. The building will be delivered completely finished and furnished as a turnkey project.

Working with Anderson Brulé Architects as the City's selected Architect, the Griffin | Swinerton Team will provide the services necessary to move the El Gabilan Library project from a final schematic design to the design of a fully constructed and equipped building with associated parking and site development.

The new 21,000 square foot, two-story building facility will replace the City's existing library on just over one acre of land.

QUARTZ HILL LIBRARY

COUNTY OF LOS ANGELES, CA



DEVELOPMENT: PUBLIC FACILITIES

Public-Private Partnership (P3)

Cost

\$12M

Size

12,000 SF

Client

County of Los Angeles

Reference Contact

Fred Hungerford
Chief Deputy County Librarian
(951) 444-6141
fhungerford@managementco
uncil.lacounty.gov

Griffin Structures partnered with Swinerton Builders to deliver a turn-key library for the County of Los Angeles. The Griffin|Swinerton comprehensive proposal to replace the County's existing branch library in the unincorporated Antelope Valley community of Quartz Hill, was structured around a lease with an option to purchase the project during the lease term. The lease structure gives the County flexibility, while the design-finance-build P3 model guarantees an occupancy cost to the County.

The Quartz Hill Library began with a County-issued RFP outlining parameters for the location—a one- to two-acre site with sole ingress/egress rights, zoning and entitlements allowing for public uses, and access to utilities that met its public library specifications. The team secured a 1.7-acre site and developed conceptual designs before submitting its proposal. The team designed the LEED Gold facility, secured entitlements and all development approvals, and financed the entire project. In 2016, Griffin|Swinerton delivered a move-in ready library, outfitted with County-specified furniture, fixtures and equipment.

This was a Public Private Partnership ("P3") project.

WEST HOLLYWOOD CITY HALL

WEST HOLLYWOOD, CA



DEVELOPMENT: PUBLIC FACILITIES

Public-Private Partnership (P3)

Cost

\$8M (\$ 1991)

Size

35,000 SF

Client

City of West Hollywood

Reference Contact

Joan English (*retired*)
Director of Transportation
(310)413-3302

Griffin Structures worked with the City of West Hollywood to redevelop an aging commercial building into a new City Hall and state-of-the-art Emergency Operations Center. The turn-key project was delivered move-in ready to serve West Hollywood residents and businesses, through a Public Private Partnership (“P3”). This project, completed in 1991, was one of the very first municipal P3 projects undertaken in the United States.

Griffin Structures is also currently acting as Owner’s Representative to the City of West Hollywood to renovate the existing City Hall. The scope of work includes updating the lobby along with several other improvements.

This was a Public-Private Partnership (“P3”) project.

Half Moon Bay Library

Half Moon Bay, CA



Cost:

\$24M

Size:

22,000 SF

Client:

City of Half Moon Bay

Contact:

Peggy Jensen,
Deputy County Manager
(650) 363-4598 |
pjensen@smcgov.org

Annie Malley
Branch Library
(650) 726-2316 x227 |
malley@smcl.org

Griffin is providing program and construction management services for a new library in the City of Half Moon Bay. The project entails demolition of the existing 7,825 square foot library and construction of a new 22,000 square foot library. Planning for the new \$24 million library involved extensive community engagement and outreach. The contemporary design includes a lobby; children's area; study, teen and literacy areas; as well as a roof deck, courtyard and atrium. The project, scheduled for completion in summer 2018, is designed to be a Net Zero Energy (NZE) building, with LEED® Silver or better certification.

The new Half Moon Bay Library project, funded by the City of Half Moon Bay, the County of San Mateo and the San Mateo County Library Joint Powers Authority, will service the San Mateo Coastsides communities and is the only library serving a 270 square mile area.

Burlingame Community Center

Burlingame, California


Cost:

\$40M

Project Duration:

2018 - 2021 (est.)

Size:

35,700 SF

Public Agency:

City of Burlingame

Contact:

Margaret Glomstad, Parks and
Recreation Director
(650) 558-7307
mglomstad@burlingame.org



The new, 35,700 square foot, two-story center will be built over the footprint of the existing facility, expanding the existing space by nearly 11,000 SF. The Center will feature an active lounge, community room, classroom, music studio, tech shop, ceramics and fine arts workshops, teen center, fitness studio, and more

Other components include the addition of new above-ground and underground parking adjacent to the new building, a new relocated playground, basketball court, and picnic area, and site improvements to the area surrounding the new Center.

Griffin Structures is providing construction management services and value engineering.

Discovery Cube Science Center

Santa Ana, California



Relevancy:

- Program and Construction Management
- Non-Profit Organization

Cost:

\$12M

Size:

44,000 SF

Project Duration:

2013 - 2015

Client:

Discovery Science Foundation

Contact:

Joe Adams
CEO, Discovery Science Foundation
(866) 552-2823
jadams@discoverycube.org

As the construction manager for the \$12M expansion of the popular Discovery Cube-Orange County Science Center in Santa Ana, Griffin managed the project that enabled the Center to expand its distinctive hands-on experiences for visitors with differing learning styles, whether kinesthetic, auditory or visual.

The 44,000 SF Discovery Pavilion expansion included a flexible black box theater, new exhibit space, a full demonstration kitchen, an educators' resource center, an expanded Launch Pad Science Store, upgraded welcome lobby and ticketing areas, and additional administrative office space. The expansion doubled Discovery Cube's guest capacity

and provided a larger, state-of-the-art exhibits.

Discovery Cube-Orange County programs and interactive features provided a natural extension to school outreach programs and served as a large-scale teaching aids for students, teachers and families, fulfilling the Discovery Science Foundation mission to *"inspire and educate young minds through engaging science-based programs and exhibits to create a meaningful impact on the communities they serve."*

San Bruno Recreation and Aquatics Center

San Bruno, CA



Relevancy

- Aquatics center
- Project and construction management

Cost:

\$49.5M (estimated)

Size:

45,000 SF building

8,200 SF outdoor pool

Griffin Structures is currently assisting the City of San Bruno with managing the design and construction phases of the new Recreation and Aquatics Center Project. This project consists of three separate phases: Phase 1 involved developing the conceptual design of the new Center; Phase 2 proceeded with the development of schematic design plans and construction drawings; and Phase 3 is construction.

The development of the conceptual design included several components, including: program alternatives; site analysis and alternatives; building

alternatives; project budget and operating strategies; analysis and evaluation of identified alternatives; recommended alternative; conceptual design package and budget; and public engagement.

The new Recreation and Aquatics Center will include the following: a natatorium for year-round aquatics, an outdoor pool with splash pad, a gymnasium, a fitness/wellness center, a community hall, a game room, conference rooms, and several multi-purpose classrooms.

Environmental Nature Center and Pre-School

Newport Beach, California



Relevancy:

- Program and Construction Management
- Non-Profit Organization

Cost:

\$12M

Size:

9,000 SF

Project Duration:

2012 - Present

Client:

Environmental Nature Center, Inc.

Contact:

Bo Glover
Executive Director
(949) 645-0618
bo@encenter.org

Griffin Structures provided program and construction management services for the delivery of the Environmental Nature Center, Orange County's first LEED® Platinum facility. The 9,000 SF education center, located on a 3.5-acre site in Newport Beach, provides visitors with an educational experience through hands-on interactions.

Through the use of photovoltaic solar panels, the \$12M Center is a zero net energy facility and the first net energy producer in the Southern California Edison service area. Other sustainable features include optimized building orientation, operable windows providing natural ventilation, composite wood

products as well recycled and renewable materials, drought-tolerant, indigenous landscape, bio-swales and rain harvesting designs eliminating all storm water runoff, and water efficient fixtures that save an average of 15,000 gallons of potable water annually. Additionally, more than 80 percent of the project's construction waste was recycled and diverted from landfills.

The Environmental Nature Center is a non-profit organization providing opportunities for enhancing the community's knowledge, understanding and appreciation of the natural world.

Yorba Linda Library & Cultural Arts Center

Yorba Linda, CA



Cost:

\$52M

Size:

45,000 SF Library;
13,500 SF Arts Center

Client:

City of Yorba Linda

Contact:

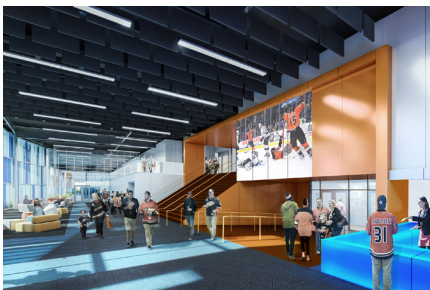
Carrie Lixey, Library Director
(714) 777-2466

The City of Yorba Linda recently retained Griffin Structures, Inc., as its Construction Manager to work with the City, Library, and Parks and Recreation staff to provide construction management services for the construction of a new two-story, approximately 45,000 square foot Library and 13,500 square foot Arts Center. The project will consist of a design phase (now through Fall of 2018) and a construction phase from Fall of 2018 to early 2020. The City of Yorba Linda has designated the Strawberry Field/Site 13 as the site for the project.

The existing 28,350 square foot Public Library facility, has had over three successive expansions to accommodate the changing needs of the community. Due to the increasing demand for services and materials, the Library facility, once again, needs to grow, but lack of space on the current lot, structural limitations and the complexity of the existing layout deter further expansion, and a new facility is needed. A new Arts Center will be incorporated and will also address needs identified in the Parks and Recreation Master Plan.

Anaheim Ducks Training Center

Irvine, California



Relevancy:

- Program and Construction Management
- Pre-engineered metal warehouse structure

Cost:

\$108M

Size:

280,000 SF

Project Duration:

2017 - Ongoing

Client:

Irvine Ice Foundation

Contact:

Bill Foltz
CFO of H&S Ventures, LLC
(949) 760-4304
bfoltz@hsventures.org

We are serving as program and construction manager and owner's representative for the new 280,000 SF Anaheim Ducks Training Center. The \$108M facility located on a 13.5 acre site at Orange County's Great Park will also serve as the new training facility for the Anaheim Ducks® National Hockey League team.

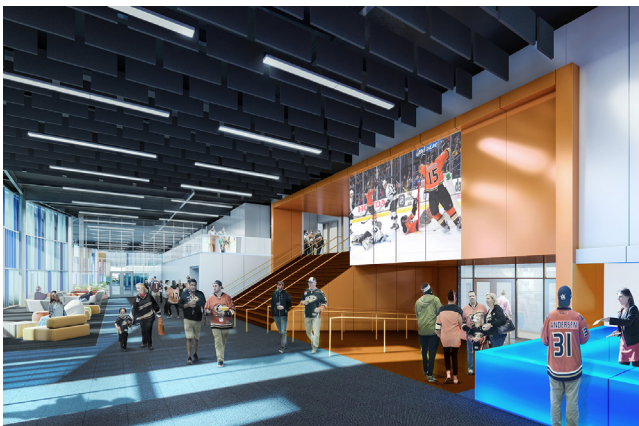
The facility will feature four indoor ice rinks—three NHL regulation rinks, and one Olympic regulation rink. The main arena will seat 2,500 and have the ability to host a wide variety of sporting and entertainment events. Other features include a sports bar, party rooms, classrooms, and

outdoor public spaces and amenities.

The pre-engineered metal framework will result in significant schedule and cost savings. The comprehensive LEED® Silver facility will fill the County's need for ice sports activities including youth and adult hockey programs, figure skating, regional and national tournaments and competitions, as well as open public recreational skating. When completed, the facility—the County's first such venue in 20 years—will be one of the largest of its kind in the nation.

Great Park Sports Complex

Irvine, CA



Cost:
\$108 million

Size:
280,000 SF

Client:
Irvine Ice Foundation

Contact:
Bill Foltz, CFO of H&S Ventures, LLC
bfoltz@hsventures.org
(949) 760-4304

Griffin Structures is serving as Program and Construction Manager and Owner's Representative for the new 280,000 SF Great Park Sports Complex. The community ice and sports facility, located on a 13.5 acre site at Orange County's Great Park will also serve as the new training facility for the Anaheim Ducks NHL hockey team.

The Complex will feature four indoor ice rinks—three NHL regulation rinks and one Olympic regulation rink. The main arena will seat 2,500 and have the ability to host a wide variety of sporting and entertainment events. Other features include a sports bar, party rooms, classrooms, and outdoor public spaces and amenities.



ROGER TORRIERO

Principal-in-Charge, Griffin|Swinerton
CEO, Griffin Structures



EDUCATION

Master of Architecture,
Accademia di Belli Arti a Firenze
Italia

Bachelor of Architecture,
Syracuse University, New York

REGISTRATIONS

California Contractor License
#793600, Classes A & B

PROFESSIONAL AFFILIATIONS

U.S. Green Building Council, Member

Urban Land Institute, Member

American Public Works Association

National Association of Industrial &
Office Parks, Member

Associated General Contractors of
America, Member

Construction Management
Association of America, Member

Design-Build Institute, Member

Santa Clara Chamber of Commerce

San Jose Silicon Valley
Chamber of Commerce

YEARS OF EXPERIENCE

40+

As CEO/President of Griffin Structures, Roger focuses on the delivery of complex projects for the private and public sectors, including administration buildings, offices, parking structures, police facilities, libraries, community centers, city halls, parks and sports complexes.

Roger's extensive involvement in virtually all aspects of both public and private sector real estate development, finance, design, and construction provides Griffin Structures with specialized expertise in the conceptualization and realization of challenging projects. He is an expert in forward planning, finance, entitlements, project delivery methodologies, and community-based participatory planning. He is also a nationally recognized leader in the successful implementation of Public / Private Partnerships (P3).

HIGHLIGHTED EXPERIENCE:

Anaheim Convention Center, Anaheim, CA

This project encompasses 830,000 square-feet and includes two 100,000-square-foot exhibit halls and a 1,350-stall interstitial parking structure. The 30-month construction schedule engaged more than 30 trades and as many as 350 workers onsite each day and required coordination with the construction of two new hotels, multiple Disney events, and continuous Convention Center events with as many as 100,000 visitors during the construction period.

County Administration South (Building 16), Orange County, CA

Griffin|Swinerton is delivering the first phase of the County's comprehensive 20-year Civic Center Facilities Master Plan through a Public-Private Partnership (P3) using tax-exempt financing and a long-term lease structure. The building is a \$188 million, 254,000 square foot, six-story office building sited over two levels of subterranean parking. The turn-key facility will house three key Departments, as well as a One Stop Shop providing "walk up service" from all 13 county departments. At the end of the lease term, the County will take ownership of the building. The estimated completion and occupancy date is in early 2020.

County Administration North (Building 14), Orange County, CA

During the delivery of County Administration South, the Team was awarded the \$197 million second phase of County's Civic Center Facilities Master Plan, which closed financing in December 2018 through a Public-Private Partnership (P3) structure. The core plan of this building is a mirror image its twin structure, but with interior customized for 7 departments, including Board of Supervisors and County CEO. The project also includes new Board Room facilities.

Great Park Ice & Five Point Arena, Irvine, CA

Griffin Structures is serving as program and construction manager and owner's representative for the new 280,000 square-foot Great Park Ice & Five Point Arena sports complex. The \$108 million community ice and sports facility, located on a 13.5 acre site at Orange County's Great Park, will also serve as the new training facility for the Anaheim Ducks® National Hockey League team. The facility will feature four indoor ice rinks; the main arena will seat 2,500 and have the ability to host a wide variety of sporting and entertainment events. Other features include a sports bar, party rooms, classrooms, and outdoor public spaces and amenities.

Police Headquarters Building, Salinas, CA

The Griffin Structures / Swinerton Builders Team is developing the new Police Service Headquarters in the City of Salinas. The facility will be delivered utilizing a Public-Private Partnership (P3) which will provide for the design, financing, construction and delivery of the new \$49 million facility. The new 74,000 square foot facility will replace the City's existing police department headquarters, built in 1958, and will accommodate anticipated future growth as identified in the City's 2014 needs assessment study. The Services Headquarters is scheduled to be completed in first quarter 2020.

Gabilan Library, Salinas, CA

Griffin Structures | Swinerton Builders are serving as the Development Team for the new El Gabilan Branch Library in the City of Salinas. This facility is being delivered utilizing a Public-Private Partnership (P3) which will provide for the design, financing, construction, and delivery of the new library. The building will be delivered completely finished and furnished as a turnkey project. The new 21,000 square foot, two-story building facility will replace the City's existing library on just over one acre of land.

REPRESENTATIVE EXPERIENCE:

- County of Orange, Dana Point Harbor, Dana Point, CA
- County of Los Angeles, Quartz Hill Library, Lancaster, CA
- Fullerton Community and Senior Center, Fullerton, CA
- Fullerton Library, Fullerton, CA
- Hesperia Civic Center Master Plan, Hesperia, CA
- Jordan Downs Housing Redevelopment, Los Angeles, CA
- Cornerstone Development, Henderson, NV
- Griffin Towers, Santa Ana, CA
- Pacific Mutual Life Ins. HQ, Newport Beach, CA
- Crossroads Corporate Center, Irvine, CA
- Unisys Headquarters Building Griffin Towers & Parking
- Environmental Nature Center, Newport Beach, CA
- Discovery Science Center, Santa Ana, CA
- Tustin Library, Tustin, CA
- Tustin Fire Station No. 37, Tustin, CA
- Laguna Beach Community Center/Senior Center and Parking Structure, Laguna Beach, CA
- Visalia Emergency Communications Center, Visalia, CA
- Buena Park Police Headquarters, Buena Park, CA
- County of Riverside Family Law Court, Riverside, CA
- Half Moon Bay Library, Half Moon Bay, CA
- Walnut Creek Corporate Yard Relocation, Walnut Creek



DAVE CALLIS

Managing Partner, Griffin | Swinerton
Executive Vice President, Swinerton Builders



EDUCATION

Bachelor of Science,
 Construction Management,
 California State University,
 Long Beach

PROFESSIONAL AFFILIATIONS

NAIOP, Member
 ACRE-IE, Member

YEARS OF EXPERIENCE

28

Dave has over 25 years of experience in construction, ranging from managing all aspects of preconstruction and construction. Dave is particularly skilled in his thorough knowledge of construction practices, codes, scheduling, estimating, budget preparation, value engineering and constructability reviews.

Other responsibilities include: business development and maintaining client relationships, interviews, presentations and final contract negotiations. Dave has experience in managing all aspects of division personnel, including hiring, project assignment, training and development.

HIGHLIGHTED EXPERIENCE:

County Administration South (Building 16), Orange County, CA

Griffin | Swinerton is delivering the first phase of the County's comprehensive 20-year Civic Center Facilities Master Plan through a Public-Private Partnership (P3) using tax-exempt financing and a long-term lease structure. The building is a \$188 million, 254,000 square foot, six-story office building sited over two levels of subterranean parking. The turn-key facility will house three key Departments, as well as a One Stop Shop providing "walk up service" from all 13 county departments. At the end of the lease term, the County will take ownership of the building. The estimated completion and occupancy date is in early 2020.

County Administration North (Building 14), Orange County, CA

During the delivery of County Administration South, the Team was awarded the \$197 million second phase of County's Civic Center Facilities Master Plan, which closed financing in December 2018 through a Public-Private Partnership (P3) structure. The core plan of this building is a mirror image its twin structure, but with interior customized for 7 departments, including Board of Supervisors and County CEO. The project also includes new Board Room facilities.

Great Park Ice & Five Point Arena, Irvine, CA

Griffin Structures is serving as program and construction manager and owner's representative for the new 280,000 square-foot Great Park Ice & Five Point Arena sports complex. The \$108 million community ice and sports facility, located on a 13.5 acre site at Orange County's Great Park, will also serve as the new training facility for the Anaheim Ducks® National Hockey League team. The facility will feature four indoor ice rinks; the main arena will seat 2,500 and have the ability to host a wide variety of sporting and entertainment events. Other features include a sports bar, party rooms, classrooms, and outdoor public spaces and amenities.

REPRESENTATIVE EXPERIENCE:

- County of Orange, County Administration Buildings South and North (P3), Santa Ana, CA
- Salinas Police Service Headquarters (P3), Salinas, CA
- El Gabilan Branch Library (P3), Salinas, CA
- Fullerton Library Renovation &Expansion, Fullerton, CA
- Turner Riverwalk, Riverside, CA
- Fullerton Community Center, Fullerton, CA
- Laguna Beach Community Center, Laguna Beach, CA
- Laguna Hills Community Center, Laguna Hills, CA
- San Bernardino Valley College Gymnasium, San Bernardino, CA
- John Wayne Airport Tenant Improvement, Santa Ana, CA
- San Dimas City Hall &Community Center, San Dimas, CA
- Burbank Community Services Center, Burbank, CA
- Cypress Community Center, Cypress, CA
- Kaiser Permanente Foothill Ranch Medical Office Building (MOB), Foothill Ranch, CA
- John Wayne Airport Parking Structure, Santa Ana, CA
- Broadcom Corporate Complex, Irvine, CA
- CHOC Parking Structure, Orange, CA
- Scholle Office Complex, Irvine, CA'
- Ontario Airport Towers, Ontario, CA
- Ladera Ranch Corporate Terrace Medical Office Building, Ladera Ranch, CA



MARK HOGLUND

COO / CFO Griffin Structures



EDUCATION

Master of Business Administration,
Finance, Real Estate, Public Policy,
The Wharton School,
University of Pennsylvania

Bachelor of Science,
McIntire School of Commerce
University of Virginia

PROFESSIONAL AFFILIATIONS

Certified Public Accountant

YEARS OF EXPERIENCE

35

Mark Hoglund joined the Griffin Structures organization in 1986 as Chief Financial Officer. During his long tenure with the organization, he has also assumed the title and responsibilities of Chief Operating Officer. Prior to joining Griffin Structures, Mr. Hoglund was an Economic and Financial Analyst for Lincoln Property Company, and a Certified Public Accountant with Arthur Anderson. Additionally, Mark served as Program Director for Lockheed Martin IMS where he was in charge of all Orange County, California, operations and governmental affairs for the company.

As part of his extensive real estate experience with Griffin Structures, Mark has structured many complex real estate deals and transactions, from arrangements with investment partners to nuanced "P3" structures. He has provided extensive expertise, gained through decades of experience in both the private and public sectors.

In addition to his real estate experience, Mark has also served in a variety of key financial and management positions in the public sector. His public service positions include Chief of Staff at the United States Interstate Commerce Commission (as a presidential appointee), Treasurer and Chief Financial Officer to Governor Pete Wilson when he campaigned for the Presidency, Chief Deputy Director for the California Department of General Services, Advisor to California State Treasurer, and Chief of Staff to the Mayor of San Diego. Mark has served as advisor to numerous local, state, and federal campaigns for elective office.

REPRESENTATIVE EXPERIENCE:

- County Administration Building South, Orange County, Santa Ana, CA
- County Administration Building North, Orange County, Santa Ana, CA
- Police Headquarters Building, Salinas, CA
- Gabilan Library, Salinas, CA
- City Hall, West Hollywood, CA
- County of Los Angeles, Quartz Hill Library, Lancaster, CA



KORIN CRAWFORD

Executive Vice President / Project Executive



Korin Crawford leads the public-private partnership (P3) business unit for Griffin Structures and is responsible for originating, evaluating, structuring, and closing development projects for public facilities, renewable energy, and commercial real estate. Korin leverages 18 years of experience in infrastructure, real estate, and M&A of property-backed operating businesses with an emphasis on P3s and real estate transactions in complex regulatory environments.

EDUCATION

Master of Science in Management,
Stanford Graduate School of Business

Master of Science, Electrical Engineering,
Stanford University

Bachelor of Science, Electrical Engineering,
Duke University

PROFESSIONAL AFFILIATIONS

National Renewable Energy Laboratory,
Energy Execs

Urban Land Institute,
Member

Cleantech Institute, Certified Cleantech
Professional

YEARS OF EXPERIENCE

18

Prior to joining Griffin Structures, Korin was an Executive Advisor to the Los Angeles City Administrative Officer (CAO) as a subject matter expert on infrastructure delivered through a variety of alternative financing methods including P3s. In this role, Korin spearheaded \$3.5 billion of investment opportunities spanning municipal facilities, transit, renewable energy, and habitat restoration projects including P3s for the Los Angeles Convention Center and Los Angeles Civic Center.

From 2006 to 2015, Korin led his own consulting and investment practice, offering advisory services to for profit and non-profit real estate investors, developers, and public agencies (including utilities, ports, city/county, redevelopment, and school districts) to finance and develop land, real estate, renewable energy, and energy efficiency. Since 2005, Korin has served on the Board of Directors for two of the San Francisco Bay Area's most respected affordable housing and community developers.

REPRESENTATIVE EXPERIENCE:

- Los Angeles Convention Center Expansion and Modernization (P3), Los Angeles, CA
- Los Angeles Civic Center Master Plan (P3), Los Angeles, CA
- Downtown Los Angeles Streetcar (P3), Los Angeles, CA
- Mission Rock / SWL 337 - Port of San Francisco (P3), San Francisco, CA
- Pier 70 Redevelopment - Port of San Francisco (P3), San Francisco, CA
- Mission Bay Redevelopment - Port of San Francisco (P3), San Francisco, CA
- Bayview Hunters Point Shipyard Redevelopment (P3), San Francisco, CA
- Oakland Army Base Disposition and Reuse (P3) - Port of Oakland, Oakland, CA
- Fillmore Renaissance and Jazz Heritage Museum (P3), San Francisco, CA
- Oakland Uptown Redevelopment (P3), Oakland, CA
- Pinole Vista and Pinole Valley Shopping Center GroundLease and DDA Audit (P3), Pinole, CA



GARY CHUBB

Project Manager



Gary is responsible for the entire project development process to ensure success during all phases of design and construction. Executive management is focused on feasibility, site logistics, financial planning, contracts, design team interface, subcontractor performance, budget compliance, quality control, timely completion and close-out of projects. Gary's professional background combines both general contracting and owner representation which affords a complete perspective on total project success and client satisfaction.

EDUCATION

B.S., Construction Management
University of Washington,
Seattle, WA, 1991

PROFESSIONAL AFFILIATIONS

APWA
USGBC
NAIOP
DBIA

YEARS OF EXPERIENCE

26

HIGHLIGHTED EXPERIENCE:

Anaheim Convention Center, Anaheim, CA

The project encompasses 830,000 square-feet and includes two 100,000-square-foot exhibit halls and a 1,350-stall interstitial parking structure. The 30-month construction schedule engaged more than 30 trades and as many as 350 workers onsite each day and required coordination with the construction of two new hotels, multiple Disney events, and continuous Convention Center events with as many as 100,000 visitors during the construction period.

Police Headquarters Building, Salinas, CA

The Griffin Structures / Swinerton Builders Team is developing the new Police Service Headquarters in the City of Salinas. The facility will be delivered utilizing a Public-Private Partnership (P3) which will provide for the design, financing, construction and delivery of the new \$55 million facility. The new 74,000 square foot facility will replace the City's existing police department headquarters, built in 1958, and will accommodate anticipated future growth as identified in the City's 2014 needs assessment study. The Services Headquarters is scheduled to be completed in first quarter 2020.

El Gabilan Library, Salinas, CA

Griffin Structures | Swinerton Builders are serving as the Development Team for the new El Gabilan Branch Library in the City of Salinas. This facility is being delivered utilizing a Public-Private Partnership (P3) which will provide for the design, financing, construction, and delivery of the new library. The building will be delivered completely finished and furnished as a turnkey project. The new 21,000 square foot, two-story building facility will replace the City's existing library on just over one acre of land.

Fullerton Community and Senior Center, Fullerton, CA

Integrated Project/Construction Management for a \$27MM, 60,000 square foot, Senior and Community Center including Boys & Girls Club, aquatics, basketball, arts/crafts, and educational programs. Services included design team coordination, constructability reviews, estimating, project and construction management, and end user training.

Fullerton Library, Fullerton, CA

Integrated Project/Construction Management for a \$10MM, 40,000 square foot, main library expansion and renovation. Services included design team management, constructability reviews, estimating, project and construction management, and end user training.

REPRESENTATIVE EXPERIENCE:

- City of Westminster Capital Improvement Program, Westminster, CA
- Environmental Nature Center, Newport Beach, CA
- Lake Forest Sports Park, Lake Forest, CA
- Orange County Transportation Authority Parking Structures
- Discovery Science Center, Santa Ana, CA
- San Dimas City Hall and Community Center, San Dimas, CA
- Cypress Community Center, Cypress, CA
- Laguna Beach Senior and Community Center, Laguna Beach, CA
- Marina Park Community and Sailing Center, Newport Beach, CA
- Huntington Beach Community and Senior Center, Huntington Beach, CA
- Quail Hill Community Center, Irvine, CA
- Tustin Main Library, Tustin, CA
- Tustin Fire Station, Tustin, CA
- Buena Park Police Headquarters, Buena Park, CA



RELEVANT EXPERIENCE

FIRM OVERVIEW

FEATURED PROJECTS

REFERENCES

TEAM BIOS

Related California is a fully-integrated real estate firm with a 30-year track record delivering top-quality, mixed-income housing and mixed-use developments across California. The company has completed 16,000 residences and currently has more than 1,300 affordable and 3,500 market rate units in pre-development. Related has a track record of consistently developing communities that exceed industry benchmarks in design, construction, sustainability and property management.

The company is backed by one of the most prominent privately owned real estate firms in the nation, with a portfolio of over \$60 billion in developments. As long-term property owners committed to sustainability and stewardship, Related forms strong public-private partnerships with civic leaders, non-profit organizations, public officials, and neighbors throughout California to revitalize communities. We are committed to excellence, working with world-class architects and designers to create distinctive new urban spaces that fit seamlessly into the fabric of existing communities.

KEY STRENGTHS

Commitment to Excellence

Related California has a 30-year track record delivering top-quality, mixed-income housing and mixed-use developments across California. We are committed to excellence working with world-class architects and designers to create distinctive new urban spaces that fit seamlessly into the fabric of existing communities. Our developments have received numerous awards and honors, including the Urban Land Institute Global Award for Excellence.

Community Partnership

Above and beyond simply constructing buildings, we approach every project with an eye towards collaboration and innovation. As long-term property owners committed to sustainability and stewardship, we form strong public-private partnerships with civic leaders, non-profit organizations, public officials, and neighbors throughout California. These have resulted in inclusive creative developments that reflect the individual character of each community.

Industry Leadership

Our innovative financing strategies allow us to create premier multifamily and mixed-use properties. Our developments set the standard for urban placemaking, consistently raising the bar for each submarket and asset class, and are on the leading edge of design, finishes and consumer demand.

Financial Strength

Related California is backed by one of the most prominent privately owned real estate firms in the nation with a portfolio of \$60 billion in developments. This affords us with unparalleled financing capacity, purchasing and negotiating leverage, and unique access to equity and debt providers. Our broad platform, operating portfolio, strong balance sheet, and long-term view allows us to weather volatile market cycles.

Sustainability

Related is a leader in environmentally-conscious real estate development and operations. Building performance and environmental responsibility are essential attributes in a quality development -- and evidence of our commitment to excellence. Our focus on urban and infill development is part of a commitment to smart growth and the environmental benefits of building in urban areas.

People

The quality, experience and talent of our people are what make Related California an industry leader. Our teams are comprised of respected and innovative professionals who excel in their fields. Most members of our leadership team have more than 20 years of experience in the industry.

One-Stop Shop

We are a fully-integrated company with unique access to in-house professionals experienced in architecture/design, planning/entitlements, finance, construction and property management. Early and frequent collaboration allows us to incorporate a variety of expertise in the earliest stages of development, resulting in highly successful projects. We approach our developments holistically from start to finish, and our developments benefit from real-time knowledge related to costs, financing options, and best practices.

Investment for the Long Term

Related operates on a 'build and hold' business model which means we invest for the long term. This allows us to transform neighborhoods and create new spaces that add value and build communities. We take pride in developing assets that stand the test of time and contribute to their surrounding neighborhood for generations.

EFFECTIVENESS TO PROVIDE AFFORDABLE HOUSING

Since its founding in 1989, Related California has been staunchly committed to affordable housing. It owns and operates over 20,000 units in California and has never converted a single unit to market rent. Related also has extensive experience in workforce housing and created new financing models in partnership with the cities of New York, Boston and San Francisco to deliver much needed residences across various income levels. The company has deep relationships with federal, state and local governments to access programs and financing to see these projects through to completion.

Related California operates on a 'build and hold' business model which means we invest for the long term. This allows us to transform neighborhoods and create new spaces that add value and build communities. We develop assets that stand the test of time and seamlessly integrate within the community. Ultimately, contributing to the surrounding neighborhood for generations. We take a holistic approach, from entitlements to lease-up, maximizing the potential of every development with real-time knowledge related to costs, financing options, and best practices.

Related is a fully-integrated development company with 30 years of experience and a portfolio of 96 completed tax-credit financed developments with more than 14,000 units of low-income housing tax credit units in California. Related California's current pipeline consists of 1,000 units under construction and 1,300 units in pre-development.

Related has been applauded for excellence in project design, planning, neighborhood development and company achievement. In the past five years, Related has received over 20 awards, ranging from the Global Award for Excellence from the Urban Land Institute to the Housing and Community Design Award for Excellence from the American Institute of Architects and the U.S. Department of Housing and Urban Development.

ITEM 12.1.

Five 88

Mixed-Use, Transit-oriented, Affordable
Workforce & Family Development

588 Mission Bay Boulevard North
San Francisco, CA 94158



Exterior elevation



Interior courtyard lobby

DEVELOPER

Related California, Chinatown Community Development Center

ARCHITECT

David Baker Architects, Gonzales Architect

GENERAL CONTRACTOR

Nibbi Brothers General Contractors

MUNICIPAL PARTNER

City of San Francisco

PROPERTY MANAGEMENT

Related Management Company

- Surpassed leasing projections
- Current vacancy rate of 1%

ATTACHMENT 3

Key Features & Awards

2018 PCBC Gold Nugget
Award of Merit - Best
Affordable Housing
Community

2018 AIA San Francisco
Design Awards - Architecture
Merit Award + Social Respon-
sibility Commendation

2018 SFBT Real Estate
Deal of the Year - Real
Estate Deal of the Year

Via a partnership with Chinatown CDC, FIVE 88 is San Francisco's largest 100% affordable housing development in the last decade. Located in San Francisco's Mission Bay Redevelopment Area, Five 88 offers 10,000 sq. ft. of retail space in close proximity to a Muni Metro station. While Five 88 features a modern urban aesthetic, design features encourage residents to connect with their environment via open courtyards, close proximity to Mission Bay Commons Park and the south waterfront of the San Francisco Bay. Residents enjoy a community pavilion with space and amenities for residents to gather, 252 secured bicycle spaces, onsite parking, a fitness center, community room and BBQ area.

- Leasing priority for employees of public healthcare institutions located in San Francisco, in addition to elderly and disabled applicants

Community Feedback: Intensive collaboration between Related, Chinatown CDC, UC Regents, Family House, and San Francisco's Office of Community Investment and Infrastructure led to the successful development of Five 88 – e.g., common pedestrian mews between Family House site and Five 88, expensive façade upgrades (i.e., corten steel) used on corner facing a public park and UCSF hospital, etc. Thoughtful consideration was given to the tenant selection plan due to the UC Regents wanting a preference for local residents working at public educational and healthcare institutions.

LEASE-UP PERIOD

Feb '17 to Oct 17

FINANCING

Tax Credit Equity	\$35,700,000
Citibank Permanent Loan	\$27,700,000
Subordinate Citi Loan	\$3,000,000
Residual Receipts Loan	\$17,000,000
Deferred Developer Fee (MGP Cap. Cont.)	\$500,000
Total Permanent Sources	\$83,900,000

INCOME LEVEL	BEDROOM TYPE		TOTAL UNITS
	1 BR	2 BR	
50% AMI	14	26	40
60% AMI	56	102	158
Manager's	2		2
Total	72	128	200

ITEM 12.1.

Mayfield Place

Mixed-use, Affordable Family Development

2500 El Camino
Palo Alto, CA 94306



Exterior elevation



Exterior elevation with courtyard

DEVELOPER

Related California, Stanford University and the City of Palo Alto

ARCHITECT

David Baker Architects

GENERAL CONTRACTOR

Segue Construction, Inc.

MUNICIPAL PARTNER

The City of Palo Alto

PROPERTY MANAGEMENT

Related Management Company

- Met leasing projections
- Current vacancy rate of 2.85%

ATTACHMENT 3

Key Features & Awards



Mayfield Place was developed via a strategic partnership between the City of Palo Alto and Stanford University. A parcel for an affordable development was identified in The Stanford Research Park with the goal of improving the City of Palo Alto's jobs/housing balance. Amenities include a fitness center, community room, barbecue area, courtyards and bike storage. Residents benefit from being conveniently located close to public transit, the California Avenue Caltrain station, recreation, entertainment, shopping and all major employers.

- Only new affordable housing development in the City of Palo Alto at the time of development
- Mixed-use development provides over 7,000 sq. ft. of street level retail and is home to the Vista Center for the Blind and Visually Impaired
- 7,000 sq. ft. of street level retail; home of the Vista Center for the Blind and Visually Impaired

Community Feedback: Related met multiple times with the College Terrace Resident's Association to mitigate concerns expressed by the community regarding the impact of construction. Sensitive to the needs of the local neighborhoods, the development partners executed a Construction Management Plan to address construction noise and dust, minimize impact on residential thoroughfares, and identify effective channels via which to communicate construction updates.

LEASE-UP PERIOD

Mar '17 to Jun '17

FINANCING

Tax Credit Equity	\$10,800,000
Tax Exempt Bonds- Union Bank	\$7,800,000
Residual Receipts Loan- Stanford	\$15,400,000
Donated Land Value	\$18,500,000
Deferred Developer Fees	\$350,000
Total Permanent Sources	\$52,850,000

INCOME LEVEL	BEDROOM TYPE			TOTAL UNITS
	1 BR	2 BR	3 BR	
50% AMI	5	5	4	14
60% AMI	19	18	18	55
Manager's		1		1
Total	24	24	22	70

ITEM 12.1.

Bloomington Grove & Lillian Court

Mixed-use, Affordable Intergenerational Development

18028 Valley Boulevard
Bloomington, CA 92316

A catalyst for positive neighborhood transformation, Bloomington Grove and Lillian Court is the first County-sponsored all-in-one capital improvement development in San Bernardino County to host a public library, community center, senior center, and extensive sewer and water infrastructure improvements.

Bloomington Grove families have access to a computer lab, conference room, two community rooms, swimming pool, BBQ, gated parking, and social services housed in a 3,630 sq. ft. community space. Lillian Court seniors enjoy 3,676 sq. ft. of community space with onsite leasing and management offices, recreation room and kitchen, senior and fitness centers, courtyard with spa, and putting green.

- Houses the 6,597 sq. ft. Bloomington Public Library
- 11 units reserved for direct referrals from The County of San Bernardino DBH; 11 units reserved for Project Based Section 8 residents

Community Feedback: Multiple public meetings and design charrettes hosted with the County's Community Development and Housing Department solicited input from Bloomington residents on the architectural style and to address concerns. Provided with community feedback, the development benefitted from countless joint efforts from various entities to ensure the community needs were met.

LEASE-UP PERIOD

Mar '16 to Jul '16

FINANCING

Tax Credit Equity	\$16,550,000
MPG Equity	\$7,900,000
AGP Equity	\$100
MHSA Loan (Principal)	\$1,350,000
MHSA Loan (Accrued Interest)	\$50,000
County Of San Bernardino Loan (Principal)	\$5,850,000
County Of San Bernardino Reimbursement Library Costs	\$2,700,000
Donated Loan Value	\$2,600,000
Total Permanent Sources	\$37,000,100

INCOME LEVEL	BEDROOM TYPE			TOTAL UNITS
	1 BR	2 BR	3 BR	
30% AMI	9	2	5	16
40% AMI	13	1	6	20
50% AMI	43	5	10	58
60% AMI			11	11
Manager's		1		1
Total	65	9	32	106

ATTACHMENT 3

Key Features & Awards

2017 PCBC Gold
Nugget Grand Award
- Best Affordable
Housing Community

2017 PCBC Gold
Nugget Award of Merit
- Best Affordable Senior
Housing Community

2017 SCANPH Homes
Within Reach Award
- Transformative Commu-
nities Development



Architectural elevation, Bloomington Grove



Community room

DEVELOPER

Related California, La Barge Industries, Housing Partners I

ARCHITECT

Wither Malcolm Architects, LLP

GENERAL CONTRACTOR

Portrait Construction, Inc.

MUNICIPAL PARTNER

County of San Bernardino

PROPERTY MANAGEMENT

The John Stewart Company

Met leasing projections

Current vacancy rate of 0.95%

ITEM 12.1.

Belmar Apartments Masterplanned, Affordable Family Development

1725 Ocean Avenue
Santa Monica, CA 90401



Western Courtyard with Pavilion



Community Great Room Facade

DEVELOPER

Related California in partnership with Community Corporation of Santa Monica

ARCHITECT

Koning Eizenberg Architecture & KTG

GENERAL CONTRACTOR

Charles Pankow Builders

MUNICIPAL PARTNER

Community Corporation of Santa Monica, City of Santa Monica

PROPERTY MANAGEMENT

Related Management Company

- Met leasing projections
- Current vacancy rate of 1.25%

ATTACHMENT 3

Key Features & Awards

- 2016 ULI Global Award for Excellence •
- 2016 The Chicago Athenaeum Museum of Architecture and Design American Architecture Award - Best New Building Designed by American Architect •
- 2016 PCBC Gold Nugget Grand Award-Best Affordable Housing Community •
- 2016 LABJ Best Mixed Use Project •
- 2015 PCBC Gold Nugget Award of Merit - Residential Community of the Year •
- 2015 LABC 45th Annual Architectural Awards - Best Housing Award •
- 2011 LABC Architectural Award - Best Design Concept - Multi-Family Market Rate •

Belmar Apartments, the affordable component of the three-part 318 unit Ocean Avenue South development, transforms the original Civic Center concept into a neighborly and sustainably responsive masterplan. Residents of the 160 artist loft and 1-3 bedroom apartment homes enjoy numerous onsite amenities which include subterranean parking, onsite social services and professional management, bike storage, family garden with BBQ grills and playground, community room, fitness center and computer lab. The heart of Belmar Apartments is the "living street," an informal walkway framed by condominiums and roll-up storefronts to the north and affordable artist lofts that shelter affordable family housing to the south.

- Featuring panoramic ocean views, Belmar Apartments is the first major residential development to be built on the highly prized Ocean Avenue in two decades
- Unparalleled access to Metro Expo Line transit, outdoor spaces at Santa Monica Beach and Tongva Park, dining and retail at Santa Monica Place, Third Street Promenade and Main Street

Community Feedback: Koning Eizenberg (in collaboration with Moore Ruble Yudell) led the community process for the masterplan and developed the design of affordable housing segments resulting in a public walk street linking affordable apartments with condominiums and the allocation of 10 Live-Work artist units.

LEASE-UP PERIOD

Feb '14 to Jul '14

FINANCING

Wells Fargo Bank - Equity	\$29,000,000
Wells Fargo Permanent Loan	\$7,700,000
Residual Receipts Loan - Santa Monica Housing Authority	\$19,400,000
MHP Loan	\$10,000,000
NOI	\$300,000
Deferred Developer Fee	\$1,300,000
Total Permanent Sources	\$67,700,000

INCOME LEVEL	BEDROOM TYPE				TOTAL UNITS
	EFF	1 BR	2 BR	3 BR	
30% AMI	4	10	20	24	58
50% AMI		9	17	21	47
60% AMI	6	9	17	21	53
			2		2
	10	28	56	66	160



The Avery

Located two blocks from the new \$4.5 billion Transbay Transit Center, San Francisco's Grand Central Station, and three blocks from the new 61-story Salesforce Tower, The Avery will be a 56-story, 548-unit residential tower with upper floors featuring 118 luxury view condominiums and lower floors accommodating 280 luxury apartments and 150 affordable apartments. The ground floor will feature 17,000 square feet of neighborhood serving retail set around an open public paseo meandering through the site.

Related California and its proposed design and development concept was selected as a result of a highly competitive selection process held by the City of San Francisco. The sculpted tower was designed by Rem Koolhaas' Office of Metropolitan Architecture (OMA-NY) partnering with the San Francisco architecture firm of Fougerson Architecture who designed the lower podium buildings of the development. Related California is partnering with Tenderloin Neighborhood Development Corporation on the affordable housing components of the development. Completion is anticipated in 2019.



Sunnydale HOPE SF

The Sunnydale Hope SF Master Plan calls for 775 units of replacement housing plus an additional 995 units of tax-credit affordable and market rate apartments located on the 50-acre site of San Francisco's largest public housing project, currently home to more than 1,700 ethnically diverse residents. Additional plans call for a new community center, new parks, a community garden, farmers market and neighborhood serving retail. To develop the Master Plan, Mercy Housing California and Related California conducted a comprehensive community planning process that included residents and community stakeholders to develop a master plan for a new mixed-income development.

Phase one will consist of a 55-unit development for low and very low-income families with studios, 1, 2 and 3-bedroom apartments. Common area amenities will include a community room, podium-level courtyard, management office, laundry rooms, on-site parking and bicycle storage for 55 bicycles. Completion of phase one is slated for fall 2019.



Related Santa Clara

Adjacent to Levi's Stadium and the convention center, at the nexus of various public transportation options and major arteries, Related's 240-acre mixed-use development will bring more than nine million square feet of innovative, sustainable and tech-enabled commercial and residential spaces, hotels, shopping, dining and entertainment venues to Santa Clara and the heart of the greater Silicon Valley region. The development will also bring expansive public spaces and a 30-acre park for fitness and recreation.

Foster + Partners will serve as the lead design architect for the first phases of the development and will collaborate with Gensler, the executive architect, on many aspects of the design and execution. Together, along with Related, these premier architectural partners will deliver the first mixed-use development in Silicon Valley to offer the scale of an urban destination and the variety of choices that support all facets of life--in one integrated pedestrian community. WSP USA will serve as the development's lead engineering firm on the main infrastructure of the project.

Related's Santa Clara development is the result of a multi-year, forward thinking public-private partnership between the City of Santa Clara and Related Companies to transform an underutilized golf course into a world-class destination for residents, visitors, companies and their employees.

When complete, the property will feature a compelling mix of uses and expansive public spaces expertly integrated into the city's existing network of pedestrian, bicycle and public-transit connections. The development will also feature new roadways and access upgrades to public transit, making it one of the premiere urban mixed-use destinations in Silicon Valley.

ITEM 12.1.

ATTACHMENT 3

Contact information for public agency references from previous projects

Related California's Public Agency References

Ben Metcalf , Principal
Stronger Foundations, LLC
ben@strongerfound.com
(510)459-0018
Former Director, California Department of Housing & Community Development

Daniel Adams, Acting Executive Director
San Francisco Mayor's Office of Housing & Community Development
dan.adams@sfgov.org
(415) 701-5616

Dave Kiddoo, Senior Director of Real Estate Development
Oakland Housing Authority
dkiddoo@oakha.org
(510) 587-2112



WILLIAM A. WITTE
Chairman and CEO
Related California

Mr. Witte is Chairman and Chief Executive Officer of Related California. For the past 29 years, and since the founding of Related California, he has been responsible for the strategic direction of the company, overall management of the firm, pursuit of new development opportunities, and oversight of planning, financing and construction of a development portfolio of over 15,000 residential units completed or under construction totaling more than \$6 billion in assets.

Prior to founding Related California in 1989, Mr. Witte served as Deputy Mayor for Housing and Neighborhoods under Mayor Art Agnos where he oversaw all housing, development and redevelopment activities for the City of San Francisco. He was Director of Housing and Economic Development under Mayor Dianne Feinstein and served as an appointed Commissioner of the San Francisco Housing Authority.

Mr. Witte previously served as Executive Assistant to Assistant Secretary for Housing/Federal Housing Commissioner Lawrence B. Simons at HUD in Washington, as Legislative Director for the National Association of Housing and Redevelopment Officials and with the Philadelphia Office of Housing and Community Development.

Mr. Witte graduated from the University of Pennsylvania with a bachelor's degree in Urban Studies and a Master in City Planning. He is Vice-Chairman of the Lusk Center for Real Estate Advisory Board at University of Southern California and a member of the Board of Overseers of the Graduate School of Design at University of Pennsylvania. Mr. Witte serves on the Advisory Boards of the Fisher Center for Real Estate and Urban Economics Policy at the Haas School of Business at University of California at Berkeley and the Orange County Human Relations Community Partners. In addition, Mr. Witte sits on the boards of the homebuilder, The New Home Company and the Shelter Partnership in Los Angeles.



ANN SILVERBERG
Chief Executive Officer, NorCal Affordable
Related California

As Chief Executive Officer for Related California's Northern California Affordable Division and recently opened office in Portland, Oregon, Ms. Silverberg is responsible for the strategic direction, overall management and daily operation of the company's Northern California affordable pipeline and portfolio.

Prior to joining Related California, Ms. Silverberg was Executive Vice President and Chief Investment Officer at BRIDGE Housing Corporation where she was responsible for directing and overseeing their Northern California Division. She led the development and redevelopment of more than 8,000 affordable, mixed-income, mixed-use and transit-oriented housing units, including the acquisition and redevelopment of nearly 1,000 public housing units in San Francisco and Sacramento, the joint venture development of mixed-income residential units with Essex in the Transbay area of San Francisco, and 306 mixed-income residential units in Milpitas. She was also responsible for the capital aggregation and equity and debt for their Low Income Housing Tax Credit (LIHTC) and non-LIHTC developments and has overseen the negotiation and placement of over \$2 billion in project level debt and equity. Ms. Silverberg brings more than 25 years of development and finance experience to Related.

Ms. Silverberg holds a Master of City and Regional Planning from the University of California, Berkeley and a Bachelor of Arts from the University of California, Los Angeles. She is a past President of the Board of Directors of the Non-Profit Housing Association. She currently serves on the Board of Directors and Executive Committee of the California Housing Consortium and is a faculty lecturer at the University of California, Berkeley.



THU NGUYEN
Sr. Development Associate
Related California

As Senior Development Associate for Related California, Ms. Nguyen is responsible for supporting the design, financing and construction of Related's Northern California affordable developments, including the redevelopment of San Francisco's largest public housing site, Sunnydale-Velasco, a 50-acre site currently home to more than 1,700 people.

Before joining Related, Ms. Nguyen worked for The Community Builders, Inc. in Washington, D.C. where she directed the application submission for the Choice Neighborhoods Initiative Implementation Grant with the City of Baltimore, secured over \$200 million in funds for affordable housing, and won the company's 2015 Top Contributor Award for initiating impactful urban neighborhood projects. Prior to The Community Builders, Ms. Nguyen was a research associate at The Urban Institute in Washington, D.C., specializing in housing discrimination.

Ms. Nguyen graduated from The Wharton School at the University of Pennsylvania with a Master in Business Administration, and from Cornell University with a Bachelor of Science in Urban and Regional Studies and a Bachelor of Arts in Africana Studies.



RELEVANT EXPERIENCE

FIRM OVERVIEW

FEATURED PROJECTS & REFERENCES

TEAM BIOS



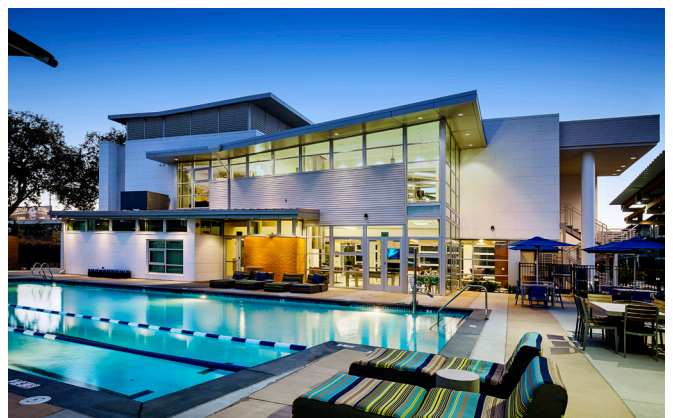
Let's build something great **together.**

For nearly thirty years, Mogavero Architects has designed buildings and communities with the goal to inspire sustainability and create places with meaning. Our award winning architecture, planning and urban design services have been provided to clients throughout California in small towns and intensely urban settings.

As skilled facilitators and outreach consultants, we assist clients in project communications and approvals, gain support for controversial projects, and let community thought inform our designs.

Mogavero Architects' LEED accredited professionals dedication to green, sustainable design has been demonstrated on projects since its inception. For a broad variety of economic, social and environmental reasons the practice focuses on dense urban infill mixed use projects. Our firm's founders pioneered cutting edge, green building with an emphasis on passive heating and cooling and ventilation systems, daylighting and other natural conservation systems.

Mogavero Architects assess the context of the building on the site, position in the neighborhood, contribution to the built environment, and future purpose. Materials, methods, and technologies are continually evaluated with an eye towards enduring value, efficiency and acclaimed design. We thrive on complex projects that involve many product types, financing sources, and stakeholders.



1331 T ST • SACRAMENTO, CA 95811 • (916) 443-1033
MOGAVEROARCHITECTS.COM



SMUD-59TH STREET REUSE

SACRAMENTO, CALIFORNIA

Redevelopment of the 59th Street Corporation Yard is a very unique opportunity for SMUD, the immediate neighborhoods and the Greater Sacramento Region.

THE REGIONAL OPPORTUNITY

SMUD has for decades been among the most engaged promoters of sustainable development practices in the region. That activity has logically been primarily in the realm of energy efficiency for buildings and process activity. With substantial changes in the economics for alternate energy generation and with state mandates for zero net energy in 2020 and 2030, the need for regional leadership in building energy efficiency has diminished.

The need for leadership falls dominantly in the realm of reducing auto dependency. This is a need for which the Corp Yard Redevelopment is optimally positioned to address.

Correspondingly, the Light Rail System is completely contained within SMUD's boundary. A corollary value for SMUD's promotion of transit oriented development is that it will increase the percentage of regional growth (ratepayers) captured within the district boundary.







ROYAL OAKS TOD

SACRAMENTO, CA

The project envisions a residential development that brings life, scale, and redevelopment to an underutilized industrial site.

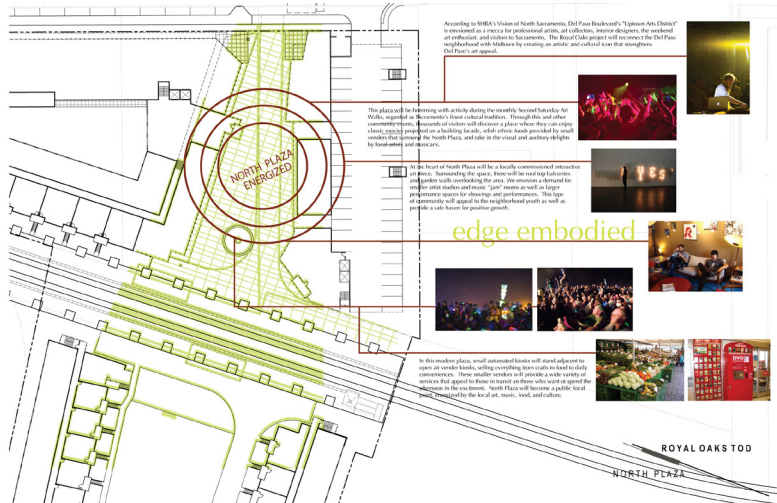
■ SUSTAINABLE SITE PLANNING AND ARCHITECTURE

The proposed Royal Oaks Transit Oriented Development (TOD) design redefines the meaning of “edge.” Instead of buffering and transitioning, the design embraces its gritty urbanity and transforms it into a bold, energized community. Straddling the Del Paso Boulevard commercial strip and quieter, residential neighborhoods on Evergreen Street, Royal Oaks TOD is poised for a renaissance of sustainable site planning and architecture: transit oriented development with a public market, kiosks, art walk, shops, office space, live/work homes, apartments and flexible community space.

The project envisions a residential development that brings life, scale, and redevelopment to an under-utilized

industrial site. Ground floor retail shops will line the entrance to a vibrant and eclectic pedestrian-oriented town square adjacent to two iconic residential buildings.

As the connection between Arden Way and the light rail station, the north plaza is envisioned to have the highest foot traffic in the community. Able to be programmed for community events, thousands of visitors will discover a place where movies can be projected on a building façade and vendors can sell ethnic foods. Automated kiosks are planned adjacent to open air stalls, selling everything from crafts to food to daily conveniences. Rooftop terraces and garden walls surround and overlook the plaza. The north plaza will become a public focal point, energized by people, art, music, and food.

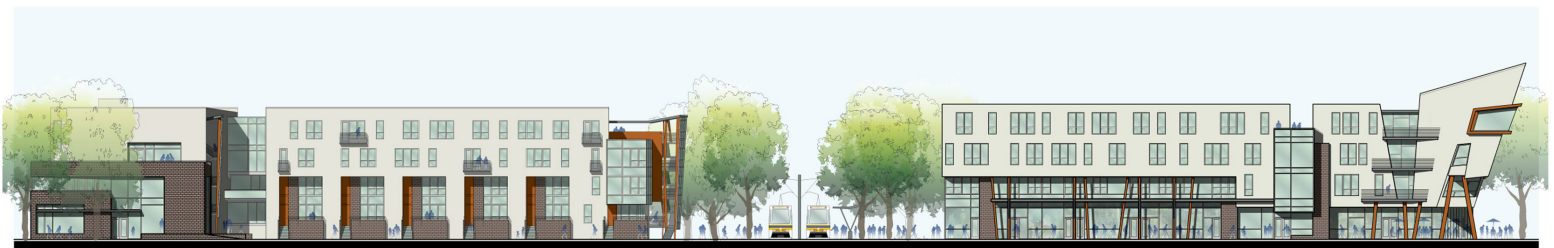


SUSTAINABLE DESIGN

- Limited car parking to encourage transit use
- Natural night ventilation cooling
- Integral solar shading
- Daylighting with high ceilings
- Solar hot water heating
- Photovoltaic electrical generation
- Grey water recycling
- Storm water detention & purification
- Low flow water fixtures
- R-23 wall and R-38 roof insulation
- Variable transmissivity glass
- Locally manufactured materials with high recycled content and low toxicity



ARDEN WAY ELEVATION



COURTYARD ELEVATIONS LOOKING WEST

OWNER/DEVELOPER:
New Faze Development

ARCHITECT AND PLANNER:
Mogavero Architects

CIVIL:
Riechers & Spence

LANDSCAPE:
Jeffrey Miller

TOTAL SITE AREA:
4.25 Acres
185,130 SF

PREVIOUS USE OF SITE:
Former Lumberjack Hardware Store

RESIDENT PROFILE:
Arts oriented twenty-somethings,
singles and couples
Single developmentally disabled in
the low income component

OF UNITS/DENSITY:
81 DUA, not including retail
346 Total Units w/flex as 48 Residential Units

UNIT SIZE:
540 SF - 970 SF

CONSTRUCTION DETAILS:
Wood-frame and Stucco over concrete podiums

mogavero
ARCHITECTS



CORDOVA CITY CENTER

RANCHO CORDOVA, CALIFORNIA

In addition to a transit-oriented character, other green strategies such as solar controls, bike storage and storm water detention are being incorporated.

■ PLANNED FOR MIXED-USE

Located across the street from a light rail transit station in the City of Rancho Cordova, this project is planned to be a mixed-use, medium-to-high-density transit oriented community. The site is currently occupied by an under utilized shopping center on an aging commercial corridor in the heart of a recently incorporated city.

The commercial program includes 37,000 s.f. of office and 10,000 s.f. of retail space configured to begin the transition to a more urban streetscape and to reinforce a town square form that will embrace the light rail transit station.

The residential program includes 207 residential units in a three-story geometry with townhouses on the second and third floors over tuck-under parking. A 75+ unit independent living senior housing facility is also planned.

The residential units are clustered around large courtyards with play areas for children and a community center is placed as a link between the residential and commercial land uses.

Parking is either on-street or structured. There are no surface parking lots and reciprocal parking will be used to reduce the number of parking spaces.

In addition to its transit-oriented character, many other green building strategies are being incorporated, including indirect evaporative cooling, daylighting, solar controls, provisions for bike storage, photovoltaic panels and storm water detention.

The project received a \$1.7 million grant from the Sacramento Area Council of Governments and from the Community Design Program for its creative approach to transit-oriented mixed-use development.



SPECIALIZED APPROACHES

- Energy efficient design
 - exceeds California's Title 24 requirements
- Transit Oriented Development: decreases traffic congestion, sprawl, need for infrastructure, while increases pedestrian safety
- Infill site location
- Natural daylighting
- Retail building narrow bays and high ceilings along the east-west elevations allows for effective daylighting and energy control
- Integration of a bris soliel (sun shading system) will shade the majority of windows bouncing natural light deeper into the space
- Mixed-use development adjacent to light rail achieves tangible benefits
- Providing mixed-uses (housing, retail, and commercial), "internalizes" many automobile trips
- Spreading demand makes shared parking possible reducing the scale of suburban parking by 25%
- The proximity to light rail adds convenience for individuals to access or exit the project without automobiles
- Operable windows and shades for natural ventilation
- Low-E2 dual pane glazed windows
- Insulation with recycled content and is formaldehyde free
- Carpet: recycled content and CRI green labeled for indoor air quality
- Low V.O.C adhesives were and contained no formaldehyde
- Acoustical ceiling panels; 40% recycled content, low V.O.C, and no formaldehyde
- Fly ash as part of concrete material
- Construction/demolition waste programs in force throughout the project

OWNER/DEVELOPER:
The Lily Company

PLANNER:
Mogavero Architects

CONSULTANTS:
Civil: Kimley-Horn
Structural: Miyamoto International
Electrical/Mechanical/Plumbing:
Sacramento Engineering
Landscape: Quadriga

GENERAL CONTRACTOR:
Brown Construction

TOTAL SITE AREA:
9.74 Acres

RETAIL AREA:
10,000 s.f.

COMMERCIAL AREA:
37,000 s.f.

COMMUNITY BUILDING:
4,800 s.f.

RESIDENTIAL AREA:
218,014 s.f.

OF UNITS / DENSITY:
Residential units: 207
23 units/acre

RESIDENT PROFILE
Broad Market Appeal

PREVIOUS USE OF SITE:
Suburban Blight

CONSTRUCTION DETAILS:
Office: Steel Frame; Concrete Deck
Residential: Wood-Frame; 1-Hr;
Sprinkler Fire Suppression

PROJECT BUDGET:
\$32.5 Million

CONTACT:
Sam Fong
The Lily Company
501 S Street, Suite 1
Sacramento, CA 95814
(916) 448-8903
lilyco-sf@sbcglobal.net



THE LOHSE APARTMENTS

ROSEVILLE, CALIFORNIA

The Mercy Housing development is one of the City of Roseville's priority sites for implementation of their Downtown Specific Plan.

■ HIGH DENSITY MIXED USE

The Lohse Apartments in the City of Roseville accomplishes the goals of the "Downtown Specific Plan" with new residential development, facilities to support the entertainment district, and enhancement of the civic core with restaurants and retail. The Mercy Housing development is located on one of the catalyst sites identified by the City as priority for implementation of their Downtown Specific Plan.

One 4-story building with 58 residences sits over subterranean parking, and includes a central outdoor court and a common area with amenities on the first floor. In addition, 2,500 square feet of commercial space is available for retail use.

The project was designed to intensify the development footprint along Vernon Street in Downtown Roseville. The design emphasizes a substantial urban scale along Vernon and Bulen Streets with height, larger volumes and more formal brick materials. The design diminishes in scale as it moves from Vernon Street to the alley to recognize the lower scale of the existing uses across the alley and the lowering of the land elevations towards the alley. This is accomplished by reducing the number of stories, and scale of volumes.

The Lohse Apartments' frontage has commercial and active common areas at the ground level. Retail spaces are set back five feet from the sidewalk with a projected canopy above to allow for outdoor sales or café seating.

DAVID J. MOGAVERO, AIA, LEED AP

PRINCIPAL

David Mogavero is the Senior Principal of Mogavero Architects. He began his career designing naturally heated and cooled buildings thirty years ago. David's practice embraces the full range of progressive community design, such as high density mixed-use infill and holistic building systems, including daylighting, natural ventilation, passive heating and cooling, solar shading, water recycling, on-site energy generation and agriculture.

David's roles as developer and environmental advocate help him conceive projects that are economically viable and sensitive to the community and the environment. Through his professional practice, writings and lectures, service as past president and board member of the Environmental Council of Sacramento and the Planning and Conservation League, and current board member of the Council of Infill Builders, David has promoted the widespread adoption of sustainable building and smart growth practices and policies.



PROJECT EXPERIENCE

623 VERNON STREET, ROSEVILLE, CA

A mixed-use 5-story concrete podium structure in Downtown Roseville with 58 units of affordable family housing, retail, common facilities, and underground parking.

SMUD CORP YARD, SACRAMENTO, CA

Master planning and feasibility analysis for the redevelopment of a 20 acre former corporation yard for approximately 750 residential units, retail, a farmers market, parks and a light rail station.

SACRAMENTO NATURAL FOODS COOP, SACRAMENTO, CA

Sustainability driven design, including 85% reduction of energy use, for a newly constructed 40,000 square foot mixed-use building.

SMUD CUSTOMER SERVICE CENTER, SACRAMENTO, CA

A 186,000 square foot multi-use facility with administrative offices, customer service facilities, featuring daylighting, natural ventilation, off peak cooling, displacement ventilation and photovoltaics.

7TH & H STREET MIXED-USE, SACRAMENTO, CA

8-story building with 150 units of affordable housing for special needs population, a clinic for residents and neighborhood retail with natural ventilation and a central plant with evaporative cooling. 185kW photovoltaic and solar domestic hot water in an urban neighborhood.

MCKINLEY VILLAGE RECREATION CENTER, SACRAMENTO, CA

The community facilities for a 375 home infill community.

SACRAMENTO CENTRAL CITY NEIGHBORHOOD DESIGN GUIDELINES

Design Guidelines and District Urban Design that incorporated design standards for streetscape improvements and buildings.

MAPLE PARK, LIVE OAK, CA

56 units of family and 35 units of senior affordable housing in two phases on 3.33 acres that is a redevelopment of a public housing site including community facilities, childcare, and a park.

THE ARBORS AT OAK PARK, SACRAMENTO, CA

A mixed-use redevelopment project with 56 one bedroom units of affordable, senior housing with ground floor retail.

CAPITOL YARDS, WEST SACRAMENTO, CA

A 270 market rate 3-story apartment community on 8.5 acres with extensive community facilities such as a park, bandstand, gym, and pool.

SMUD VEHICLE STORAGE FACILITY, SACRAMENTO, CA

A seven acre area that established standards for making extensive paved areas environmentally sustainable in 1997. It includes dry wall recharge, landscaped swale conveyance and detention for stormwater and extensive shading to reduce summer temperatures.

RIVER'S SIDE AT WASHINGTON SQUARE, WEST SACRAMENTO, CA

A mixed-use urban infill community that includes for sale ownership residences and a mixed use building with rental apartments above retail space. Winner of Gold Nugget Award, PCBC.

PROJECT EXPERIENCE (CONTINUED)

CANNERY LOFTS, DAVIS, CA

A 62 unit family affordable housing community within the master planned Cannery community including community facilities.

WEST GATEWAY PLACE, WEST SACRAMENTO, CA

A 4-story wood frame mixed-use project at a gateway to West Sacramento and Sacramento with 77 units of affordable family housing over ground floor retail, community facilities and structure parking.

URBAN LEAGUE WORKFORCE TRAINING CENTER, SACRAMENTO, CA

A 30,000 square foot learning center with counseling offices, classroom, meeting rooms, and child care using natural ventilation, daylighting, indirect evaporative cooling and photovoltaics.

1200 PARK AVENUE, CHICO, CA

107 senior apartments in 2 and 3-story buildings for affordable senior housing in an urban neighborhood.

SIERRA OAKS BUILDING, SACRAMENTO, CA

A naturally-daylighted 3-story office building with subterranean parking which redeveloped a suburban infill site.

R STREET DEVELOPMENT AND URBAN DESIGN PLAN, SACRAMENTO, CA

Planning documents for redevelopment of the 2 mile long, 70 block former industrial and rail corridor that bisect the Central City.

SPEECHES, PAPERS & PUBLICATIONS

- "Smart Growth in America," World Resource Institute Conference, Mexico City 2013
- "Barriers to Infill," Presentation Stockton Climate Action Committee Meeting, May 2012
- "Charting Path to Net Zero," Panel Presentation Housing California Conference, April 2012
- "Landuse Planning Challenges," Planning and Conservation League, Sacramento, CA, February 2012
- "Design First, Materials Second: Integrated Design:," CRA Annual Conference, November 2011
- "Barriers to Infill," Great Valley Center Annual Conference, May 2010
- "Ecological Building 101," National Wildlife Federation Conference, April 2010
- "Principles for a Land Use Legislative

Program," Planning & Conservation League, 2010

- "Ecological Building 101," Sacramento Sustainability Forum, August 2009
- "Ecological Building," Preservation Roundtable, Sacramento CA, December 13, 2008
- "Transportation & Land Use," Green Summit, Sacramento CA, November - 15, 2008
- "Ecological Building," Planning Academy of Sacramento, October 22, 2008
- "Designing for Infill," Panel, North State BIA Regional Infill, October 16, 2008
- "Controlling Cost & Value Engineering," North State BIA Conference, October 8, 2008
- "Designing with Community Participation: Getting to Mutually

Beneficial," Non-Profit Housing Association Fall Conference, San Francisco CA, September 23, 2008

- "Ecological Health," Local Public Health & the Built Environment, April 17, 2008
- "Redevelopment: Building Better Communities," 2008 CRA Annual Conference, Anaheim CA, March 27, 2008
- "California Main Street Alliance," Sacramento CA, February 25, 2008
- "Ecological Building," Planning & Conservation League Symposium, Sacramento, CA, January 12, 2008
- "Think Global/Act Local - Revitalizing Aging Strip Centers," National League of Cities Conference, New Orleans LA, November 15, 2007
- "Ecological Building," Great Valley Center Annual Conference

EDUCATION:

- BA in Architecture, State University of New York, 1974
- Ohio State University, School of Architecture, 1967-71

PROFESSIONAL CERTIFICATION:

- Architect, California, 1979
- License No. C10145
- LEED Accredited Professional

PROFESSIONAL EXPERIENCE:

- Principal, Mogavero Architects 1984-present
- Partner, Mogavero + Unruh, 1979-83

PROFESSIONAL AFFILIATIONS:

- American Institute of Architects
- Past President, Current Board Member, Environmental Council of Sacramento, 1987-present
- U.S. Green Building Council
- Urban Land Institute
- North State Building Industry Association
- UC Davis Landscape Department: Advisory Committee
- Council of Infill Builders Board Member

COMMUNITY ACTIVITIES & AWARDS:

- Multiple design awards from the AIA, APA, ULI, Multifamily Executive, NAHB Green Architecture Instructor, 2001-2012 UC Davis Extension building, sustainable design, energy conservation and building design
- Planning and Conservation League, Past President and Board Member
- Environmental Council of Sacramento, Past President and Board Member
- 2001 Carla Bard Award
- ECOS Environmentalist of the Year

RENNER JOHNSTON, AIA, LEED AP
PRINCIPAL

Renner became passionate about architecture while working in Europe and returned to the U.S. for a Masters in Architecture at the University of Oregon.

Having been with Mogavero Architects since 1997, Renner shares the firm's long commitment to green sustainable design. As a Principal, he has designed and managed projects including infill, affordable and market rate housing, mixed-use, urban design and large solar arrays.

Renner has also worked on several master planning projects including, the Mather Campus Vision plan, Grass Valley Workforce Housing plan and the Baechtel Charrette for the City of Willits.



PROJECT EXPERIENCE

7TH & H STREETS MIXED-USE RESIDENTIAL TOWER, SACRAMENTO, CA

A Downtown Sacramento 8-story tower with affordable housing for the special needs population, including a clinic for residents and neighborhood retail. Project manager for Mercy Housing California.

SMUD PHOTOVOLTAIC & HYDROGEN FACILITIES, SACRAMENTO, CA

Design of a solar-powered hydrogen refueling facility, and public education area for learning about hydrogen and fuel cell vehicles.

WEST GATEWAY PLACE, WEST SACRAMENTO, CA

Mixed-use 4-story buildings with 77 residences, podium and community space, including retail on ground floor. Completed in April, 2017 with LEED-Silver. Winner of 2017 NAHB Best in American Living, Multifamily Affordable category.

MARINA VISTA / ALDER GROVE VISION PLAN, SACRAMENTO, CA

Architectural Vision Plan for the redevelopment of 719 public housing residential units. Extensive public outreach and visioning process for development.

MATHER VETERAN'S VILLAGE, PHASE 1 & 2, SACRAMENTO, CA

A permanent supportive housing for Veterans. Includes 50 affordable units with full Solar PV, Solar Thermal and Greywater System. Phase 2 renovates a 20,000 sf infirmary building for homeless Veterans and will include community space and senior services. Building is designed to be net zero.

SIERRA VILLAGE PHASE 1 & 2, DINUBA, CA

Solar-powered community with 100 affordable family residences and a community building.

ZETTIE MILLER'S HAVEN, STOCKTON, CA

Solar-powered special needs community for people with disabilities, with 82 elevator-accessible affordable residences.

CORNET BUILDING RENOVATION & RESIDENCES AT OLD TOWN KERN, BAKERSFIELD, CA

Renovation of a mid-century modern history building as a community center with residences on upper floor. Project included five 3-story buildings with affordable residences.

CUARTO DINING HALL, UC DAVIS CAMPUS, DAVIS, CA

Design-Build and complete renovation. Completed in Spring 2010 with LEED-Silver.

MATHER CAMPUS VISION PLAN, SACRAMENTO, CA

Developed design concepts for a 31 acre campus for SHRA and the Federal Department of Health Administration.

COLONIA SAN MARTIN, SACRAMENTO, CA

60 units of affordable apartments for Mercy Housing and the AIDS Housing Alliance that feature many green components: Solar PV and Solar Thermal, day-lighting, 25% better than California energy code. Nominated for California Stormwater Quality award.

THE GALLERY, DAVIS, CA

A mixed-use, residential over café demonstration project for LJ Urban to showcase green design and technology.

PROJECT EXPERIENCE (CONTINUED)

LIBRARY LOFTS, DOWNTOWN SACRAMENTO, CA

21 stories, including 295 condos, 35,000 sf office and 15,000 sf retail, and 450-space garage. Concept design for D.R. Horton.

CORDOVA CITY CENTER, RANCHO CORDOVA, CA

206 family townhouse units and 75 independent living senior units with a mixed-use component of 11,000 sf retail and 30,000 sf office.

ALMADEN CAMPUS SOLAR PROJECT, SANTA CLARA, CA

200-KW solar panel administration building addition and solar shelter project. Designed as a showpiece to highlight the District's commitment to sustainable energy.

GRASS VALLEY WORKFORCE HOUSING, GRASS VALLEY, CA

Developed a series of prototype housing designs for three infill sites with difficult terrain.

DESIGN CHARRETTE FOR BAECHTEL ROAD, WILLITS, CA

Week-long Charrette with Dan Burden to develop a series of development options along a new road alignment for the City of Willits.

ALBERTSON'S LAKE SHORE AVENUE, OAKLAND, CA

Concept design for renovation of a complex infill site and parking structure expansion.

LAVE RESIDENCE, PAJARO DUNES, SANTA CRUZ COUNTY, CA

3-story Beach House, including Coastal Commission review.

LEXINGTON APARTMENTS, DAVIS, CA

\$17 million in new construction of a 3-story, 120-unit apartment building above 3,100 sf of retail and commercial space. Winner of Gold Nugget Award, PCBC.

FAIRFIELD TRANSIT PROJECTS, FAIRFIELD, CA

3 multi-modal transit facilities on infill sites. Prepared designs for the City of Fairfield Park & Ride Expansions. The Red Top Road and Fairfield Transportation Center expansions were constructed.

CASCADE APARTMENTS, SACRAMENTO, CA

74-unit apartment complex renovation and addition of a new solar-powered community building.

CARRINGTON CIRCLE APARTMENTS, SACRAMENTO, CA

78-unit apartment complex renovation totaling 43,800 sf with a 2,000 sf community building.

EDUCATION

- Masters in Architecture, University of Oregon 1996
- Architecture & Drawing Courses, Fachhochschule, Vochshochschule & Goethe Institute, Dusseldorf & Duisburg, Germany 1991-92
- BA, Philosophy with Honors, Connecticut College 1989
- University of Edinburgh, Edinburgh, Scotland 1987-88 Year Abroad

PROFESSIONAL CERTIFICATION & MEMBERSHIPS

- Architect, California, C28934
- AIA Member
- LEED Accredited Professional
- Environmental Council of Sacramento, Former Board Member
- GOETHE INSTITUTE - Duisburg, Germany, Certificate 1991
- Fluent in spoken German

LECTURES & PUBLICATIONS

- "Greywater in Multi-Family," Housing California 2016
- "Navigating the New T-24," Housing California 2014
- "Seniors in the City," Leading Age 2013
- "Doing it Without RDA," CALFHA 2012
- "Building 7th & H," AIACV 2012
- "Green Architecture," Lecturer, UC Davis Extension 2006 - 2013
- "Community By Design," Speaker, Housing California 2009 & CRA 2009
- "A Ray of Light: Using MHSA Funding" Speaker, CRA Conference 2008
- "Measuring Green" Speaker Lorman Seminars, Stockton, CA 2008
- "Architecture and Green Business Practices," UC Davis Graduate School of Management 2008
- "LEED-Existing Buildings," Speaker, Institute for Real Estate Management 2008

- "Green Building Climate Action Team," Advisory Group for the State of California 2008

PROFESSIONAL AND COMMUNITY ACTIVITIES

- U.S. Green Building Council NCC, Former Chair, Sacramento Branch
- Green Architecture Instructor, UC Davis Extension Program 2015-17

CONTACT

2012 K Street
Sacramento, CA 95811
(916) 443.1033
rjohnston@mogaveroarchitects.com

envelopead | aΛua

RELEVANT EXPERIENCE

FIRM OVERVIEW

FEATURED PROJECTS

TEAM BIOS

envelope A + D

envelope A+D is an architecture and design firm exploring points between polarities: public + private; temporary + permanent; flexible + fixed; design + execution. Their multi-disciplinary approach to finding the optimum coordinates of features, systems and style for projects of every scale and typology has garnered them several awards: Architectural Record's Design Vanguard, Best Building of 2012 by the American Institute of Architects San Francisco and inclusion in the United States Pavilion at the 2012 Venice Architecture Biennale.

envelope A+D is headquartered in the San Francisco Bay Area and has a satellite studio in Los Angeles. Their work is widely published in magazines and journals, including the New York Times, Interior Design, Architect, Architectural Record, Metropolitan Home, Elle Décor, San Francisco Magazine, California Home & Design, Dwell, the Architect's Newspaper and the San Francisco Chronicle.

envelope A+D is a structure for working: an open, flexible container in which creativity and experimentation occur; a collaborative design group inclusive of outside disciplines and individuals. We reconceptualize modes of living and building to advance new models of public/private space and to craft compelling visions of the emerging urban condition. We design spaces as platforms for eliciting interactions both expected and delightfully unforeseen and design for the convergence of networks—physical, social, public, private—that activate place.

We embed flexibility in our designs because we think that responsiveness—to people, a neighborhood, a city and an economy—is the way to set the pace of change, and not just keep up with it. We design for immediacy and for the future, believing that these objectives are not mutually exclusive; that the temporary should be durable and the permanent should be adaptive.

We implement sustainable practices in our work at all scales, from the material to the regional, reflecting our belief that architects, as creative thinkers, must also be stewards of the earth.



NOW HUNTERS POINT

95,000sf

client : PG&E

EVENT	YEAR	ATTENDANCE	KEY STAKEHOLDERS
BMagic Backpack Giveaway	Annual (2016 - 2019)	5,000 (2019)	BMagic, Bayview schools, area families, partner community orgs.
Bayview Circus Festival	Annual (2014-2019)	3,500 (2019)	Bayview Opera House, Circus Bella, Bayview residents + families, partner orgs.
Fall Harvest Festival	Annual (2014-2019)	1,200 (2018)	Bayview residents + families, partner community orgs.

PROXY

17,000sf

client : HERE FOR NOW, Proxy, LLC

EVENT	YEAR	ATTENDANCE	KEY STAKEHOLDERS
Spring / Fall Film Series	Annual (2014-2019)	1,500 (Spring 2019)	Hayes Valley merchants, HV Neighborhood Assoc. (HVNA), partner orgs.
SF Jazz Festival	Annual (2013-2019)	1,000 (2019)	SF Jazz, HVNA, HV merchants, San Francisco residents

PROXY (octavia blvd. Lots K+L)
property owner : city of san francisco

DURATION	ANNUAL VENDOR INCOME	KEY VENDORS (TYPE)
2011 - Ongoing	\$ 3,000,000+ (total for all vendors)	Biergarten (food + alc.), Aether (apparel), Smitten (food), Ritual Coffee (food)

PUBLIC OUTREACH AND ENGAGEMENT

We approach event programming, site stewardship, and vendor curation as opportunities for engagement with local stakeholders and community members about the future of the place that we are bringing to life. This means that every event listed included opportunities for input into site improvements, programming decisions, and vendor types by anyone who attended or visited.



West Oakland Gateway

Location: Oakland, CA

Typology: Activation, public space

Year of Completion: 2016 (unbuilt)

Size: 3 acres

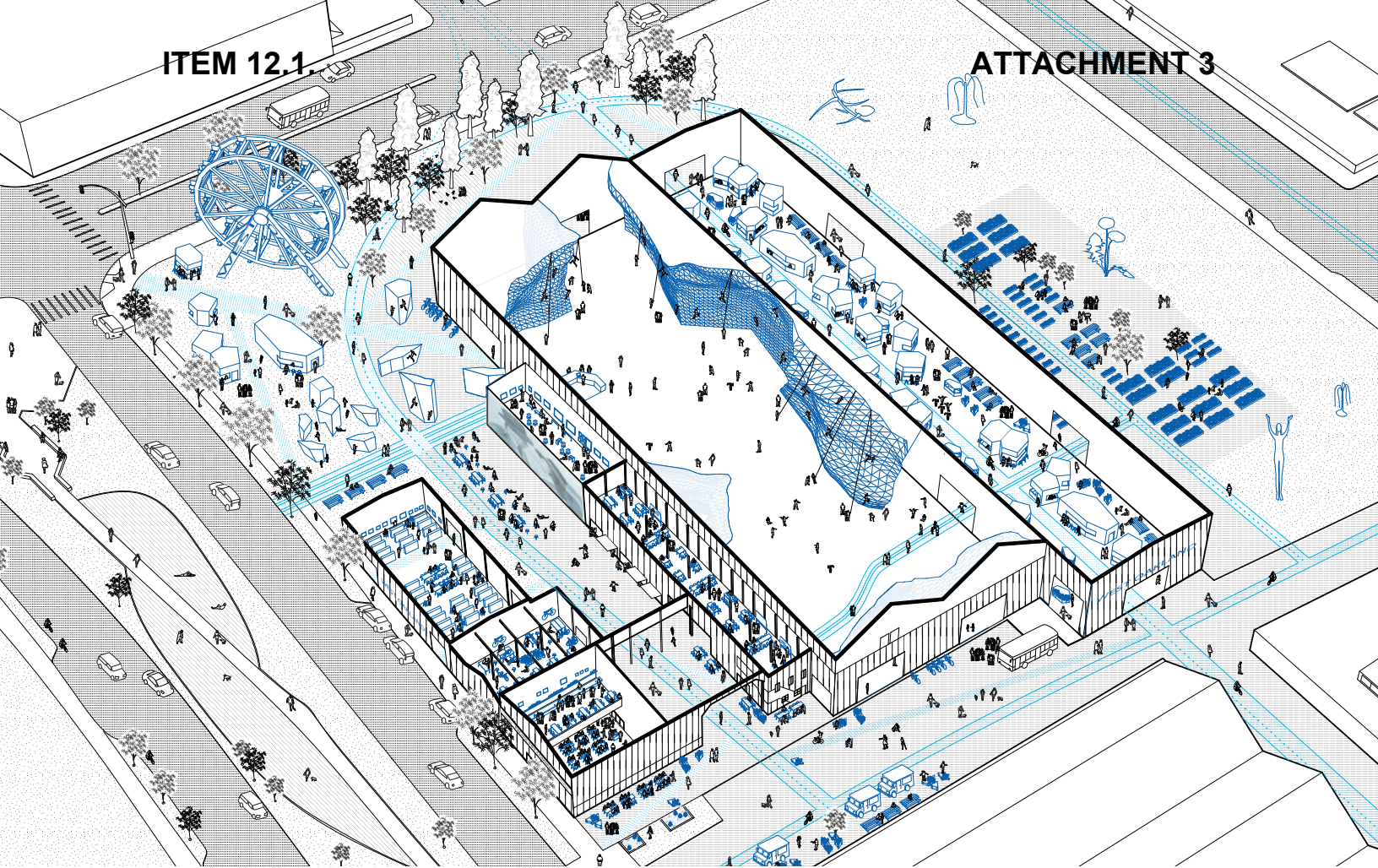
Situated at the gateway to West Oakland, this project imagines a vibrant future for a former pipeworks factory. Components of the Bay Bridge were assembled in this once-bustling manufacturing site. Today the Pacific Pipe Company's collection of now semi-derelict buildings have the potential to become a new community hub within a changing neighborhood.

In times of flux, transforming a site so steeped in local history requires extra care. Drawing on our experience with both PROXY and NOW Hunters Point, envelope proposed a multi-year process that would unfold iteratively with the involvement of area residents. Through ongoing activations, this process would invite the West Oakland neighborhood—a historically African-American community facing rapid gentrification after decades of disinvestment—to shape a vision for the site deeply informed by local needs and desires.

To find appropriate points of departure for this plan, we undertook an analysis of existing resources and constraints within the West Oakland area, including comparing amenities and institutions with neighboring areas. We identified five areas of focus for West Oakland Gateway's interim activations: cultural production, resource sharing, food, micro-enterprise, and spectacular events.

Beginning with a lightweight reoccupation of existing spaces, the project would evolve over time driven by a feedback loop of ongoing community engagement and an involved cohort of tenants and vendors. The West Oakland Gateway would emerge organically, ultimately accommodating a range of permanent uses and users rooted in the neighborhood.





population + housing growth

the west oakland population is growing rapidly

total number of housing units is also increasing in the neighborhood

the vacancy rate is now decreasing; as of 2015, 91% of units were occupied

2000



21,048



8,592



7,594

88%

998

12%

2010



24,978

+19%



12,086

+49%



10,429

86%

1,657

14%

2015



26,172

+5%



12,414

+3%



11,344

91%

1,070

9%

PROXY

Location: San Francisco, CA
Typology: Temporary urban activation - retail, food, arts, events
Year of Completion: 2008 - Ongoing
Size: 17,000 square feet

PROXY is a temporary two-block project that creates a concentrated, ever changing experience in the heart of San Francisco's Hayes Valley neighborhood. Taking the place of a parking lot and conceptualized as a place-holder for a more permanent development, PROXY demonstrates how, through minimal means, voids in the city fabric can become thriving centers of ingenuity and fun that positively affect the quality of life in the surrounding neighborhood.

PROXY's combination of provisional architectural frameworks and thoroughly researched, site-specific programming act as a content machine tied to the pace of contemporary culture. PROXY's success can be largely attributed to its invitation for artists, designers, content creators and passers-by to act on PROXY, play around in it and invent it for themselves. These chance collisions between multidisciplinary actors result in a richness of experience that draws in people to engage with each other and with their environment in delightful ways.

The principles of openness, risk-taking and stewardship inform envelope A+D's comprehensive relationship to PROXY as not only the architect but the developer, fabricator, cultural curator and fiscal strategist. Following PROXY's motto of "HERE FOR NOW", we see PROXY as a real-time laboratory in which impermanence may be exploited to find means by which architecture can support cities for both short-term and long-term development and wellness.





NOW_Hunters Point

Location: San Francisco, CA

Typology: Public park, streetscape + plaza, interim uses and structures

Year of Completion: 2008 - Ongoing

Size: 43 Acres

NOW_Hunters Point was created as part of a plan to revitalize the forty-three acre site of a former Pacific Gas & Electric Company power plant in the Bayview-Hunters Point area of San Francisco. A working-class neighborhood almost since San Francisco's founding, Bayview-Hunters Point has weathered immense change over the last thirty years, and now faces imminent gentrification as one of the last affordable neighborhoods in the city.

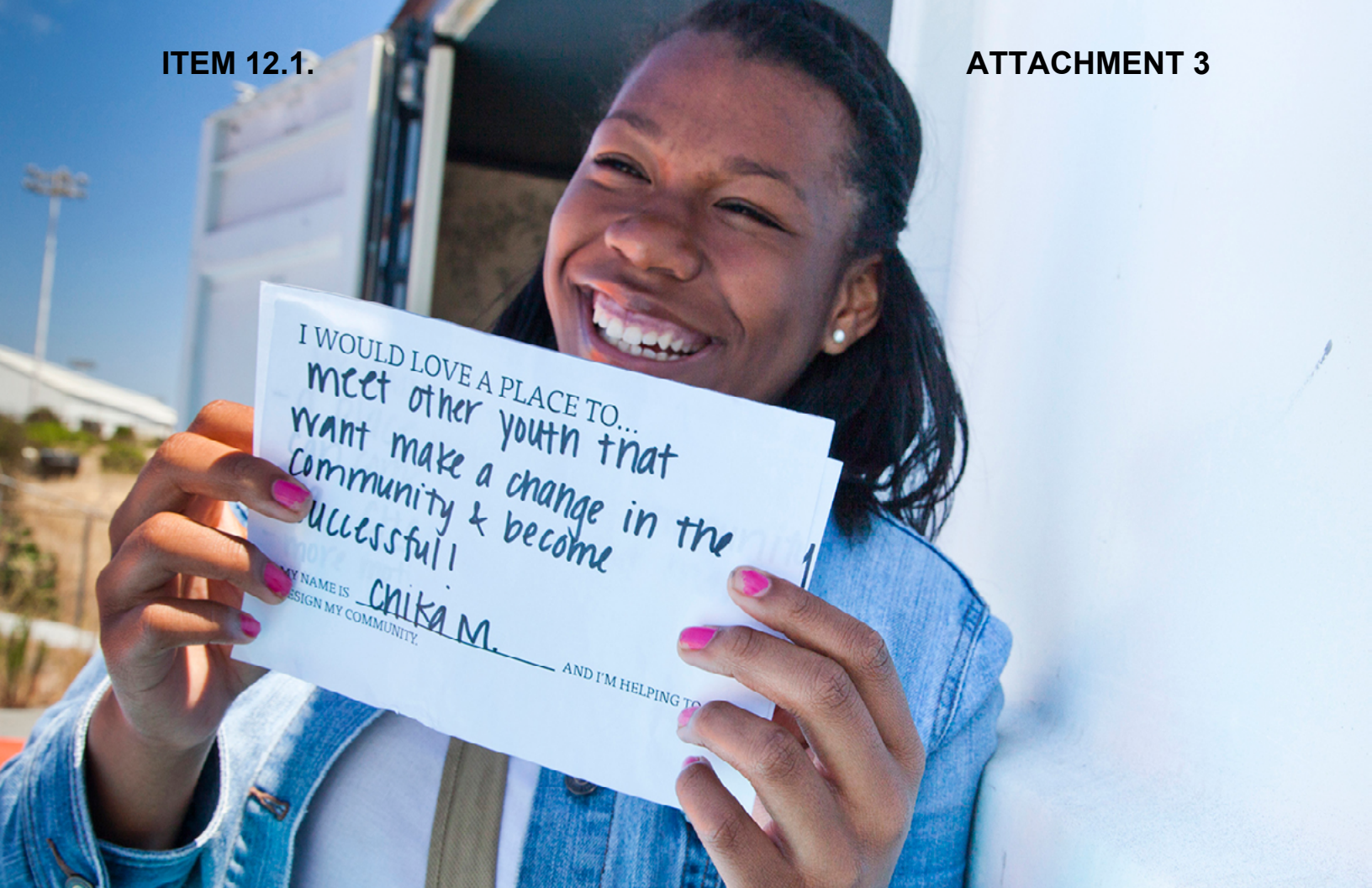
Hired to design a series of public spaces along the site's shoreline and streetscape, as well as to activate portions of the interior through interim use, we crafted a strategy that utilizes live prototyping not only to test objects—like the Listening Booth used to record neighbors' stories—but to establish a way of engaging community members in the design process that is fundamentally reciprocal and respectful.

NOW_Hunters Point is framed around an incremental, community-led approach in which an array of interim uses—job training, mobile health clinics, access to fresh food, youth activities and tutoring—are implemented to support the existing community against the strong currents of change that are already in motion. Over the lifespan of the project, these programmatic elements, gathered in an Interim Use Hub, will be rotated and refined as people vote with their feet about which uses are best suited for the site and its visitors. Gradually, a space will emerge that can be needed, and loved, by the people for whom it exists.

Along the way, the insights that we take from this constant conversation will create a feedback loop within the design process, shaping the form and content of the permanent public space improvements, and suggesting directions for the long-term development of the land.

Ultimately, our aim is to transform a formerly forbidden post-industrial site into a center for building capacity and connection, reconstructing it both physically and perceptually into a place that acknowledges its deep roots in history even as it writes a new narrative for its future.





I WOULD LOVE A PLACE TO...
meet other youth that
want make a change in the
community & become
successful!

MY NAME IS CHIKI M.
DESIGN MY COMMUNITY.

AND I'M HELPING TO





Hunters Point Shoreline

Location: San Francisco, CA
Typology: Public park
Year of Completion: 2017
Size: 43 Acres

The Pacific Gas and Electric Hunters Point Site is a multi-faceted property in the midst of a complex, multi-year transformation. Since 2013, envelope A+D in collaboration with RHAA and Liz Ogbu (Studio O) have led an innovative planning process, developing NOW Hunters Point using interim uses to cultivate a deeper, ongoing dialogue with the community about the site's future development. Hunters Point Shoreline, a new hundred-foot wide public access improvement, is the first permanent project informed by this process to move forward.

Fostering community access to and enjoyment of the site's shoreline was the impetus for the project. The project stretches along the bay from Heron's Head Park to India Basin, and incorporates an extension of the Bay Trail, a bicycle and pedestrian path running along the San Francisco's waterfront which will eventually circumnavigate the entire bay. A series of gathering areas along the path capture different vantage points and highlight the inherent qualities of the site.

Visitors experience a sense of immersion in the landscape as well as the site's layered history. As they move from sculpted hardscapes with native plantings to open meadows by landscape designer John Greenlee, an overlay of didactic elements—text and graphics embedded within the park's concrete walls, pathways and benches—reveal the community voices and events that define site's legacy.

The NOW Hunters Point community process was integral to the development of the vision, design and historical content of the Hunters Point Shoreline's vision. After fulfilling an intensive approvals process including the Army Corps of Engineers and the Bay Conservation and Development Commission, the Hunters Point Shoreline opened in spring 2017.









DOUGLAS BURNHAM
principal + founder, envelope A+D

Education:
Bachelor of Architecture
Cornell University School of Architecture

Bio:

Douglas is the founder and principal architect of envelope A+D and has been a practicing architect for over twenty years. His recent work in San Francisco—including PROXY in Hayes Valley and work on the former PG&E power plant site in Hunters Point—employs temporary urban interventions to explore the transformational potential of a diverse mix of well-curated, neighborhood-serving uses. Douglas holds a Bachelor of Architecture degree from the Cornell University School of Architecture, where he received the prize for best thesis. Concurrent with his architectural practice, Douglas has been an adjunct professor at California College of the Arts since 2004. From 2007-2010 Douglas led the SFMOMA's Architecture + Design Forum as Chair, where he now serves on the Forum's Executive Committee.

Relevant Experience:

PROXY, San Francisco, CA, 2010 - Current
NOW Hunters Point, San Francisco, CA, 2013 - Current
CCA Back Lot, San Francisco, CA, 2014

Recognition:

Design Vanguard, Architectural Record, 2012
Kirby Ward Fitzpatrick Prize, Architectural Foundation of San Francisco, 2012
Honorable Mention: New Practices, AIA SF, 2009



NATHAN JOHN
partner, envelope A+D

Education:
Master of Architecture
University of California, Berkeley
Bachelor of Arts
Sarah Lawrence College

Bio:
Nathan's work leverages the techniques of the hacker/maker movement and the sensibility of the architectural avant-garde in testing the potential of small, temporary interventions to reorient our perceptions of urban environments. At envelope A+D, Nathan draws on his experience in community organizing in his leadership of the firm's public realm work. Nathan holds a Master of Architecture degree from UC Berkeley, where he received the Eisner Prize, the department's highest honor. He has also been the recipient of several fellowships supporting his research on public space. A child of the suburbs, he fell in love with cities while working as a bicycle messenger in Dublin, Ireland.

Relevant Experience:
Hunters Point Shoreline, San Francisco, CA
NOW Hunters Point, San Francisco, CA
Greenway 31, Berkeley, CA

Honors + Fellowships:
Eisner Prize in Architecture, UC Berkeley
Arts Research Center Fellow, UC Berkeley
John K. Branner Traveling Fellow
Thomas J. Watson Traveling Fellow



LEX PHELAN
associate partner, envelope A+D

Education:
Bachelor of Architecture
Virginia Polytechnic Institute and State University

Bio:
Architect Lex Phelan focuses on architecture and planning projects involving sensitive cultural contexts and natural habitats, such as Radhaus, a new restaurant within the historic Fort Mason Center, a vision plan for the Headlands Center for the Arts, and a mixed-use urban infill project in the Sonoran Desert. She also leads initiatives in project management and delivery, developing best practices for the office.

While earning her Bachelor of Architecture at Virginia Tech, Lex created her own year-abroad program in Shanghai, furthering her architectural studies in a vastly different context, while also working as a product designer. She began her career in Germany, becoming a licensed architect and member of the North-Rhine-Westphalia Chamber of Architects, well versed in design and construction methods for public buildings, schools, and residences.

Lex's experience shaped her interest in the social possibilities of design and promoting new models for collective life in a global society — a line of inquiry she continues to pursue at envelope A+D. Her work recognizes the potential of the built environment to enhance physiological and emotional well-being among occupants and advocates a design approach that prioritizes community needs and equitable access to a healthy, sustainable environment.

Relevant Experience:
Radhaus, San Francisco, CA
Chroma, Tucson, AZ



RELEVANT EXPERIENCE

FIRM OVERVIEW

FEATURED PROJECTS

TEAM BIOS

ABOUT US

At Project for Public Spaces, we believe that great public spaces strengthen communities. We bring those public spaces to life by planning and designing them with the people who use them every day, and by equipping people with skills and tools to fuel lasting change in the places they share. Together, we create community-powered public spaces around the world.

Project for Public Spaces (PPS) is a nonprofit educational and technical assistance organization with an international reputation for its success in the creation of more livable communities. Over the past 40 years, PPS has grown from a small group of dedicated out-of-the-box thinkers studying how people use public space, to the leader of a global movement for placemaking that continues to change places and lives around the world. With an interdisciplinary team comprised of around 30 people, we have directly helped more than 3,000 communities in 47 countries to build stronger and more dynamic public spaces.

PPS is recognized internationally for our success in helping communities enhance their unique sense of place, promote active and healthy lifestyles, foster contact between diverse populations, and work towards environmental sustainability. We have worked with various partners to transform public spaces around the world: public and private organizations; federal, state, and municipal agencies; business improvement districts; the private sector; neighborhood associations; chambers of commerce; charitable foundations; and other civic groups.

PPS staff bring a wide variety of professional skills and years of experience working around the world on a vast array of public spaces. PPS's staff is trained in architecture, landscape architecture, urban planning, urban design, environmental psychology, arts administration, and sociology. We collaborate with local architects, landscape architects, engineering firms, transportation consultants, retail planners, and community organizations.

PLACEMAKING

A TRANSFORMATIVE APPROACH

Our services for development begins with robust stakeholder engagement.



With community participation at its center, placemaking capitalizes on a local community's assets, inspiration, and potential.

Strengthening the connection between people and the places they share, **placemaking** refers to a collaborative process by which we can shape our public realm in order to maximize shared value. More than just promoting better urban design, placemaking facilitates creative patterns of use, paying particular attention to the physical, cultural, and social identities that define a place and support its ongoing evolution.

A COMMUNITY-POWERED PROCESS

By putting stakeholder engagement at the center of our process, PPS addresses uncertainty early instead of allowing it to derail the project later. Our user-friendly engagement and observation tools and our strong facilitation skills foster a more constructive, creative relationship between developers and their stakeholders than the average public process.

BUILDING CONSENSUS

Our outreach skills apply to project teams and public, private, and civic stakeholders, too. We know that success relies on strong alignment and coordination across disciplines and sectors. We ensure that the project team has access to all of the relevant information and approvals, to diverse perspectives and out-of-the-box ideas, and to a roster of future partners in implementation and management. We excel at using public space as the literal common ground to bring these coalitions together, and our focus on quick wins helps build trust among stakeholders and keep up momentum throughout the entire process.

INTEGRATING DESIGN, PROGRAMMING, AND MANAGEMENT

Whenever we plan or improve a public space, we treat design, programming, and management as part of one integrated approach. Design provides an important foundation for a great public space, but is rarely enough on its own. All too often, traditional design professionals create an inflexible finished product without testing their assumptions and without room to adapt after ribbon-cutting. What sets PPS apart is that we start by defining a vision for the public space's uses and activities throughout the day, week, and year. Then, we develop a conceptual design, an activation plan, and a management plan to achieve that vision, and work iteratively and collaboratively with the whole project team to realize it.

INTERDISCIPLINARY DESIGN EXPERTISE

As an interdisciplinary placemaking nonprofit, the Project for Public Spaces team includes architects, landscape architects, planners, and researchers. Through this range of expertise, we specialize in translating community needs and ideas into practical design elements. In particular, we provide guidance and expertise in the following areas:

Flexibility Public spaces must be designed and managed to respond to the changing needs of a community. We ensure a public space has the infrastructure and layout to host a wide variety of activities and events, and the ability to grow and evolve over the long term.

Access and Linkages Great public spaces rely on a constant feed of foot traffic. We consider every space within the broader urban fabric to optimize access by foot, transit, bicycle, and car, and to create vital connections to other nearby destinations and public spaces.

Amenities We pioneered the study of seating, lighting, shade, and landscaping in public space, and know better than anyone how to use these elements to make people feel safe and comfortable.

Siting and Ground Floors PPS is an expert in the arrangement of public spaces, streets, and adjacent buildings. We can also help with the design of storefronts, restaurants, public buildings, and other ground floor uses that enhance vitality and contribute to the success of retail and other commercial uses.

Precedent Research We have worked directly in more than 3,000 communities around the world, and studied public spaces in many more. That means we have seen what works firsthand, and we know how to apply and adapt this wealth of global case studies, best practices, and innovations to the local context of your development.

The Brookings Institution and Project for Public Spaces are currently collaborating to create a new cross-disciplinary approach to city building that integrates the reinforcing benefits of vibrant public spaces, innovative urban economies, and inclusive growth.



➤ The Beach at Campus Martius in downtown Detroit began as an temporary activation in 2013 and has grown to be a major downtown attraction.

THINKING LIGHTER, QUICKER, AND CHEAPER

Often the changes that a public space really needs in order to become more functional and enticing do not require big investments of time and money. New amenities, programs, aesthetic improvements, and even lightweight development can be implemented in a matter of weeks not years, and this process of experimentation allows developers to safely test out ideas and quickly build goodwill with the community.



Neighborhoods throughout the City are experiencing record growth, and the Downtown is at the forefront. Market Square is at the center of much of this development and investing in this asset is critical to Downtown's continued growth.

—Luke Ravenstahl,
Mayor of Pittsburgh

SELECTED PROJECTS

Downtown Detroit Public Spaces
Discovery Green
Pearl Brewery
Sundance Square

DOWNTOWN DETROIT PUBLIC SPACES

DETROIT, MI


**ECONOMIC
DEVELOPMENT**

**PUBLIC
PARK**

**YEAR-ROUND
PROGRAMMING**


CLIENT

Downtown Detroit Partnership
and Rock Ventures/
Opportunity Detroit

COMPLETED

2001-2016

SERVICES

- Place Evaluation & User Analysis
- Community Engagement & Visioning
- Programming
- Place Plans & Design
- Lighter, Quicker, Cheaper

Placemaking revived the heart of the Detroit community.

Project for Public Spaces has worked with local partners in downtown Detroit for nearly two decades. As the city fell upon hard times, our placemaking efforts in the heart of downtown provided a beacon of hope for residents and an engine for economic revitalization. Over the years, PPS has worked with multiple sites and clients in the area, but it all started with Campus Martius. Once the hub of economic and social life for the city, by the time PPS began working in Campus Martius in 1999, it had become little more than an unfriendly traffic island. Across five engagements, PPS used every tool in its toolbox to transform this intersection into what locals now call “Detroit’s gathering place.”

These community-driven improvements caught the attention first of Compuware and then of Quicken Loans, both of which moved their headquarters next to Campus Martius, and brought jobs and investment back downtown. Today, Campus Martius attracts more than two million people annually, the surrounding district has attracted 20,000 new jobs and over \$2 billion of real estate investment, and since the Detroit declared bankruptcy in 2013, the park has become a symbol of the city’s resilience and renewal.

DISCOVERY GREEN

HOUSTON, TX



**ECONOMIC
DEVELOPMENT**



**PUBLIC
PARK**



**COMMUNITY
ENGAGEMENT**



CLIENT

Discovery Green Conservancy

COMPLETED

2005-2008

SERVICES

- Community Engagement & Visioning
- Programming
- Place Concepts & Designs
- Design Review

Discovery Green transformed a 12-acre parking lot into a verdant downtown destination and a catalyst for economic and social change.

For years, downtown Houston was an automobile-centric, placeless district without any public spaces for residents to congregate. PPS was hired by the Discovery Green Conservancy to lead a public visioning process in order to transform 12 acres of underused green space and parking lots near the Convention Center into an urban oasis that serves as a village green, a source of health and happiness for Houstonians, and a window into the diverse talents and traditions that enrich life in the city.

The park opened in Spring 2008, and it has been phenomenally successful. It now attracts more than 1.5 million visitors to its 600+ free events annually, consistently drawing local patrons. Discovery Green has catalyzed \$1.25 billion in nearby development; a number of residential and commercial projects have specifically noted Discovery Green as the impetus for their investment. The park has certainly boosted business at the nearby Convention Center, but most importantly, Discovery Green has put downtown back on the map as a place for Houstonians to play, relax, meet one another, and even as a place to live.





PLACEMAKING IN ACTION

1. Synchronicity of Color.

Margo Sawyer's kaleidoscopic art wall is a favorite place for Houstonians to snap a photo.

2. A Downtown Oasis.

Rentable kayaks give visitors the opportunity to get up close and personal with Kinder Lake, a naturalistic water element in the heart of downtown Houston.

3. Movie Night. Free film screenings keep locals coming to Discovery Green well into the evening.

4. Light and Shade. On the Brown Foundation Promenade, people stroll under a shady canopy of hundred-year-old oak trees and alongside an otherworldly art installation.

5. Art Blooms Here. Temporary art installations and performances keep Discovery Green fresh and exciting, long after opening day.

6. The Main Stage. The Anheuser-Busch Stage provides a state-of-the-art venue for hundreds of Houston musicians and performers every year.

7. Gateway Fountain. Besides the park's hundreds of regular events, Gateway Fountain is one of its biggest draws. In the summer, children love its cool 14-foot jets of water, with flexible seating nearby for parents.



PEARL BREWERY

SAN ANTONIO, TX



**ECONOMIC
DEVELOPMENT**



**PROGRAM
PLANNING**



**MIXED-USE
DEVELOPMENT**



CLIENT

Silver Ventures

COMPLETED

2005-2018

SERVICES

- Place Evaluation & User Analysis
- Community Engagement & Visioning
- Programming
- Place Plans & Design

Pearl Brewery is now a top destination in San Antonio.

The historic Pearl Brewery, a 20-acre campus located along the San Antonio River, stood empty for several years after closing in 2001. Silver Ventures, a local developer, purchased the site in 2002 and developed an ambitious vision. The vision was intended to completely transform the Pearl Brewery site and the surrounding neighborhood into a mixed-use development, combining education and learning with other uses including residential, dining, culture, arts, shopping, and recreation.

Along with the development team, PPS worked with MJM Management Group to create a program of activities and management plan for Pearl Brewery that included recommendations for public spaces, maintenance, security, hospitality, programming, marketing and promotion, alongside a market, plans for commercial tenant management, and parking. Evolving incrementally over the past decade, gradually bringing restaurants in and creating destinations, Pearl Brewery was recently honored with the Global Award for Excellence by the Urban Land Institute. It is now a top destination in the city and rivals downtown as a nightlife and shopping district.



➤ Pearl Park is just one of the four public spaces at Pearl and provides a flexible space and opportunity for year-round free programming.

➤ A strong physical and visual connection between activity inside buildings and outdoor public spaces is important to the success of both spaces.

SUNDANCE SQUARE

FORT WORTH, TX



**PUBLIC
PARK**



**COMMUNITY
ENGAGEMENT**



**YEAR-ROUND
PROGRAMMING**



CLIENT

Downtown Fort Worth

COMPLETED

2010

SERVICES

- Place Evaluation & User Analysis
- Community Engagement & Visioning
- Place Plans & Design

Sundance Square has helped catalyzed economic revitalization throughout the entire downtown.

Like many American cities, residents of Fort Worth thought of its downtown as an area to pass through, not as a destination itself. Although it was bustling with office workers during weekdays, and some events drew crowds on weekends, most of the time it felt desolate. Downtown Fort Worth brought in PPS to assist in the design of Sundance Square, a new central place for the city. After undergoing an extensive placemaking process, PPS recommended that the square begin to incorporate daily activities, a market, public art, exhibitions, and larger annual events. Design recommendations included the creation of active edges and supported both visitor and community uses and ensured that the square would be popular throughout the week and seasons. The capping off of two major streets allowed for additional development, supporting ground floor activation and businesses to move downtown.

Sundance Square opened to great acclaim in 2013. An ongoing activation and management strategy has led to the creation of a successful public space that is revitalizing downtown Fort Worth.



Events both small and large can be accommodated in the plaza due to the flexibility of the space, which also has many sub-places within it.

Year-round programming and iconic features, including a splash pad, invite visitors of all ages to the plaza and has helped catalyzed economic revitalization throughout the entire downtown.

Portals to PLACES

Thinking
beyond Stops
and Stations

to

Community
Mobility
Hubs

The Goal

Our *Portals to PLACES* program focuses on creating transit facilities that support communities. These transit stops and stations are well integrated into the communities they serve at the local and regional level, meet the needs of passengers through useful amenities, and serve as accessible, active, sociable and comfortable public spaces.

The Audience

The program will provide city officials, decision-makers, and transit facility owners and managers with tools to deploy the program's approach to improve upon the transit areas under their purview. Thought leadership and resources under the program will also support community leaders and transit advocates in their work.

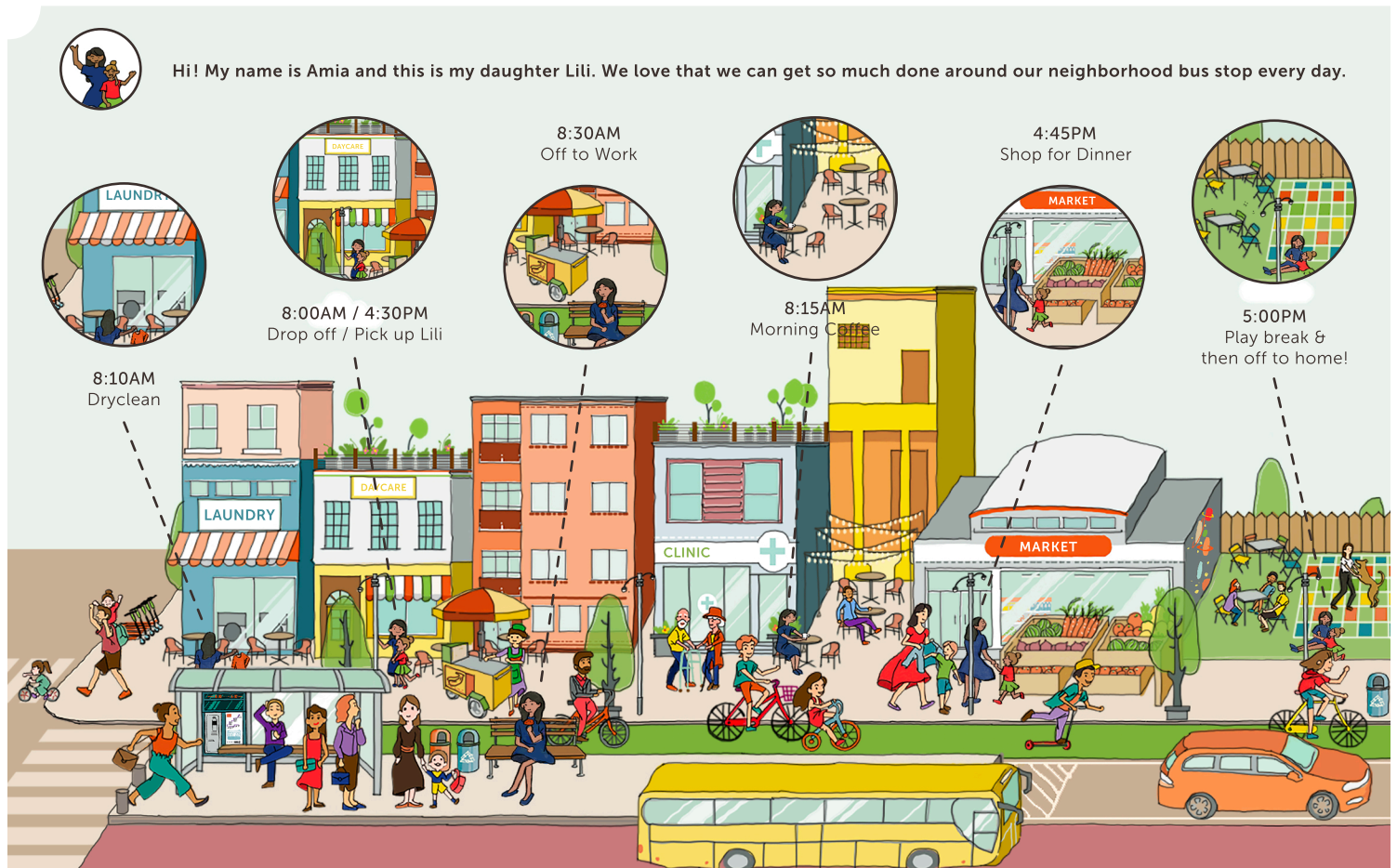
Ultimately, the beneficiaries of the program will be people in communities who use public transit out of necessity and for their leisure. Specific emphasis will be placed on transit stops and stations serving low-income or otherwise marginalized populations who rely most heavily on public transit and where ancillary services and adequate passenger amenities are lacking.

A Program of —



The Intended Impact

To improve the quality of life of all-purpose transit riders, especially those in low-income communities, by transforming their stops / stations into multi-use destinations. These destinations will alleviate the need for owning automobiles for daily trips, reduce time spent in transit, and enhance the opportunity to build social capital.



From Portals

to

PLACES

Strategies

Thought leadership and knowledge sharing.

Our team will create and share resources on a dedicated program page on the Project for Public Spaces website including case studies, slideshows, reports and publications; station typologies and specific recommendations for each; and an ongoing blog feed.

Community outreach.

We will deploy wide-ranging community surveys to target transit riders beginning in New York City, and replicate this strategy in other cities and transit-dependent communities. A synthesis of these findings will inform the program and shared with our target audiences through online and in-person engagements in other cities.

Toolkits and trainings.

We will create resources to help our audiences improve transit stations and stops in their own communities. Online resources, such as how-to guides and toolkits, will ensure that our knowledge is accessible, digestible, and implementable. Training for targeted audience groups will provide specialized instruction on how to transform transit stops into great places.

Strategic Project Development.

PPS will also be available for on-site technical assistance, including conducting station audits and working with individuals and community organizations to improve public life in and around targeted transit stops. Projects will be chosen in areas that have the following characteristics:

- 1 Residents rely heavily on public transit, often spending an hour or more in transit each day;
- 2 The median income for the neighborhood served by a stop is below the median income for the city or the neighborhood is a majority-minority community;
- 3 Nearby daily destinations lack connectivity on foot.

Needs

The program will actively address the ongoing crisis of lack of sense of place—a lack of community gathering places and a related lack of trust, belonging, and pride—in our communities by highlighting the largely overlooked opportunity of transit stops as public spaces.

The program will improve last-mile connectivity and reduce the need for short auto trips by creating a density of everyday destinations in and around stations and stops.

The program will also aim to alter perceptions of public transit usage, often laden with a social-economic bias that inhibits mode shift and lasting investment in these systems.

The program will advocate for an increase in funding for adequate passenger amenities at public transit stops.



Illustrations by Jiayi Cheng

A Program of —



Project for Public Spaces

Team Bios

Cynthia Nikitin

Senior Vice President

Cynthia is a Senior Vice President at Project for Public Spaces (PPS), specializing in development of downtown master plans, transit station enhancement plans including transit oriented development, placemaking around civic institutions and federal buildings, and creative placemaking. In her twenty seven years at Project for Public Spaces, Cynthia has initiated and led numerous multi-year programs, including the Southwest Airlines Heart of the Community grant program, where she provided technical assistance to local community partners to bring new life to centrally located public spaces in 18 communities across North America; NJ Transit's Model Stations Program which redefined the way the agency designs and manages its rail stations to serve as portals and places; New York State DOT's TOD education program to engage communities along a planned BRT line to reassess and expand upon their mobility options; and Directed the Citizens' Institute on Rural Design™ a leadership initiative of the US National Endowment for the Arts where she developed strategic partnerships with rural-focused organizations, tribal communities, and cultural institutions to assist 19 small towns in overcoming a wide array of design challenges.

Gary Toth

Executive Vice President

Gary Toth has helped to lead a national movement to integrate land use and transportation issues as a means to creating more livable, walkable communities and streets. He is a well rounded engineer who is as equally familiar with the details of engineering as he is with the best approaches for facilitating the delicate interactions between transportation agencies and their stakeholders. He spent the first 34 years at the New Jersey Department of Transportation (NJDOT) and subsequently and 10 years as Director of Transportation for the Project for Public Spaces (PPS).

Since joining PPS in 2007, Gary has been a thought leader in reframing the goals of transportation towards Placemaking, Livability and Multi-modal. He has worked with dozens of communities to help them plan and create more sustainable streets and transportation networks with sound engineering principles, but doing so within the lens of a local Place Vision. He has conducted dozens of trainings and community engagement sessions. His work at PPS builds upon his expertise in transportation and land use gained while at NJDOT; he has since evolved it into Place Led Transportation. His approach reframes Complete Streets, Road Diets and Livable Streets from contested conversations about reallocation of space to Building Communities through Transportation.

Nidhi Gulati

Program Manager, Transportation

Nidhi Gulati is a trained Architect and Urban Researcher and leads the Streets and Transportation program at Project for Public Spaces. In that capacity, she is in charge of strategic planning for the program, leading new research and resources, initiating and managing external partnerships, and project management. Nidhi joined PPS in 2013 as an associate and built a portfolio of more than 20 projects across the US and abroad, delivering her first keynote speech at the Second International Forum on Public Spaces in Bogota, Columbia in 2014. She is an active contributor for the company blog, and plays an advisory role on a variety of projects across the organization. Ingrained in all her work is a commitment to better serve the most vulnerable populations in our cities and towns, including women and children.



HackerLab

RELEVANT EXPERIENCE

FIRM OVERVIEW

LOCATIONS

TEAM BIOS



Build. Code. Unite.

Hacker Lab is an all-in-one makerspace, coworking facility and workforce incubator. We bring people, training, and advanced prototyping equipment together under one roof, giving you the opportunity to bring your vision to life. We currently operate three facilities in the Greater Sacramento region, including the cities of Rancho Cordova, Rocklin, and Sacramento.

We're a membership organization offering individual and corporate classes for adults and youth, including a mentor program. We provide offices and desks, maker cages, event and meeting space, which fosters our amazing and growing community of change makers and innovators.

Makerspace

Equipped with woodshop, welding, jewelry, 3D printers, laser cutters, various milling devices, and the latest computers and electronics, our makerspaces are places in which people with shared interests, especially in entrepreneurship, technology, or art, can gather to work on projects while sharing ideas, equipment, and knowledge. We operate over 15K SF of space, \$500K+ of equipment, 50 available machines, and nearly 1000 drill bits.

CoWorking

Get work done alongside a community of fellow makers, coders, and entrepreneurs. With locations in Sacramento, Rocklin, and Rancho Cordova, Hacker Lab creates a network of like-minded entrepreneurs, coders, makers, and hackers all brought together around the same idea: creating something cool. We operate 3 convenient locations with Greater Sacramento, provide 24/7 access, ultra fast 1 Gigabit ethernet, with over 15,000 cups of coffee chugged.



ITEM 12.1.

Hacker Lab – Locations

ATTACHMENT 3



Hacker Lab Rancho Cordova
11275 Sunrise Gold Cir Ste. A
Rancho Cordova, CA 95742



HackerLab Rocklin
4415 Granite Drive
Rocklin, CA 95677



HackerLab Sacramento
2533 R Street
Sacramento CA 95816

The Hacker Lab Team



Gina Lujan
CEO / Hacker Lab



Eric Ullrich
COO / Hacker Lab



RELEVANT EXPERIENCE

FIRM OVERVIEW

FEATURED PROJECTS

TEAM BIOS

Project Team

Griffin's financing team has extensive experience working with local California governments and non-profits to finance social infrastructure public private partnerships. The Griffin team is anchored by Citigroup ("Citi"), the #1 ranked firm in the California public finance market and the market leader in financing convention center facilities using low-cost tax-exempt securities. The financing team Griffin has assembled will be available at all times to provide the services necessary to a successful transaction. A brief summary of the financing team is provided below.

Griffin's City of Rancho Cordova Financing Team

Name	Role In Transaction	Experience
Day-to-Day Banking		
Chris Mukai, Managing Director	Project Manager, Co-Head of Western Region	Total Experience: 700 issues - \$333 billion par value. Calif. Experience: 554 issues - \$314 billion par value. Calif. Lease Rev. Bonds: 97 issues - \$13 billion par value. Co-Head of Western Region. 26 years of experience
Stephen Field, Director	Social Infrastructure Specialist	Primary day-to-day banking for Citi's western region social infrastructure P3 projects. Primary day-to-day banker for 2017 and 2018 Orange County P3 Project. 13 years of experience. Over \$30 billion of senior managed experience.
Devin Dillard, Associate	Quantitative and Analytical Support	Serves as primary quantitative banker for issuers throughout the Western Region including State of California, County of Los Angeles and City of San Diego. 5 years of experience.

Relevant Experience

Citi's Public Finance Presence in California. Providing California clients with the highest level of service is one of Citi's biggest priorities. Citi maintains a strong network of professionals in California, including a full-service municipal bond sales, trading and underwriting desk based in Los Angeles. Citi has been serving as a trusted partner to California municipal clients for over 50 years. Citi's Los Angeles based municipal syndicate desk is Wall Street's largest municipal trading and underwriting desk on the West Coast, which on average trades between \$300-\$500 million of California tax-exempt bonds on a weekly basis.

Market Leader in Financing Social Infrastructure P3 Projects. Citi is a market leader in helping to develop and implement social infrastructure public private partnership projects. Working with the Griffin team, Citi developed a unique financing structure for Orange County Civic Center Improvement Program that allowed the County of Orange to take advantage of the efficiencies of a P3 structure while utilizing the County's high credit quality to borrow at the lowest cost to fund the project. To this point, as part of the efforts on the Phase II project, Citi developed a comprehensive rating strategy for the County of Orange which helped result in the County receiving a AAA rating from Fitch (a one notch upgrade). The case study provided below has more information on County of Orange's Civic Center Improvement Program.

Leader in National P3 and Project Finance. Citi has worked with US state and local governments on P3s for the past 30 years. Our experience exceeds 100 transactions in the US and runs the gamut of asset classes, including parking facilities, surface transportation, water and wastewater collection and treatment, air and sea ports, real estate, conventional and renewable energy, solid waste disposal, social infrastructure, and schools. Citi presents considerable experience structuring P3s around unique federal, state, and local tax and other requirements.



**#1 Negotiated Underwriter
17 of the last 25 Years**

**#1 National Availability
Payment and Lease
Underwriter**

**#1 Underwriter of California
Social P3 Projects**

As a leader in P3s, Citi has considerable recent experience in all aspects of the P3 space, including working for both public sector sponsors and private sector developers, and serving in both sell-side and buy-side capacities. Historically, Citi led many of the ground-breaking transportation P3s, including the Chicago Skyway, the first significant brownfield toll asset monetization completed in the US, and SR-91 in California, the first managed lanes financing completed in the US. A table showing highlights of Citi's P3 and project finance transactions since 2012 is below.

Project	Amount Financed	Financial Close	Citi's Role / Project Description
Orange County Civic Center Infrastructure Improvement Program – Phase I	\$152 mm	2017	Citi served as sole senior manager for the Developer, Griffin Swinerton, for Phase I of the Civic Center Master Plan, the first P3 for Orange County. The project will house offices for governmental functions and is the first of several phases for the County's new Civic Center.
Orange County Civic Center Infrastructure Improvement Program – Phase II	\$185 mm	2018	Citi, working with the Griffin Swinerton team, to complete Phase II of the County of Orange's Civic Center Master Plan in December 2018. The project will provide office space for various County agencies, a room for the Board of Supervisors and an underground parking structure.
CalPlant I LLC Project	\$228 mm	2017	In May 2017, Citi served as joint bookrunning manager for a non-rated offering for CalAg LLC, totaling over \$228 million, to finance a rice straw to medium density fiberboard plant.
Georgia Proton Treatment Center Project	\$219 mm	2017	Citi served as sole senior managing underwriter for the GA Proton Treatment Center on a transaction to finance a therapy treatment center in Atlanta. The center will house pencil beam proton therapy equipment, diagnostic equipment, treatment equipment, planning equipment, imaging equipment (MRI machines) and a parking deck.
Irving Convention Center Hotel Project	\$124 mm	2017	Citi served as senior managing underwriter and placement agent for the Public Finance Authority's bonds to finance the Irving Convention Center Hotel Project in Irving, TX. Once constructed, the hotel will contain approximately 350 rooms and will operate as the convention center headquarters hotel for the City of Irving's convention center.
Transform 66 – Outside the Beltway	TBD	TBD	Citi is serving on the underwriting team for the Cintra-led consortium for the design, construction, financing, operation, and maintenance for greenfield express lanes on I-66 in Northern Virginia.
Denver Great Hall	TBD	TBD	Citi is serving as senior book-running manager for the Ferrovial-led consortium for the design, construction, management, maintenance and financing of a redeveloped Great Hall in the main terminal at Denver International Airport.
UMass Boston Student Housing Project	\$130 mm	2016	Citi served as senior manager with the Provident Resources Group on a transaction to finance the development of a new 1,077-bed student housing facility on the campus of the University of Massachusetts.
City of Scranton Parking Concession	\$38 mm	2016	Citi served as sole manager with the National Development Council for this transaction. The project was a concession and lease payment to the City of Scranton via the Scranton Parking Authority to acquire a 45-year leasehold interest and certain rights with respect to the Structured Parking System and Metered Parking System in Scranton, Pennsylvania and fund essential structural capital improvements to the system

Project	Amount Financed	Financial Close	Citi's Role / Project Description
LaGuardia Airport Terminal Building	\$2.4 bn	2016	Citi served as senior manager for the Meridiam / Skanska consortium for the design, construction, and financing of the LaGuardia Airport Terminal Building P3, which will replace the central terminal building, supporting facilities and infrastructure as part of the Port Authority of New York and New Jersey's efforts to improve airport and regional mobility.
Natgasoline LLC Project	\$532 mm	2016	In April and August of 2016, Citi served as senior manager and initial purchaser for two separate non-investment grade limited offerings for Natgasoline LLC, totaling over \$532 million, to finance a methanol production facility.
State Highway 288 Project	\$273 mm	2016	Citi served as lead senior manager for the ACS Infrastructure Development / InfraRed Capital Partners / Shikun & Binui consortium for the design, construction and financing of managed lanes in Harris County, Texas.
I-77 HOT Lanes Project	\$100 mm	2015	Citi served as senior bookrunner for the Cintra Infraestructuras / Aberdeen Global Infrastructure Partners consortium for the design, construction and financing of high occupancy toll lanes in the existing I-77 corridor in Mecklenburg and Iredell Counties in North Carolina.
I-69 Section 5 Project	\$244 mm	2014	Citi served as lead underwriter for the Isolux Infrastructure and Infra PSP consortium. The project is the design, construction and financing of the upgrade of 21 miles of State Road 37 to interstate highway standards.
VitAg Florida LLC Project	\$64mm	2014	Citi served as senior manager for the Fertilizer Revenue and Construction Risk bonds to finance the acquisition, construction and equipping of solid waste disposal facilities, consisting of a biosolids-to-fertilizer facility and related assets.
Iowa Fertilizer Company Project	\$1.2 bn	2013	Citi served as senior manager to Orascom for the Midwestern Disaster Area Revenue Bonds to finance a nitrogen facility in Iowa.
North Tarrant Express – Segment 3A/3B	\$274 mm	2013	Citi served as financial advisor to the Cintra and Meridiam consortium for the design, construction, and financing of managed toll lanes in the Dallas-Fort Worth area.
Continental Airlines Project	\$630 mm	2012	Citi served as senior manager for the Special Facility Revenue Bonds Remarketing related to terminal improvements at Newark Liberty International Airport.

Resumes

Lead Financing Team

CHRISTOPHER MUKAI
Managing Director
Co-Head of Western Region

Los Angeles
 (213) 486-8992
christopher.mukai@citi.com

Throughout his 26-year career in public finance, Chris has helped U.S. state and local governments complete over 800 financings and raise over \$375 billion for infrastructure and working capital needs. Prior to joining Citigroup in 2001, Chris spent 10 years in public finance for Merrill Lynch in Los Angeles. In addition to managing the firms' overall public finance practice in the Western U.S., Chris has general coverage responsibility for the firm's Los Angeles, Orange and San Diego County public finance clients, as well as the State of California and all its related departments and agencies. Two of his financings have garnered "Deal of the Year" status from Governing magazine: San Bernardino County COPs (1995) and San Diego County POBs (2002). He also served as Senior Banker for the San Diego Unified School District's \$485 million GO bond financing which was recognized by The Bond Buyer as Far West and National Deal-of-the-Year in December 2016. Chris is also Citi's senior West Coast real estate finance expert, having completed over 50 development and redevelopment financings and over 100 lease financings with a total par value exceeding \$10 billion for California issuers such as the State of California; the counties of Orange, Los Angeles, Santa Clara, San Bernardino, and San Diego; and the cities of Las Vegas, Sacramento, Anaheim, Los Angeles and San Diego. Chris' P3 real estate project finance experience includes non-recourse project financings for the City of Sacramento (Sheraton Grand Convention Center Hotel Project) and the City of Overland Park, Kansas (Sheraton Convention Center Hotel Project), and a hotel lease financing for the City of Montebello (Home2Suites). Of particular note, Chris served as the lead banker for the Griffin|Swinerton team's Orange County Civic Center Infrastructure Improvement Program Phase I and Phase II financings that was closed earlier this year. He graduated with highest honors from UCLA with a degree in Economics/Business and is a Municipal Securities and General Securities Principal (Series 7, 24, 53 and 63).

STEPHEN FIELD
Director
Western Region

Los Angeles
 (213) 486-7197
stephen.field@citi.com

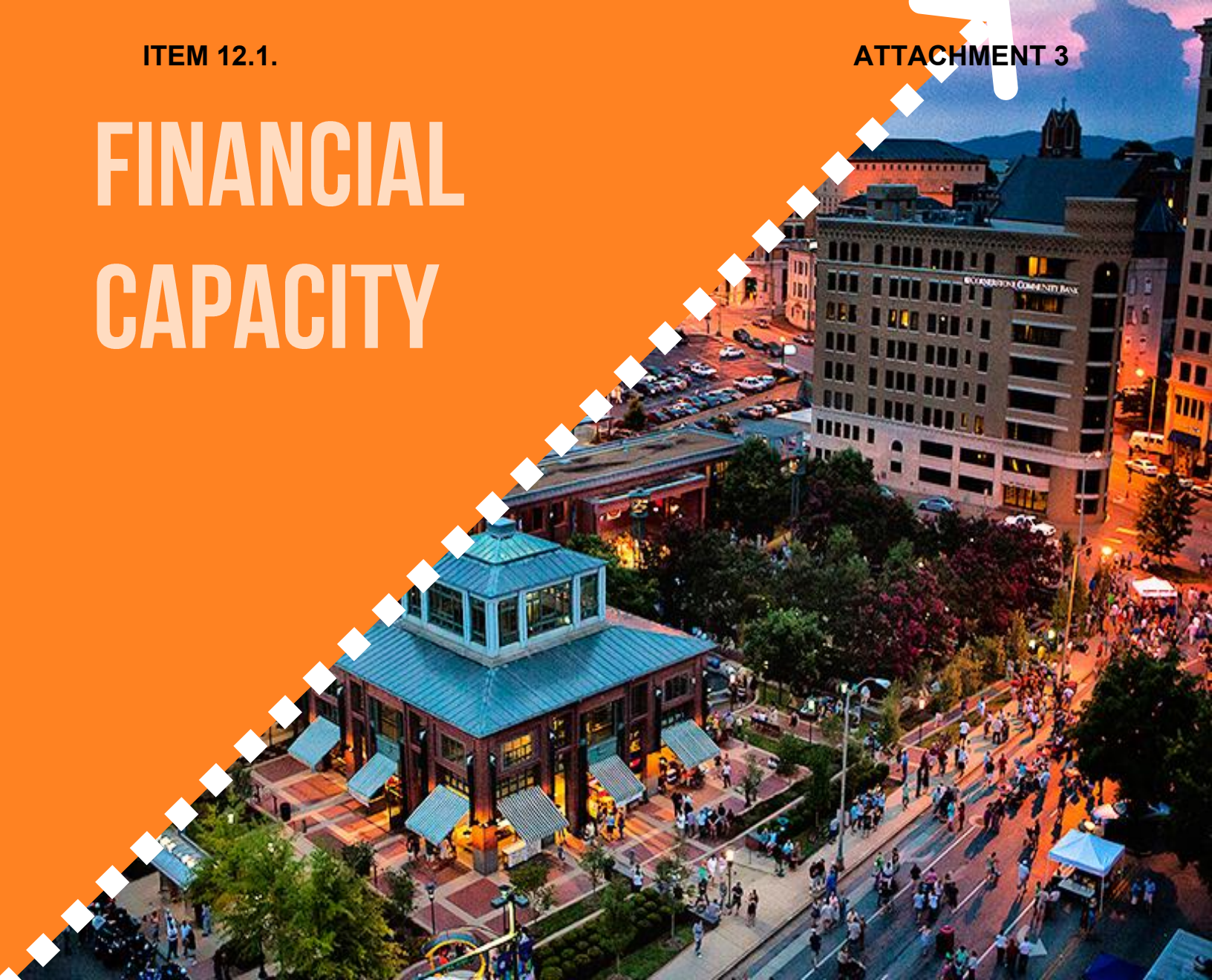
Stephen has been with Citi since 2011 and specializes in leading Citi's efforts with Western Region social infrastructure projects. Most recently, he helped lead Citi's efforts on the Orange County Civic Center Infrastructure Improvement Program Phase I and Phase II Civic Center Improvement financings. He has worked extensively with issuers throughout California and the Western region and his social infrastructure P3 experience includes senior managed financings for Orange County, the City of Montebello and Government of Guam in addition to lease revenue and COP financing experience for Los Angeles County, Ventura County, Contra Costa County, Douglas County Nevada and the Government of Guam. Stephen has a M.S. in Finance from the University of Arizona, a B.S. in Finance from the University of Missouri. Stephen is a registered representative and holds Series 7, 63 and 79 licenses.

DEVIN DILLARD
Associate
Western Region

Los Angeles
 213.486.7197
devin.dillard@citi.com

Devin joined Citi's Los Angeles Public Finance Department in August 2016 from Citi's Quantitative Structuring Group in New York. He regularly provides analytic and quantitative support for issuers in California, with a focus on the State, city and county issuers including the City of San Diego and County of San Diego. Devin's other experience includes assisting in financings for the City of Los Angeles, County of Los Angeles, State of Hawai'i, the San Diego County Water Authority, the Metropolitan Water District of Southern California, the Port of Long Beach, McCarran International Airport, the District of Columbia, the State of Connecticut, and the Massachusetts School Building Authority among others. Devin received a Bachelor of Arts degree in Economics from Washington and Lee University in Virginia.

FINANCIAL CAPACITY



Financial Capacity
Statement

Financial Partners'
Letters of Support



Financial Capacity
Statement

FINANCIAL CAPACITY

One of the Team's greatest assets is its financial strength and expertise. This includes significant net worth and liquidity, access to capital, financial flexibility, and ability to minimize risk.

GRIFFIN|SWINERTON

Griffin|Swinerton has the financial capacity to manage this project and provide the necessary management all the way through construction to final delivery. Griffin|Swinerton offers the following three letters and financial statements as evidence of our ability and our intent to finance the design, entitlements, construction, and completion of the community facilities within Mills Station. The attached letters are from City National Bank, Citigroup (Citi), and Zurich North American Surety.

- The letter from City National Bank evidences our Team's ability to finance the project with conventional construction loans and corporate lines of credit to fund pre-development expenses.
- The letter from Zurich North American Surety evidences Griffin|Swinerton's financial capacity to guarantee the completion of construction with performance and completion bonds.
- Financial qualifications provided by Citigroup (Citi) demonstrate our track record of working together to execute industry-leading public-private partnerships (P3s) and close privately issued tax exempt bond offerings.

Leveraging the relationships described in this section and more, Griffin|Swinerton has successfully reached financing close on nearly \$500 million of construction within the past two years, including:

- | | |
|---|--------------------------|
| • County Administration North (Building 14), County of Orange | \$200 million (Dec 2018) |
| • County Administration South (Building 16), County of Orange | \$188 million (Jun 2017) |
| • Police Services Headquarters Building, City of Salinas | \$55 million (Jun 2018) |
| • El Gabilan Library, City of Salinas | \$21 million (Jun 2018) |



Jim Edson | Senior Vice President
Commercial Banking Services
Tel: (925) 274-5125 Fax: (925) 274-5138

September 9, 2019

Ms. Laura Fickle
City of Rancho Cordova
2729 Prospect Park Drive
Rancho Cordova, CA 95670

**SUBJECT: Griffin/Swinerton, LLC
Mills Station District**

Dear Ms. Fickle:

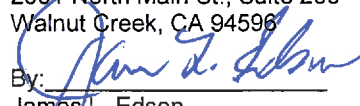
We understand that Griffin/Swinerton, LLC ("the LLC"), of which Swinerton Builders and Griffin Structures, Inc. are Members, is leading a development team that is proposing on the "P3" delivery of the approximately 10-acre Mills Station District project as a Mixed-Use Community District and Public Plaza contemplated by the City of Rancho Cordova ("City"). City National Bank ("the Bank") is pleased to provide information about Swinerton Incorporated ("the Company") and its 14-year long credit and deposit relationship with the Bank.

The Company is a valued customer relationship for City National Bank. The Bank makes available to the Company an unsecured revolving line of credit in the amount of \$75,000,000. In accordance with banking practices the revolving line has a scheduled date for review, renewal and extension on December 31, 2021. There is no balance owing and outstanding under the line at this time. The Company has met all of its commitments to the Bank in connection with this facility and remains in full compliance with agreements.

The Bank also provided a credit facility to finance a "P3" library project for Griffin/Swinerton, constructed by Swinerton Builders. That project encompassed successful development and financing by Griffin/Swinerton for the County of Los Angeles' Quartz Hill Public Library. Griffin/Swinerton met all responsibilities to the Bank in connection with that facility. The Bank will be interested in considering financing for the subject Mills Station District Mixed-Use Development, subject to fulfillment of its usual due diligence.

Additionally, the Company maintains cash on deposit with the Bank in dollar amounts that consistently average a mid-eight figure balance. The Company's checking accounts have always been handled satisfactorily as agreed and the Bank has never returned a check presented for payment due to insufficiency of funds. The Company's relationship has at all times been very satisfactory for the Bank.

The Bank can recommend Swinerton Incorporated, Swinerton Builders and Griffin/Swinerton, LLC on the basis of highly satisfactory experience with day to day dealings. Should you have any further questions or need to speak with the Bank directly, please contact me by phone at (925) 274-5125.

Sincerely,
CITY NATIONAL BANK, ABA#122016066
2001 North Main St., Suite 200
Walnut Creek, CA 94596
By: 
James L. Edson
Senior Vice President (925) 274-5125

ITEM 12.1.

Christopher Mukai
Managing Director

One California Plaza
300 S Grand Ave, Suite 3110
Los Angeles, CA 90071

T 213 486-8992
F 213 486-8919
christopher.mukai@citi.com

ATTACHMENT 3



September 17, 2019

Confidential

Attention: Mr. Korin Crawford
Griffin|Swinerton
2 Technology Dr.
Irvine, CA 92618

Dear Korin:

Citigroup Global Markets Inc. ("Citi") is pleased to submit this letter of support to Griffin|Swinerton in connection with its response to the Request for Proposals ("RFP") submitted to the City of Rancho Cordova (the "City") for the Mills Station District P3 Master Development Opportunity (the "Project"). This letter serves to demonstrate Citi's interest in potentially serving as an underwriter in connection with the financing for the Project.

As the #1 ranked firm in the California public finance market, Citi has extensive track record of successfully executed financings for projects similar in size and nature to the City's Project. Most relevant to the City's contemplated Project, Citi senior managed the financing of the County of Orange's ("the County") Phase I and II Civic Center Improvement Program. Working with the Griffin|Swinerton team, Citi developed a unique financing structure which allowed the County to take advantage of the efficiencies of a P3 structure while utilizing the County's high credit quality to borrow at the lowest cost to fund the project. Citi is also currently engaged as senior managing underwriter by Griffin|Swinerton on the financing of the "Riverside Alive" Mixed-Use Development and Convention Center expansion project, which will once again seek to utilize the Citi and Griffin|Swinerton modified P3 delivery model to transform downtown Riverside in what is anticipated to be one of the most significant developments in the City's recent history.

Additionally, Citi has been integrally involved with U.S. state and local governments as well as governmental entities in financing and advising on P3 transactions for the past 30 years. Our P3 experience exceeds 100 transactions in the U.S., running the gamut of asset classes, including student housing, transportation, conventional and renewable energy, solid waste disposal, water and wastewater collection and treatment, hotels, real estate, and air and sea ports. Citi presents considerable experience structuring P3s around unique federal, state and local tax and other requirements.

Citi is providing the information contained in this letter for discussion purposes only in anticipation of serving as an underwriter in connection with the financing for the Project. This letter is not a recommendation by Citi that Griffin|Swinerton or the City take any action related to the transaction contemplated by this letter. If appointed as an underwriter, Citi may provide Griffin|Swinerton, from time to time, with advice concerning the structure, timing, terms, and other similar matters concerning a debt issuance that Citi is seeking to underwrite. However, in connection with such underwriting services, Citi would propose to serve solely as an underwriter and not as a financial advisor. The primary role of Citi, as an underwriter, is to purchase securities, for resale, in an arm's-length commercial transaction between the issuer of the securities and Citi. In its role as underwriter or purchaser, Citi would have financial and other interests that differ from those of the issuer. Moreover, when Citi acts as underwriter, Citi is not acting as a "municipal advisor" or providing "advice", within the meaning of such terms as set forth in Section 15B of the Securities Exchange Act of 1934.

Please note that this letter is for informational purposes only and may not be relied upon by any party for any purposes. This letter shall not create any legal obligations on our part, including, without limitation, any commitment to provide financing to Griffin|Swinerton in connection with the Project. We reserve all rights to

conduct full due diligence and shall have sole discretion as to whether or not we will participate as an underwriter in connection with the financing of the Project. We are, however, extremely interested in continuing our communications with Griffin|Swinerton and evaluating the possible role we may play as a potential underwriter for the Project in the future. Actual underwriting of any debt financing in connection with the Project would be subject to, among other things (a) satisfactory completion of Citi's customary due diligence review, (b) the consummation of the Project, including the underwriting of any securities, on terms and conditions and pursuant to documentation satisfactory to Citi; (c) the receipt of any necessary governmental, contractual, regulatory, board of directors or security holders' consents or approvals; and (d) the absence of any material adverse change to the Project or to the financial markets generally.

For clarity, nothing in this letter should be considered to constitute, or be construed as, an offer or proposal by, or obligation of, Citi or any of its affiliates to proceed with any transaction, including the Project. Nothing herein is intended to create a binding obligation upon Citi or its affiliates, and no past or future action, course of conduct or failure to act relating to the Project or relating to the negotiation of terms of any possible definitive agreements shall give rise to any obligation or other liability on the part of Citi or its affiliates.

This letter and the terms and conditions hereof are confidential. This letter is being delivered solely for use by you and based on the understanding that no disclosure of, or reference to, this letter shall be made to any person or entity other than Griffin|Swinerton, and its directors and senior officers who (i) are directly involved in the Project, (ii) require such disclosure in connection with such involvement and (iii) who agree to be bound by this confidentiality provision (each a "Recipient"); provided, however, that Griffin|Swinerton may include this letter in connection with its response to the RFP, provided that (i) the full text of this letter is reproduced in Griffin|Swinerton's response to the RFP (including, without limitation, the "Confidential" header) and (ii) Citi has approved in advance any disclosure in Griffin|Swinerton's response to the RFP referring (directly or indirectly) to Citi and/or this letter. In the event that any Recipient is required by law or regulation to disclose this letter or any term or condition hereof, such Recipient shall promptly provide us with notice prior to such disclosure.

Neither Citi nor any of its affiliates shall have any liability (whether direct or indirect or in contract, tort or otherwise) to Griffin|Swinerton, or any member thereof, or any other person, including, without limitation any member of Griffin|Swinerton respective security holders, claiming through their respective companies or Griffin|Swinerton, as the case may be, for or in connection with the delivery of this letter.

We appreciate the opportunity to continue to work alongside you on this important financing.

Sincerely yours,

CITIGROUP GLOBAL MARKETS INC.

By: 

Christopher Mukai
Managing Director



Zurich North America Surety

525 Market Street, Suite 2900
San Francisco, Ca. 94105

Phone: 415-538-7100

Fax: 415-538-7366

<http://www.zurichna.com>

September 6, 2019

City of Rancho Cordova
2729 Prospect Park Drive
Rancho Cordova, CA 95670RE: Griffin/Swinerton, LLC
Mills Station District Mixed-Use Community Building(s), Housing, and Public Plaza

To Whom It May Concern:

The surety requirements for Griffin/Swinerton, LLC, are handled by Fidelity and Deposit Company of Maryland NAIC #39306, Contact: Tim Jacobson, 525 Market Street, Suite 2900, San Francisco, California 94105, Telephone (415) 538-7363, in partnership with Liberty Mutual Insurance Company, NAIC #23043 Contact: Lisa Merlin, 71 Stevenson St., Suite 600, San Francisco, CA, 94105, Telephone: 415/777-1307 ext. 34850, Fax 415/896-9072, both California Admitted Carriers authorized to issue surety bonds in the State of California, and highly regarded surety companies.

Zurich American Insurance Company and/or its subsidiary, Fidelity and Deposit Company of Maryland and Liberty Mutual Insurance have provided surety credit to Griffin/Swinerton, LLC for single projects to \$500,000,000 in the past and for an aggregate level of \$5,000,000,000. Zurich/F&D is rated "A+" (Superior) with a financial size category of XV (\$2 billion+) by AM Best and has a US Treasury Limit of \$638,519,000. Liberty Mutual Insurance Company is rated "A" (Excellent), Class XV and has a US Treasury Limit exceeding \$1,289,139,000. Arthur J. Gallagher & Co., 1255 Battery Street, Suite #450, San Francisco, CA 94111 has been the Surety Broker for Griffin/Swinerton, LLC for over 27 years.

If Griffin/Swinerton, LLC is awarded a contract and requests that we provide the necessary Performance and/or Payment Bonds, we will be prepared to execute the bonds subject to our acceptable review of the contract terms and conditions, bond forms, appropriate contract funding and any other underwriting considerations at the time of the request.

Our consideration and issuance of bonds is a matter solely between Griffin/Swinerton, LLC and ourselves, and we assume no liability to third parties or to you by the issuance of this letter.

We trust that this information meets with your satisfaction. If there are further questions, please feel free to contact us.

Very truly yours,
Fidelity and Deposit Company of Maryland

Liberty Mutual Insurance Company

Betty L. Tolentino, Attorney-in-Fact

Betty L. Tolentino, Attorney-in-Fact

BLT:jcr

FINANCIAL CAPACITY TO DEVELOP THE PROJECT

Related California is among the largest developers of affordable housing and mixed income housing in the state. Since its inception 30 years ago, we have successfully closed financing and completed construction on 96 Low Income Housing Tax Credit (LIHTC)-financed developments totaling nearly 11,000 affordable units. These projects support working families and individuals within a wide range of incomes from extremely low to moderate.

Our strength as a developer is evidenced by our continued organizational health during economic downturns. During the last recession in 2007, Related closed escrow on five deals, completed seven new developments, totaling 892 units, and rehabilitated additional affordable housing units.

Related's portfolio reveals the breadth and depth of our understanding of public and private resources and how to best leverage them to produce much needed affordable housing. We have experience with the following funding sources:

- Low-Income Housing Tax Credits (LIHTC) (4% and 9%)
- Tax-Exempt Bond Financing
- Multifamily Housing Program (MHP) funds
- Proposition 1C Transit Oriented Development (TOD) funds
- Proposition 1C Infill Infrastructure Grant (IIG) funds
- Affordable Housing Program (AHP) funds
- Low/Mod set-aside funds
- Neighborhood Stabilization Program (NSP) funds
- Community Development Block Grants (CDBG) funds
- Project-Based Section 8
- HOME funds
- Rental Assistance Demonstration (RAD) funds
- HOPE VI
- Mental Health Services Act (MHSA) funds
- Affordable Housing and Sustainable Communities (AHSC) funds

Related California is backed by The Related Companies, L.P., one of the most prominent privately owned real estate firms in the nation with a portfolio of over \$60 billion in development. Related California is able to set itself apart from most of its competitors as this level of volume creates unparalleled financing capacity and substantial purchasing and negotiating power, along with lower construction, operating and marketing costs.

Related's significant net worth and liquidity provide the capacity and flexibility needed to execute the largest and most complex real estate development and investment opportunities. In addition to its own financial resources, Related has an extraordinary track record of securing third-party debt and equity financing for both single assets and large-scale, mixed-use development projects.

Related enjoys longstanding relationships with the largest and most active providers of real estate debt and equity capital. Related has recently secured debt financings from Wells Fargo, JP Morgan, Bank of America, Deutsche Bank, Fannie Mae, Freddie Mac, Bank of China and HSBC, among others.

Related has also historically been the largest user of tax-exempt bonds for mixed-income rental housing in California. We have generally utilized low floater tax-exempt debt, supported by an equity letter of credit from a large pension fund, together with low-income housing tax credits to enhance returns on these projects, ultimately providing our local agency partners maximum leverage for their investment.

ABILITY TO OBTAIN ENTITLEMENTS

Related California has an extensive track record of executing and developing some of the most creative, ambitious, and highly-complex mixed-use housing developments in the country. We are a fully-integrated company with unique access to in-house professionals experienced in architecture/design, planning/entitlements, finance, construction and property management.

The resourcing of these initial efforts will be led by a team of Bay Area-based Related executives with decades of experience in complex entitlements, delivery of large-scale mixed-use projects and delivery of market-rate and mixed-income housing throughout California. Of particular note is Related's unparalleled success in entitling and successfully adjudicating the City Place project in Santa Clara. This 9.2 million square foot, mixed-use master plan will be a walkable, town center development, delivering an exceptional live, work, play environment that will come to define the center of Silicon Valley. It also required extensive involvement with regional agencies including California Department of Transportation, Santa Clara Valley Transportation Authority, San Francisco Bay Regional Water Quality Control Board, California Department of Resources Recycling and Recovery, Santa Clara County Lead Environmental Agency and more.

Our impeccable performance history and success rate in obtaining entitlements for our developments provides our partners, governments, cities, housing authorities and redevelopment agencies with peace of mind that Related has the proficiency to successfully obtain entitlements. Related has successfully led and completed the entitlement process on 96 tax credit financed developments, of which 74 were new construction developments.

EFFECTIVENESS TO PROVIDE AFFORDABLE HOUSING

Since its founding in 1989, Related California has been staunchly committed to affordable housing. It owns and operates over 20,000 units in California and has never converted a single unit to market rent. Related also has extensive experience in workforce housing and created new financing models in partnership with the cities of New York, Boston and San Francisco to deliver much needed residences across various income levels. The company has deep relationships with federal, state and local governments to access programs and financing to see these projects through to completion.

Related California operates on a 'build and hold' business model which means we invest for the long term. This allows us to transform neighborhoods and create new spaces that add value and build communities. We develop assets that stand the test of time and seamlessly integrate within the community. Ultimately, contributing to the surrounding neighborhood for generations. We take a holistic approach, from entitlements to lease-up, maximizing the potential of every development with real-time knowledge related to costs, financing options, and best practices.

Related is a fully-integrated development company with 30 years of experience and a portfolio of 96 completed tax-credit financed developments with more than 14,000 units of low-income housing tax credit units in California. Related California's current pipeline consists of 1,000 units under construction and 1,300 units in pre-development.

Related has been applauded for excellence in project design, planning, neighborhood development and company achievement. In the past five years, Related has received over 20 awards, ranging from the Global Award for Excellence from the Urban Land Institute to the Housing and Community Design Award for Excellence from the American Institute of Architects and the U.S. Department of Housing and Urban Development.

**Mills Station District
Letter of Interest**



Presented by

SKK Developments | C2K Architecture | The Hodgson Company
Cunningham Engineering | Bill Blake, AMS Planning & Research
FPI Management | Pioneer Law Group

Sotiris K. Kolokotronis
SKK Developments
1121 18th Street
Sacramento, CA 95811
916-449-8989
sotiris@skkdevelopments.com

September 20, 2019

City of Rancho Cordova
Community Development Department
2729 Prospect Park Drive
Rancho Cordova, CA 95670

Dear City of Rancho Cordova - Community Development Department,

On behalf of SKK Developments and our entire team, please accept this response to the City of Rancho Cordova's Request for Letters of Interest for Mills Station District. Our development team has decades of experience in mixed-use, infill projects that have leveraged the talents and investment of multiple public and private partners, and we are excited for the opportunity to collaborate with the City of Rancho Cordova on this catalytic development.

Our team has put together a proposal that reflects the City of Rancho Cordova's vision for this project and addresses the City's top priorities as identified in the Request for Letters of Interest. Our proposed design is centered around a public plaza featuring both indoor and outdoor performance spaces, an arts and market hall, wellness pavilion and community center. In keeping with the vision set forth by the City of Rancho Cordova, the development will be designed to host a wide range of cultural and recreational programming, bringing together residents, visitors, students, light rail commuters and the greater community. It will also include 640-700 residential units, commercial and retail spaces and parking across eight buildings.

We have assembled a development team with the experience and capabilities to bring Mills Station to its full potential. Over the last 30 years, SKK Developments has been involved in the development of six master-planned communities, 7,000 residential home sites, 1,500 multi-family units, 2,000 homes, and 300,000 square feet of commercial buildings in four states, valued at over \$1.7 billion. SKK Developments currently has nearly 500 residential units under

construction and another 1,700 units in the entitlements and planning process. Together these projects represent nearly \$650 million worth of investment in the Sacramento region.

The City of Rancho Cordova's forward-looking vision for the Mills Station District will have an indelible impact, not just on this neighborhood but on the entire region. At the local level, it will serve as a gathering space for an already dynamic community, provide much-needed housing, and attract even more development to the area. From a regional standpoint, the project will bring density that will increase light rail ridership and complement the activities around Folsom Lake College. Our team shares the City's vision and has the experience, passion and financial capabilities to develop Mills Station to its full potential.

We look forward to discussing the details of our proposal with you.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Sotiris K. Kolokotronis', with a long horizontal flourish extending to the right.

Sotiris K. Kolokotronis
SKK Developments

MILLS STATION DISTRICT PROJECT NARRATIVE

The City of Rancho Cordova issued this Request for Letter of Interest following months of planning, including multiple visioning sessions and needs assessments. We have reviewed the results of these sessions and studies carefully and have taken them into close consideration in our proposed project approach. A member of our team, Bill Blake, is a Director at AMS Planning & Research, which conducted the Rancho Cordova Performing Arts Feasibility Study, and played a key role in the selection of cultural and recreational amenities. We drew on our experience developing urban infill mixed-use projects in other cities, most notably in Sacramento's Midtown and Portland's Pearl District. Above all, we are seeking to create a destination that will serve as a cultural hub, spur economic growth, increase light rail ridership, complement the activities around Folsom Lake College, support community health and wellness, bring together diverse populations and instill a sense of pride and ownership among the community.

I. PROJECT OVERVIEW

Our proposal is a mixed-use project centered around a public plaza featuring both indoor and outdoor performance spaces, a wellness pavilion, arts and market hall and community center. The design includes eight buildings containing 640-700 residential units, commercial and retail spaces and parking. Our goal is to create a design that is open, accessible and inviting – a place that will serve as a community resource and gathering place, not just for Mills Station residents but for the entire region.

Public Amenities

The development will include four multi-level buildings and multiple outdoor spaces dedicated to public amenities including:

- **Arts & Market Hall, *a first for the Sacramento area***, with artist's studios (long term tenants and community drop in), coworking and classroom space, an arts and music lending library, art exhibition and retail opportunities, as well as cafe and food purveyor space. Adjacent to the Arts & Market Hall is an outdoor green for periodic farmers or arts markets that also provides a verdant welcome to visitors and residents.¹

¹ Please note that the renderings in Appendix A feature a Market Hall and Cultural Center in two separate buildings. We plan on combining these into one Arts & Market Hall, creating the first such structure in the region.

- **Central Public Plaza** with a small amphitheater, covered event/yoga pavilion, and ample parklike landscaping. The plaza is surrounded by a circular drive that can be closed for large special events.
- **Flexible Performance and Event Space** for performances, rehearsals, classes or events, outfitted with modular seating, lighting grid, entry lobby, and smaller adjacent rooms for breakout sessions, storage or “backstage” use.
- **Wellness Pavilion** featuring both indoor and outdoor fitness spaces, including a basketball court.
- **Community Center** with ground floor retail, meeting/classroom space, daycare and outdoor children’s play area including a splash pad and playground.

Public Programming

Our project aims to create spaces that both have a strong sense of identity, but are highly flexible, to allow for programming to expand and iterate over time. These spaces would be programmed by and funded with the collaboration of local partners and potential retail, civic, or educational tenants. Programming that our spaces might support are:

- Artists in Residence - performing or visual artists are invited to live in the residential units while working/teaching/performing in the various spaces on site
- Farmers and Artisan Markets
- Art Classes and Exhibitions
- Outdoor Yoga and Fitness Classes
- Youth Basketball Workshops
- Concerts, Comedy Shows, Plays
- Town Halls
- Educational Lectures and Forums
- Study Groups
- “Walk” or “Jog-A-Thons” (circular drive)

Residential Program

The residential program includes a mix of rental units across four multi-level buildings. These units would be market rate or possibly an 80/20 mix of market and affordable housing. The average unit size is 780-800 square feet, and features include 10’ to 12’ ceilings, abundant natural light, modern finishes, balconies and ample storage. Residential amenities might include:

- Fitness Center
- Secure Parking Garage

- Bike Storage
- Swimming Pool
- Fitness Center
- 24-Hour Package Lockers
- Pet Spa
- Free High-Speed Wi-Fi Hotspots
- Controlled-Access Building
- On-Site Management
- Smart Home Systems
- Full-Sized Washer-Dryers
- Keyless Entry

Parking, Transportation and Pedestrian Accessibility

Our project would encourage visitors and residents to utilize light rail, ridesharing services and other alternative modes of transportation:

- A raised footpath from the light rail station encourages foot traffic from commuters and provides a safe entry into the community
- ADA accessibility
- Ample bike racks for visitors
- Indoor bike rooms for residents
- Electric vehicle charging stations
- Ridesharing stations

In addition, we would provide sufficient parking for residents and visitors with:

- On-site street parking
- On-site secure underground garage parking
- Adjacent, off-site parking through partnerships with other property owners in the area, in particular RT and Folsom Lake College.

Our goal is to optimize the resources of the project and maximize public benefit through thoughtful collaboration with our neighbors.

II. INCLUSIVE PROJECT APPROACH

Our development team welcomes a collaborative and inclusive project delivery approach with the City of Rancho Cordova, Folsom Lake College, Regional Transit, other public agencies, private partners, and other stakeholders. Our goal is to develop the best possible project for Mills Station, and we consider those groups critical members of our larger team and vital to our project success. Our team's strength is our ability to listen and work with everyone at the table to find the best solution for this site, regardless of organization or role. We have extensive experience working with public sector partners to deliver successful projects and transform neighborhoods, and we are bringing the full weight of that experience to bear on this project.

We are also committed to the idea that people should be given the opportunity to input decisions imposed by institutions that affect their lives. As such, we fully support community forum and public outreach methods and look forward to additional opportunities for this type of engagement. We have already been in contact with Folsom Lake College (Rancho Cordova Center), Cordova Parks and Recreation Department, the Folsom Cordova Community Partnership and other groups that participated in the visioning sessions, and we will continue working with the greater Rancho Cordova community if selected for this project.

We are also cognizant of the very diverse and multilingual population in this area and will be sensitive to their needs for services and integration into the community.

III. FINANCING APPROACH

Capitalization for this project will come from a variety of public and private sources. Our plan is to utilize City funding for infrastructure, public spaces and any potential required environmental remediation. The housing will be market rate units and will be financed entirely with private capital (both debt and equity). The development team has strong investor and lender connections. Over the last four decades, the members of the development team have capitalized projects valued at more than \$1.7 billion.

Furthermore, we contemplate utilizing Opportunity Zone tax incentives and transit-oriented development funds allocated through federal, state and regional agencies. The development team is also evaluating the allocation of 20% of the units as affordable housing, which would make additional funding available in the form of tax credits and tax-exempt bonds.

IV. OUR DEVELOPMENT TEAM

Our team's ability to design, finance and build urban infill mixed-use projects in the region is unmatched. Integral to our development vision is the belief that not only is residential density the most sustainable way to live, it also cultivates the most exciting and attractive of neighborhoods.

We also have a history of commitment to the arts communities, both as individual artists, collectors and art administrators, and collectively, through our charitable support of arts organizations and by hiring local artists to activate our buildings with their work. In 2018, we hosted 300 high school students for an immersive art festival to raise money for public art education. We are celebrating the opening of H16 Apartments with a five-story immersive theatrical event in March 2020, and we are wrapping an entire building with a mural during Wide Open Walls 2020. Our passion for the arts and vast network in the creative community, combined with our unparalleled experience in urban infill mixed-use developments, makes us uniquely qualified for the Mills Station development opportunity.



Sotiris Kolokotronis
Founder & President

Sotiris K. Kolokotronis is the Founder and President of SKK Developments, a real estate firm that specializes in mixed-use, multi-family and land development projects.

Sotiris began his real estate career in 1985. Since 1987, he has been involved as principal in developing more than 7,000 residential home sites, 2,000 single family homes, 2,000 multi-family units and 300,000 square feet of commercial buildings in Northern California, Colorado, Nevada and Oregon valued at \$1.7 billion.

His projects have played an important role in shaping the landscaping of the Sacramento region, and in particular the renaissance of Midtown Sacramento since the early 2000s with the development of a number of urban mixed-use projects. These projects – L Street Lofts, 1801L, The Fremont Building, Capitol Park Homes, Q19 Apartments and 20PQR Townhomes – contain 501 ownership and rental residential units and 32,000 square feet of retail space; valued at \$235 million.

Sotiris is currently involved in the development of seven additional projects in Sacramento's Midtown and other infill locations – The Press Building, H16 Apartments, E16 Apartments, 15th & G, Mansion Apartments, Arden Gateway, and Natomas Fountains – containing 1,700 residential units valued at approximately \$650 million. He is also involved in the planning and entitlement of 3,000 acres.

SKK's projects and team have been recognized by numerous, respected agencies and organizations for pioneering designs and incorporating principles of smart growth, including:

- 2019 NAIOP "Person of the Year" (Sotiris Kolokotronis)
- 2019 Sacramento Business Journal Real Estate Project of the Year for Q19 Apartments
- 2009 Community Services Planning Council People Helping People Award for Executive Leadership
- SACOG 2005 Regional Business of the Year Award
- 2005 Comstock's Vanguard Award

- 2006 North State Building Industry Achievement Award
- 2006 Sacramento Business Journal Real Estate Project of the Year and Best Infill Project for 1801 L Street
- 2007 Sacramento Mutual Housing Association Community Development Award for Smart Growth

Sotiris has been involved and supportive of many civic, cultural, political and philanthropic organizations. He is currently serving or has served on the boards and committees of:

- City of Sacramento Inclusive Economic and Community Development Investment Committee
- Sac Metro Advocates for Rail and Transit (SMART)
- Sacramento Metro Chamber
- CSUS School of Business Administration
- Education Now!
- Friends of Light Rail and Transit
- Midtown Association
- Handle District
- Salvation Army Advisory Board
- Urban Land Institute, Sacramento District Council
- Sacramento Habitat for Humanity
- Solar Cookers International
- Michael's Episcopal Day School
- Sacramento Urban League
- Sacramento Symphony Association
- Families First
- Youth Development Network
- North State Building Industry Association
- Sacramento Sports Commission

Sotiris is the 2006 University of California, Davis Graduate School of Management Executive-in-Residence, member of the Policy Advisory Board, Fisher Center for Real Estate and Urban Economics, UC Berkeley, Haas School of Business and Senior Fellow of the American Leadership Forum, Mountain Valley Chapter, Class VIII.

Sotiris received his bachelor's degree in economics from the University of Athens, engaged in graduate studies in economics at California State University, Sacramento and earned his MBA degree from the University of California at Berkeley. He and his family reside in Sacramento, California.

**Anastasia Bonaccorso****Vice President of Development & Operations**

Anastasia Bonaccorso is the Vice President of Development & Operations for SKK Developments where she manages the current portfolio, new development opportunities and company operations. Anastasia has over a decade of experience in project, marketing and event management both in the non-profit and corporate sectors including at Stanford University, California Pacific Medical Center, ISEC Partners, UC Berkeley and CMP Media. She graduated Phi Beta Kappa from UC Berkeley's Haas School of Business.

In addition, Anastasia has been involved in the performing arts for more than three decades as an actor, singer, musician, writer and producer. She holds a Masters in Fine Arts from UCLA, graduated from American Conservatory Theatre's Summer Congress, and was selected to study on scholarship with the British American Drama Academy's summer program at Oxford. She has acted in commercials, industrials, short films and extensively in live theatre, choral groups and musical ensembles. She has taught acting at UCLA and B Street Theatre and most recently served as B Street's Director of Community Engagement. Born and raised in Sacramento, she lives in Folsom with her husband David and their toddler Nicolo where when lucky, she finds fifteen minutes to work on her latest unfinished screenplay.



John Hodgson
Founder and President

The Hodgson Company is a Sacramento based real estate development, land use, and government advocacy firm that specializes in the entitlement and development of real estate and land use projects throughout Northern California. The Hodgson Company has been involved in some of the region's most innovative residential and commercial developments, including master planned communities, infill development, and mixed-use projects. The Hodgson Company has a strong interest and experience in urban revitalization, sustainable mixed-use development and economic development.

John Hodgson is Founder and President of The Hodgson Company and has served as a land use attorney, advocate, and project manager for numerous property owner groups in the development of over 11,000 acres of mixed-use master-planned projects throughout the greater Northern California region. Those projects include the Woodland Research Park (Woodland, CA), Davis Innovation Center (Davis, CA), Panhandle PUD (Sacramento, CA), Laguna Ridge Specific Plan (Elk Grove, CA), Folsom South Area Plan (Folsom, CA), Sunridge and Suncreek Specific Plans (Rancho Cordova, CA) and the Elverta Specific Plan (Sacramento County).

John served six years as Chair of the Capitol Area Development Authority (CADA) which is responsible for development of the 42 square blocks surrounding the State Capitol in Sacramento. In his capacity as CADA chair he is credited with contributing to the revitalization of midtown Sacramento. More recently, he has spent considerable time working on infill projects in the City of Sacramento as well as other urban centers in the region.

John is a graduate of UC Davis and UC Davis School of Law (King Hall). He is a former Chair of the Urban Land Institute Sacramento District Council and currently serves on the Boards of the Sacramento Downtown Partnership, Midtown Association and North State Building Industry Association (Chair, Urban Infill Council).

With decades of experience and a distinguished portfolio of successful projects, the Hodgson Company strives to set the highest standard of quality for sustainable real estate development in the greater Sacramento region and beyond.

www.thehodgsoncompany.com



C2K Architecture

In 2010, C2K was founded with just a handful of people in Portland, OR. With them, they brought diverse project experience and a resiliency and resourcefulness necessary given the time. The varied skillsets, intellects talents, and astute sense of leadership that brought these people together laid the foundation for our current practice. Led by Principals Kevin Sauser and John Wright, our current staff totals nearly 30 insightful, creative people whose primary mission is to build and maintain relationships and to work collaboratively with clients, jurisdictions and consultants to find elegant solutions to problems both obvious and those unforeseen. The experience of forging partnerships is as fundamental for the future of our practice as it is in our daily efforts.

Within the disciplines of architecture, planning and interiors, the C2K portfolio includes high rises, mixed-use developments, corporate offices, retail centers, hospitality and entertainment venues, healthcare and fitness facilities, distribution centers, master planning, industrial projects and residential projects of all varieties. This broad range of experience has shown us that lessons learned with one project type often inform another. From our office in Portland, we serve projects and clients across the nation and around the world with a majority of our work located in Northern California. Our work continues to humbly remind us that every person, group or organization we encounter is a neighbor regardless of geography.



Kevin Sauser
Principal, AIA, NCARB

Kevin Sauser will be the principal-in-charge for C2K architecture. Kevin is a co-owner of C2K and has been with the firm since 2011. He has over 24 years of architectural experience with projects ranging from remodels to \$500 million mixed-use developments.



Samuel Sanderson
Associate Principal, AIA, NCARB

Sam Sanderson joined C2K in 2015 after moving to Portland from California. He has over 19 years experience specializing in housing and mixed-use developments. Sam will be the project manager for C2K acting as the primary contact with the City of Rancho Cordova and the design team. He has been the project manager for the Q19, E16, and H16 apartment projects for SKK Developments.

www.c2karch.com



Cunningham Engineering

Cunningham Engineering is celebrating 35 years of successful business relationships and completed projects in the Sacramento region. Originally a single discipline civil engineering firm, the company has evolved over the decades into a multi-discipline, client-focused firm with civil engineers and landscape architects collaborating to provide exceptional service and efficient designs to our clients. With office locations in Yolo and Sacramento Counties, we aspire to find solutions that emphasize sustainability and the quality of the built environment.

Staffing

Our staff includes registered civil engineers, a geoenvironmental and geotechnical engineer, registered landscape architects, landscape and civil designers, CAD technicians, drafters, and graphic designers. Cunningham Principals and Project Managers are directly involved with all of our projects to provide clients with the customer service that has earned us our proven reputation of both design and communication excellence.

Commitment to Client Goals

Clients describe their experience with Cunningham as a partnership that goes beyond mere contract fulfillment and consistently helps them to meet their objectives. The relationships that develop are based on a commitment to thoroughly understand each project, its requirements, and our Clients' expectations.

Our strength lies in the ability to apply this understanding in a proactive and solution-oriented approach to meeting Client needs. A reputation for quality service, technically accurate plans delivered on a realistic timeline, and impeccable integrity has been earned through three decades of serving the region's professional design needs.

Public-Private Partnership (P3) Experience

Cunningham has played an integral role in consulting with the public agency and private partners to make P3 delivery method a viable solution. Cunningham's P3 projects have included Primero Grove, Colleges at La Rue, Davis Commons and Aggie Village, UC Davis West Village, and 8th & Wake Graduate Housing.

Below is a sampling of Cunningham's recent infill and mixed-use projects:

- 9onF Townhomes | Sacramento, CA
- 16 Powerhouse | Sacramento, CA
- 2600 Capitol Avenue | Sacramento, CA
- Cathedral Building | Sacramento, CA
- Del Rio Live-Work | Davis, CA
- East End Gateway, Sites 2 and 3 (16th & O) | Sacramento, CA
- The Elliott Building | Sacramento, CA
- The Ice Blocks Mixed-Use Development | Sacramento, CA
- La Valentina | Sacramento, CA
- MARRS Building | Sacramento, CA
- Mercy Housing 7th & H Streets | Sacramento, CA
- O1 Lofts | Sacramento, CA
- The Press @ Midtown Quarter | Sacramento, CA
- Q19 at Midtown | Sacramento, CA
- Sutter Brownstones | Sacramento, CA
- Sutter Park - Sutter Memorial Site | Sacramento, CA
- Twin Rivers | Sacramento, CA

FPI Management**FPI MANAGEMENT**

FPI has been providing professional property management services to multi-family housing owners for over 49 years. Currently, FPI has in its inventory approximately 110,000 units, located in 14 states.

FPI has developed expertise in a widely diversified inventory of properties. FPI's current portfolio includes "AAA" luxury and conventional apartment communities, as well as properties developed under all low and moderate-income programs i.e., LIHTC, HUD insured, USDA, Bond Financed, and Section 8. FPI's experience in property management has developed a firm whose capabilities will meet the demands of the most sophisticated investor. Our clients include institutional investors, international real estate investment firms, financial institutions, multifamily development builders, private investors, and City, County and State agencies.

FPI is effective in all aspects of property management, from the marketing and lease-up of a newly constructed project, to the on-going operation of a property at sustained occupancy. FPI has established itself as a leader in the industry in the performance of marketing techniques, capital and preventative maintenance programs and administrative control.

FPI is directed by a hands-on Owner/President, CEO who has actively guided the company for over 40 years. Mr. Treadaway has been the Chief Executive Officer in charge of FPI since 1972. He is responsible for the development of the signature company culture that is unique to FPI. Through motivation of the Executive Team: Portfolio Managers, Accounting, IT, HR and Administrative support, Mr. Treadaway assures that the objectives of the FPI clients are being achieved. The corporate culture of FPI is grounded in integrity, respect, and a focus on doing the right thing. These values have been the trademark of the continued success of FPI since 1968.



Rosa Chong
Director

Rosa Chong has been in the multi-family property management industry with FPI Management since 2003. During her tenure, she has managed both Market Rate and Tax Credit Affordable Housing communities, primarily in Northern California with emphasis in the Greater Sacramento Area. Rosa holds a Bachelor of Science Degree in Business Management and Marketing from Sacramento State University, combined with 16 years of experience, her knowledge provides a solid foundation for her Executive oversight of approximately 1,500 units.

www.fpimgt.com



Bill Blake
Director

Bill Blake is a Director at AMS and heads the firm's Sacramento office. He returned to AMS in 2016 after having been a Project Manager from 2000-2005. Prior to rejoining AMS, Bill was the Managing Director of the B Street Theatre in Sacramento. The B Street Theatre produces over 450 performances a year with an emphasis on new plays, provides educational programs reaching dozens of schools and school districts, and offers theatre arts classes in the community. In addition to managing these diverse activities of the company, Bill led B Street in the planning, fundraising, design and development of its new mixed-use performing arts complex, The Sofia Tsakopoulos Center for the Arts, which opened in February 2018.

Bill has been involved in dozens of consulting and planning projects with clients ranging from federal agencies and municipal governments, to small and large not-for-profit organizations; he has developed strategic plans, business plans and feasibility studies for cultural facilities and organizations, including performing arts centers, theaters, museums and interpretive centers, as well as historic theaters. Of note in the Sacramento region, in 2003 Bill lead the AMS team that completed the feasibility study for Folsom Lake College that resulted in the development of the Harris Center for the Arts.

Bill's recent and current projects include partnering with Group 4 Architecture, Research + Planning, Inc. (Group 4) to support the City of Elk Grove in a Library Services and Cultural Arts Facilities Plan for the City's new Civic Center Development. He is assisting the City of Boise as they advance the design of a new event center on the Boise Main Library campus. He is conducting a performing arts feasibility analysis for the California State University, Fresno, to determine the needs, program activities, and scenarios for operation of a new performing arts facility. And he recently assisted the City of Vancouver, British Columbia, in a multi-part study that identified gaps in supply and demand in the City's performing and cultural arts infrastructure.

Prior to joining AMS in 2000, Bill was the General Manager of the Everett Performing Arts Center and served as an administrator at the Village Theatre, both located in Washington State. Bill also worked as an arts educator at the Seattle Children's Theatre and the Idyllwild Arts Academy in Southern California.

Bill has a Master's in Arts Administration from Goucher College in Baltimore and an undergraduate degree in Theatre Production from Principia College in Illinois. He lives in Sacramento with his wife and daughter and remains an active member of the arts community.

www.ams-online.com



Andrea Matarazzo
Founding Partner

Andrea Matarazzo is a founding partner of Pioneer Law Group, LLP, bringing to the firm over 25 years of professional experience in land use, real estate development, and environmental law. Andrea is an expert in the environmental regulations that affect the way our clients do business, particularly regarding environmental review under the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA). She works closely with project proponents, public agencies, and environmental consultants to provide the strategic advice and reliable counsel necessary to steer a wide range of large, complex and sometimes controversial projects through the CEQA/NEPA review process.

www.pioneerlawgroup.net

V. RELEVANT EXPERIENCE**1801L**

- Midtown Sacramento, CA
- Mixed Use/Mixed Income/Urban Infill
- 176 Residential Units, 10,000 SF Retail
- Completed: 2006

After assembling vacant properties between 18th and 19th Streets along L Street in Midtown Sacramento, SKK developed this mixed-use project which includes 11,000 square feet of retail space with restaurants, services and 12 live-work units, 164 mixed income rental apartments, as well as 163 below grade parking spaces.

**United Artists Olympus Pointe**

- Roseville, CA
- Mixed-Use
- 110,000 SF Office, 12 Screen Movie Theatre, Restaurant
- Completed: 1997

Laguna West

Elk Grove, CA

- Master planned/mixed-use/multi-family and single-family residential
- 1,033 acres, 1,800 single-family homes, 1,500 multi-family units, lake, park, office, daycare, school, commercial and industrial space.
- Completed: 1999

Located 11 miles south of downtown Sacramento, this award-winning 1,033-acre mixed-use community was one of the very first master planned communities in the United States based on Neo-traditional principles offering transportation choices, housing choice and diversity, and quality design. With over 1,800 single-family homes and 1,500 multi-family units, a 73-acre lake, parks, office space, two daycare sites, an elementary school site, and commercial and light industrial uses, the project has been featured in Time, Newsweek, U.S. News and World Report, The New York Times, and The Los Angeles Times, as well as on ABC's "Good Morning, America" and "World News Tonight," and has been the subject of national discussion regarding new planning trends. Apple Computer chose Laguna West to locate a logistics division facility.

Two of the key planning goals of Laguna West were to create a true sense of community and to focus on public spaces. The lake, finished parks, waterfront promenade, jogging trails, and pedestrian bridges are accessible to all residents of the Laguna West community. The centerpiece of the community consists of a town hall and park, which features a playground, basketball court, and rose garden and connects to the lake. The town hall combines the functions of a community and recreation center with classrooms and an indoor theater/outdoor amphitheater. This public amenity was gifted to the Elk Grove Community Parks & Recreation District.



VI. SKK DEVELOPMENTS PROJECT PORTFOLIO

COMPLETED PROJECTS (SINCE 2001)

	Fremont Building	Capitol Park Homes	1801 L	L Street Lofts	Q19	20 PQR Townhomes	TOTAL
Year Completed	2001	2002	2006	2008	2018	2018	
Description	Mixed-use, mixed-income rental apartments	Single-family, for-sale homes	Mixed-use, mixed-income rental apartments	Mixed-use, for-sale condominiums	Mixed-use, rental apartments	Single-family for sale townhomes	
Estimated Current Value	\$ 26,000,000	\$ 32,000,000	\$ 70,000,000	\$ 70,000,000	\$ 26,800,000	\$ 22,400,000	\$247,200,000
Units	69	64	176	92	68	32	501
Retail Sq. Footage	12,000		11,000	6,400	2,000		31,400 sf.



L STREET LOFTS

UNDER CONSTRUCTION

	H16	E16	The Press Building	TOTAL
Estimated Completed	Early 2020	Fall 2020	Spring 2020	
Description	Mixed-use, rental apartments	Mixed-use, rental apartments	Mixed-use, rental apartments	
Estimated Current Value	\$ 36,000,000	\$ 35,000,000	\$ 125,000,000	\$196,000,000
Units	95	95	277	467
Retail Sq. Footage			8,600	8,600 sf

**E16 APARTMENTS**



H16 APARTMENTS



THE PRESS

IN DEVELOPMENT

	Arden Gateway	Mansion Apartments	Natomas Fountains	15th & G	TOTAL
Phase	Entitlements Submitted	Entitlements Submitted	Planning Stages	Planning Stages	
Construction Start	Fall 2019	Winter 2020	Fall 2020	Fall 2020	
Description	Rental apartments and townhomes	Mixed-use, rental apartments	Garden style rental apartments	Rental apartments	
Estimated Current Value	\$240,000,000	\$85,000,000	\$103,000,000	\$ 10,500,000	\$438,500,000
Units	737	181	312	30	1,260



ARDEN GATEWAY

MANSION
APARTMENTS

VII. PUBLIC AGENCY REFERENCES**Ron Alvarado**

Title: Former Executive Director, Capital Area Development Authority (CADA)

E-mail: alvaradoron@comcast.net; ralvarado@sbmcorp.com

Phone: 916-565-3649

Ryan DeVore

Title: Community Development Director, City of Sacramento

E-mail: RDeVore@cityofsacramento.org

Phone: 916-808-8860

Mark Stivers

Title: Acting Deputy Director, Financial Assistance, California Department of Housing and Community Development

Formerly with California Tax Allocation Committee, California Treasurer's Office

E-mail: mark.stivers@hcd.ca.gov

Michael McKeever

Title: Former Executive Director, Sacramento Area Council of Governments (SACOG)

E-mail: mckeeverducks@comcast.net

Phone: 916-296-2014

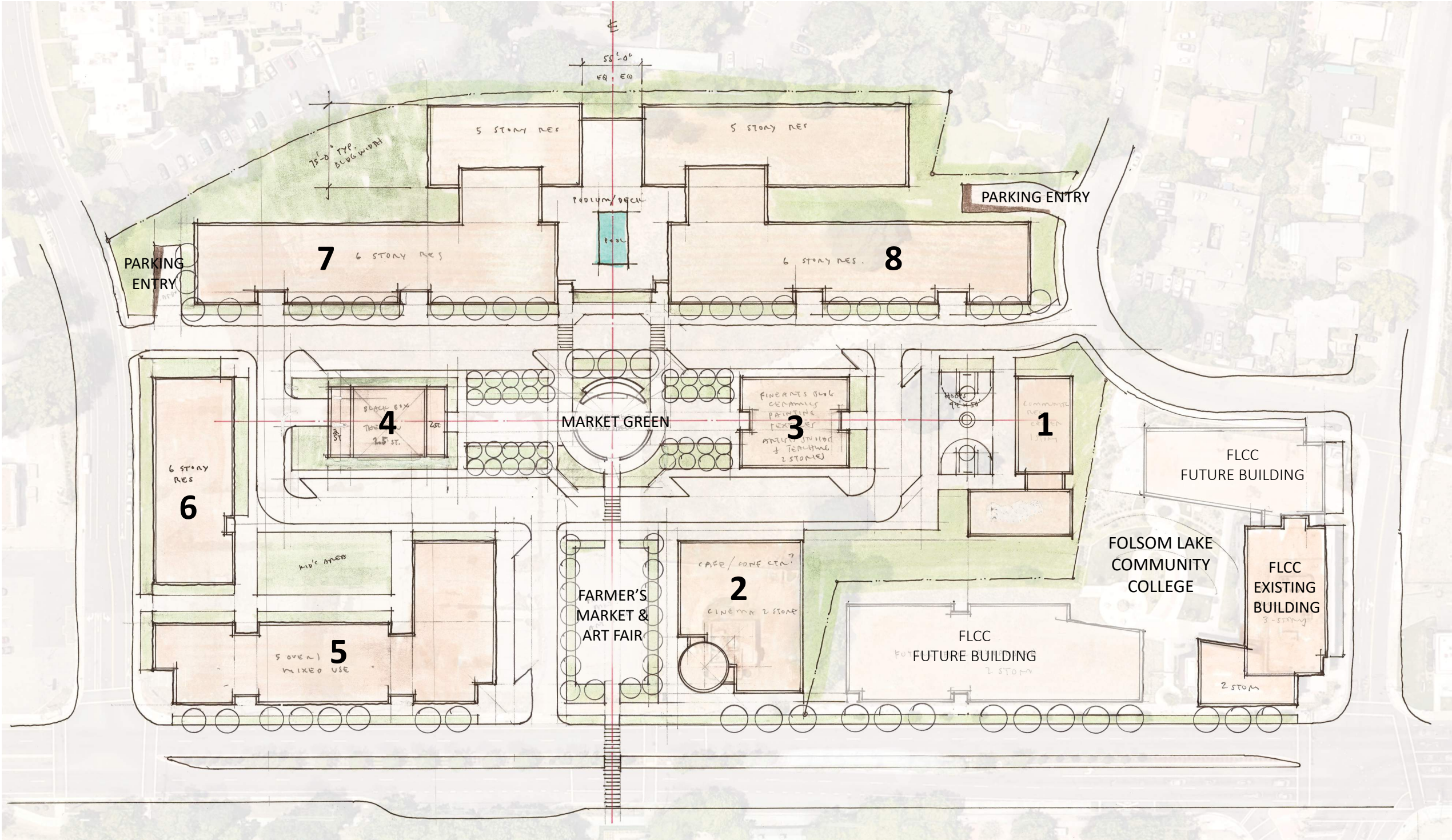


ITEM 12.1.

Mills Station/ Rancho Cordova, CA

SITE PLAN

SCALE: 1"=100'-0"



- 1. WELLNESS PAVILION**
 - FITNESS CENTER
 - FLEX SPACE
 - OUTDOOR FITNESS SPACES
- 2. MARKET HALL**
 - SMALL RETAIL (CAFE)
 - EXHIBITION SPACE
 - MULTI-PURPOSE SPACE
- 3. CULTURAL CENTER**
 - ARTIST STUDIOS
 - ART EXHIBITION SPACE
 - COWORKING ON LEVEL 2
 - ADDITIONAL STUDIOS ON LEVEL 2
- 4. FLEXIBLE PERFORMANCE & EVENT SPACE**
- 5. RESIDENTIAL/COMMUNITY CENTER**
 - LEVEL 1:
 - CONFERENCE ROOM
 - CLASSROOMS
 - RETAIL
 - DAY CARE
 - OUTDOOR KIDS PLAY AREA
 - RESIDENTIAL AT UPPER FLOORS
- 6. RESIDENTIAL**
- 7. RESIDENTIAL**
- 8. RESIDENTIAL**

ITEM 12.1.

Mills Station/ Rancho Cordova, CA

AERIAL PERSPECTIVE LOOKING NORTHWEST

ATTACHMENT 4 The Vision



1. WELLNESS PAVILION

FITNESS CENTER
FLEX SPACE
OUTDOOR FITNESS SPACES

2. MARKET HALL

SMALL RETAIL (CAFE)
EXHIBITION SPACE
MULTI-PURPOSE SPACE

3. CULTURAL CENTER

ARTIST STUDIOS
ART EXHIBITION SPACE
COWORKING ON LEVEL 2
ADDITIONAL STUDIOS ON LEVEL 2

4. FLEXIBLE PERFORMANCE & EVENT SPACE

5. RESIDENTIAL/COMMUNITY CENTER

LEVEL 1:
CONFERENCE ROOM
CLASSROOMS
RETAIL
DAY CARE
OUTDOOR KIDS PLAY AREA
RESIDENTIAL AT UPPER FLOORS

6. RESIDENTIAL

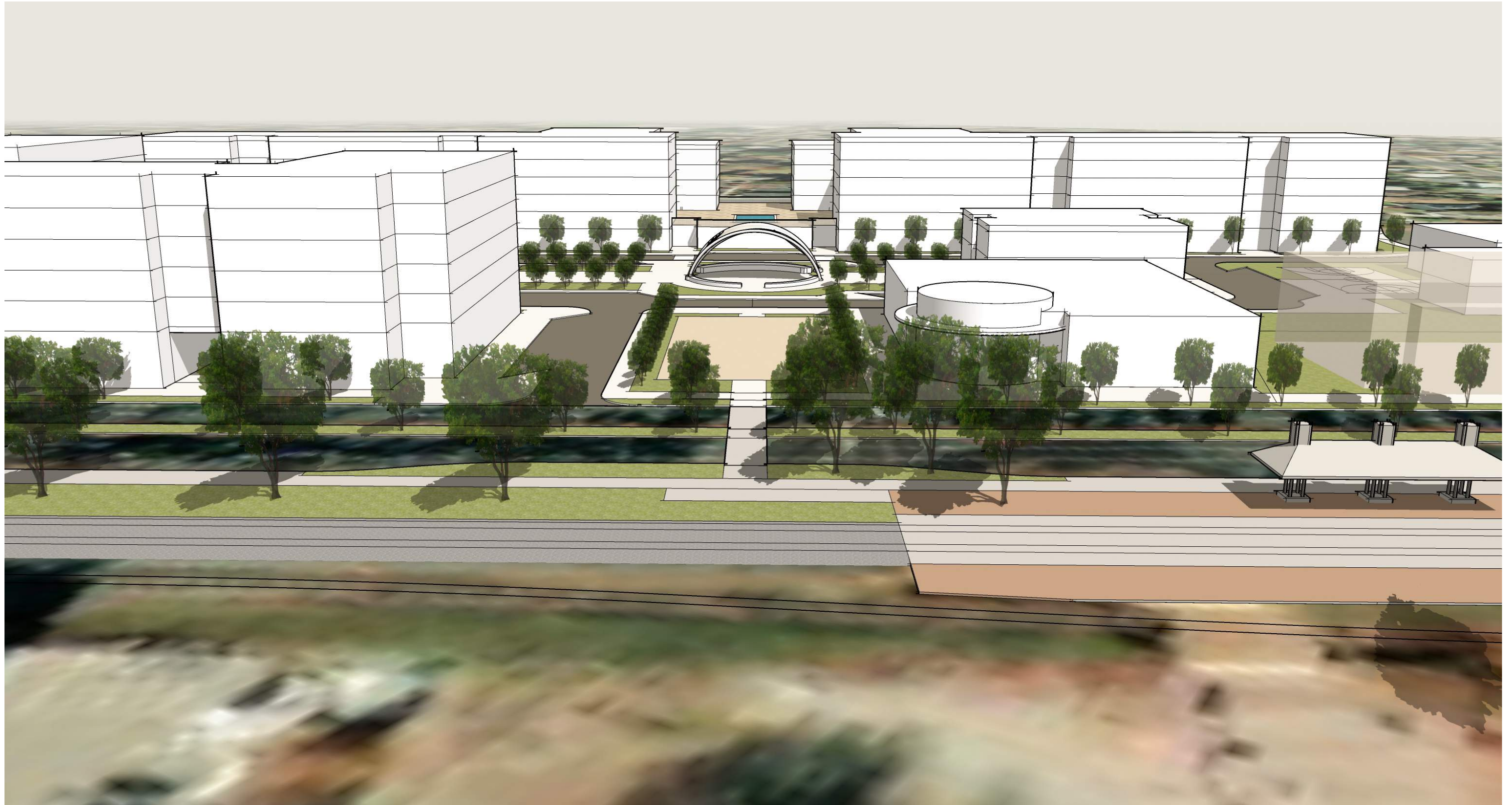
7. RESIDENTIAL

8. RESIDENTIAL

AERIAL PERSPECTIVE LOOKING NORTHWEST



AERIAL PERSPECTIVE LOOKING NORTH





Mills Station District P3 Master Development Opportunity

September 20, 2019



Submitted by Civic Partners & SVA Architects
www.civicpartners.com / www.sva-architects.com

TABLE OF CONTENTS



1	Executive Summary	<i>page 01</i>
----------	--------------------------	----------------

2	General Site Concept	<i>page 06</i>
----------	-----------------------------	----------------

3	Financial Capacity	<i>page 13</i>
----------	---------------------------	----------------

4	Team Qualifications	<i>page 17</i>
----------	----------------------------	----------------

5	Public Agency References	<i>page 47</i>
----------	---------------------------------	----------------

1.

EXECUTIVE SUMMARY



The Development Team led by Civic Partners includes SVA Architects, Hunt Real Estate Capital, Otto Construction, AFL-CIO Investment Trust, and Lifescapes International. This experienced, highly skilled, and well-financed team is uniquely qualified to conceive, process and implement a significant mixed-use, multipurpose, commercial, retail and residential project through a public-private partnership with the City of Rancho Cordova. The team intends to work closely with the City, as well as the community, in transitioning the property into a vibrant, high quality destination.

This team desires to enter into an “Exclusive Right to Negotiate” agreement under which the details of the proposed plan can be further refined, ensuring a viable project where the goals of the City are achieved while also meeting the needs of the local community.

The Civic Partners Development team has the experience and expertise to optimize the financial strategy with a mix and quantity of uses that encourages synergy among Public Facilities, residential, retail, office and outdoor gathering spaces. The overall project will exhibit a strong centralized theme and appropriate architectural character to unify the varying uses in a safe and inviting atmosphere. The objective is to meet the goals of the City & community, while providing a successful, economically sound project in a vibrant people-oriented design.

The Development Team will also evaluate the potential for integrating additional surrounding properties into the overall vision for Rancho Cordova. The intention is to provide a plan designed to enhance and extend a “sense of community” throughout the neighborhood, where residents and local visitors will be encouraged to meet their fellow community members.

The Civic Partners Development Team has a strong track record in joint public-private endeavors with extensive experience in high quality mixed-use component projects, and a solid financial foundation. This team is uniquely qualified to implement an economically successful project designed with cultural, recreational, commercial and residential uses to benefit the City and community.

Urban development is a success when it becomes “a place” not a project; “an experience” not a visit; “a bringing together” not an assemblage. This cannot be achieved by one entity alone, rather it requires the involvement of a consortium of varied disciplines and talents. Our team, when merged with the team of public participants and consultants already in place, will create a dynamic destination through the vision of its participants.



This Civic Partner Development Team looks forward to the opportunity to join with Rancho Cordova to create a mixed-use corridor and community landmark.

Outlined below are a few things the team will keep in mind as we venture into the more detailed aspects of the project.

- ◊ Remain sensitive to community's concerns.
- ◊ Be accessible to, and include, public and neighborhood groups as much as possible.
- ◊ Don't promise the community or anyone else more than can be delivered.
- ◊ Be careful not to overbuild the area, resulting in standing vacancy.
- ◊ Maintain open communication among members of the team and the City staff.
- ◊ Keep the vision, or big picture, in mind as work progresses on individual components.
- ◊ Begin now to strategize a public information campaign. Public support for this project is critical in order to smoothly move forward. The current inclusion of civic leaders outside of government in the selection committee is a great start.



CIVIC PARTNERS

MAIN CONTACT:

Steven P. Semingson, President
T: 714.230.8000
E: spsemingson@civicpartners.com

7777 Center Avenue, Suite 230
Huntington Beach, CA 92647
www.civicpartners.com



PROCESS & PUBLIC PARTICIPATION



FUTURE PROCESS

As the development process moves forward, it is the desire of this team to continue discussions with interested parties including discussions with other nearby landowners and community members of influence. We expect the process will include potential acquisition negotiations with adjacent landowners, additional traffic and environmental studies, workshops with interested parties, and market validations for the various components of the proposed project. The future plan will also include, but is not limited to, the following processes:



1. Visioning Process

The program plan, including the design, is to be developed through a participative process. The Development Team will seek the advice of the general public well beyond the required public hearings. It will seek out the most knowledgeable local individuals and citizen groups to assist in the planning of the private uses to be developed on the original site and the site as potentially expanded. It is the intention of the Development Team to seek input from interested parties through workshops and focus groups, which may include presentations, surveys, and formal, as well as informal meetings. For these workshops and focus groups, the Development Team will approach various organizations, including neighborhood groups, business organizations, the Chamber of Commerce, City agencies, adjacent landowners and other interested parties and continue discussions with the neighboring Folsom Lake College.



The Civic Partners Development Team intends to integrate to the greatest extent possible public facilities with residential, business and retail uses. This will be a place to live and where the general public will be encouraged to come together to conduct business, host meetings, work, enjoy recreational facilities, shop, relax and attend events. The input of the public will be essential to devise the best formula of uses to make the development plan the greatest success possible.

2. Development Agreement and Negotiations

The following describes a typical process and type of development agreement, or major deal points to be negotiated. The Civic Partners Development Team will request the City enter into an Exclusive Right to Negotiate (ERN) agreement. The purpose of this ERN is to commit each party to the task of creating a Disposition and Development Agreement (DDA). It is anticipated that the ERN will be in force for a period of six to twelve months and sufficient for the drafting and execution of the DDA. The DDA itself will formalize the details regarding the type and form of commitment of each party involved. It will include the major deal points involved in the formation, design and development of the proposed public facilities and privately owned improvements. These usually include, but are not limited to, the following:

- ◇ Definition of the Specific Development Areas.
- ◇ Reaffirmation of the General Development Plan.
- ◇ The Site Plan for the Public and Private Improvements.
- ◇ Timing Schedule for the Design, Financing and Construction of the Improvements.
- ◇ Financing Plan for Both Public and Private Improvements.
- ◇ Land Ownership Structure for the Privately Owned Improvements.
- ◇ Cost Structure Estimate for the Public Improvements along with the Sources and Uses of Funds for Construction.

3. Design Process – Public Facilities

Following is a summary of the design process for the site, including controls to ensure that the public dollars are spent in a prudent and efficient manner.

The Development Team's extensive experience in preconstruction services in the planning, design, and construction of public facilities does not give them all the right answers – rather it has taught them all the right questions. The team has learned to listen. Certainly, we must guide, negotiate, and direct a highly interactive design process. But each government clients' needs are unique to them, and the right design must therefore be equally unique. The team has studied the site and surrounding environs and, from that exercise, has developed the beginnings of a vision; nonetheless, any preconceived notions are just that, and community interaction will definitely influence the vision to be implemented.

This same philosophy is applied to the subject of cost control. Otto's preconstruction database includes detailed cost figures on a wide array of similar projects. Their approach is to establish a menu providing the cost of optional building systems on day one of the project. They define creative strategies to minimize costs and maximize standards of design. This process assures all design decisions will be made in the context of cost/benefit. All parties can then track the budget day-to-day.

Our team will start with defining your priorities and goals, which guide budget allocation and design decisions. A strong command of these priorities ensures costs are allocated where they create the most value to the client. Understanding these priorities will allow Otto to manage the budget throughout the design process and make recommendations, should changes be required. When these decisions must be made, Otto uses life cycle cost analysis to help us understand the real value and long-term financial impact of these decisions. One of the advantages of utilizing design-build is that our team will collaborate on priorities and goals for the project while also providing real-time budgeting. Otto's estimators will work closely with the entire team early in the programming and design phase and throughout the design process, utilizing Target Value Design (TVD) methodology. This will keep the project on budget and avoid unexpected changes during construction.

Otto will provide TVD services throughout the development of the project's design. As the design sets and options are developed, evaluated, and refined, more detailed cost information will be available. The Target Cost for each cluster and cumulative total Target Cost for the project will be updated bi-weekly, documented on A3 sheets and shared with the team. On TVD projects, we see that cost estimates typically decline as design develops due to the proactive value engineering inherent in the process.



Our team will be guided by detailed cost estimates, with continuous cost feedback steering design decisions. Early on, we will lead the full team through a series of workshops to define the project values, and rank those according to priorities. Otto uses these consensus priorities to establish the budgets for project elements, putting more weight on those areas that bring more value to the project. Once specific cost targets are established for project elements (ex. enclosure, interiors, MEPF), the project team can then work together to optimize each one to maximize value. After each submittal, a detailed cost estimate validates the continuous budget feedback.

It is of the utmost importance to have the design and cost controls as integrated services. A single source responsibility is critical to ensure that processing and timing fall into proper expectations.

Several members of this project team have worked together on numerous public-private projects and are fully qualified to deliver the proposed project.

PUBLIC INVOLVEMENT

The support of the general public is very important for both the short and long term success of the project. These individuals will be the ultimate workers, patrons, clients and occupants for whom the project is intended to serve. A participatory role for the general public in the creation of the project is in the best interest of the Development Team. The visioning will build on the work that has been done to date, including that which is available within the Mills Station District Project Information.

With the community and with the City, we propose to engage citizens with various backgrounds that have no relation to the development to assist us with participation in brainstorming sessions to develop the design objective for this parcel and related properties.

We recommend that the initial program and design meetings also be in the form of brainstorming sessions. We would conduct “hands-on” planning and design sessions that can be accomplished together, to expedite both the project schedule and to efficiently find and develop solutions. Following each session, drawings would be openly displayed for viewing and further evaluation by the project representatives and general public. Our methodology focuses on reviewing various design alternatives. As we conceive and evaluate each alternative, Rancho Cordova staff and the general public will be working with the development and design team to analyze the positive and possible negatives of each choice, including any cost impacts.

Our team will provide recommendations for optimum and alternative solutions for final review and approval. During the development of the design concepts and design documents, we encourage opportunities for the public to provide comments. This design development team embraces involvement from the community. It is essential in integrating the project into the community fabric and creating long lasting support.

2.

GENERAL SITE CONCEPT



With its central location and convenient accessibility from various corners of the city and region, it is our VISION to create a place for community members to discover, connect, relax, engage, enjoy the local art and food scene, and embrace culture and performing arts.



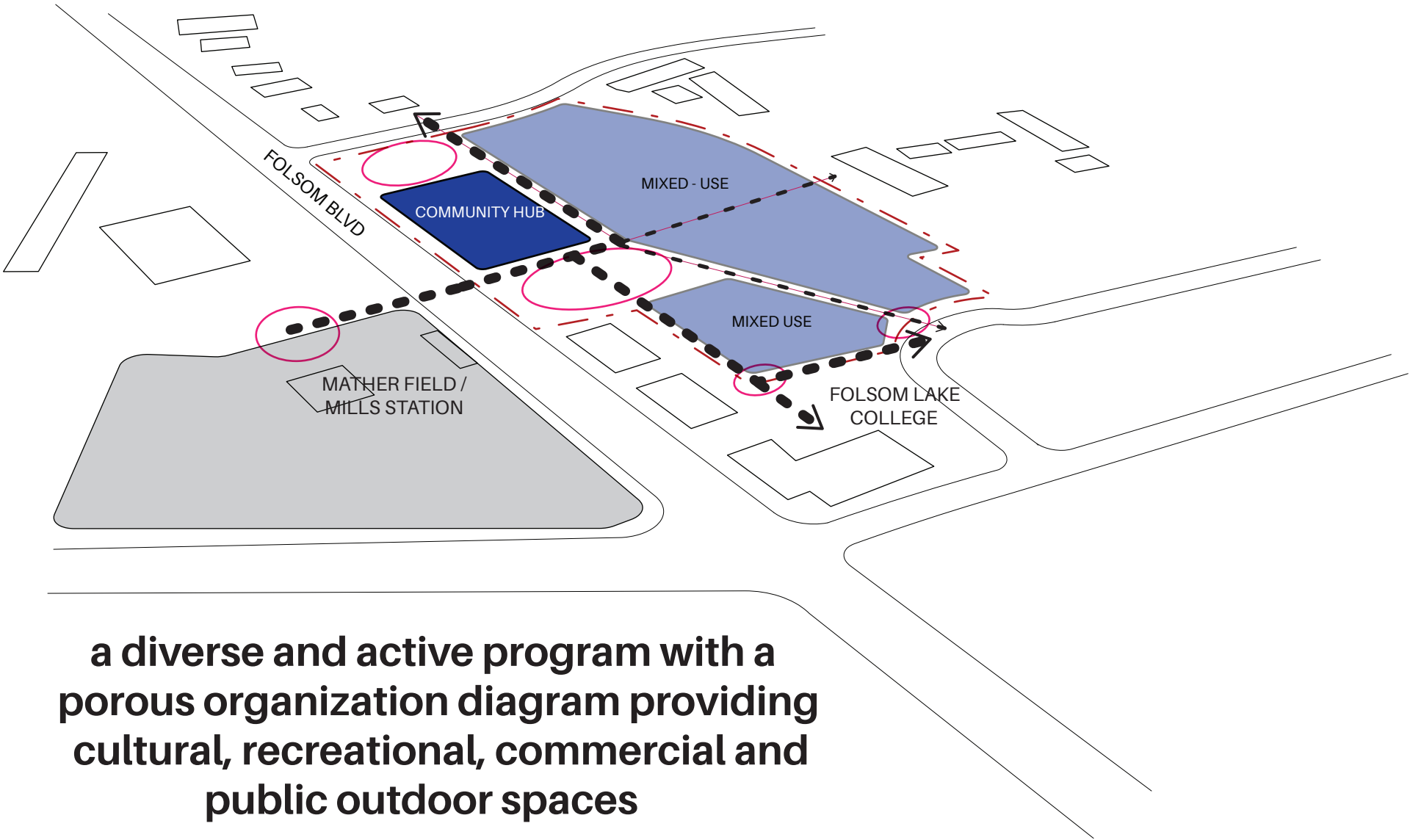
CREATING A COMMUNITY

With the goal of creating an active space, a diverse program is envisioned for the new Mills Station District.

The District will be anchored by a +/- 30,000 sq. ft. flexible multipurpose **Community Hub** that occupies one acre of the site. The Community space will be programmed to host multiple facilities including a gym, flexible black box and performance spaces, classrooms, rehearsal rooms, and local food vendors. The reserved one acre will also have room to accommodate parking needs as required.

In order to create a lively community, four to five acres of the site will incorporate **Type III Wrap Mixed-Use Buildings** with cultural, recreational and commercial components at the ground level, and residential at the upper levels. One of the primary goals is to utilize connecting corridors to activate. The mixed-use component will have the potential to be developed into a mid-range to high density product dependent on the city and community's need. Parking spaces will also be integrated onto the allocated four to five acres to sustain the parking needs for residents and visitors alike.

The remaining acreage of the site will be carefully articulated and crafted to integrate **outdoor public spaces** that spill out from the Community Space with a multipurpose and flexible nature and include vehicular and pedestrian circulation through the site.

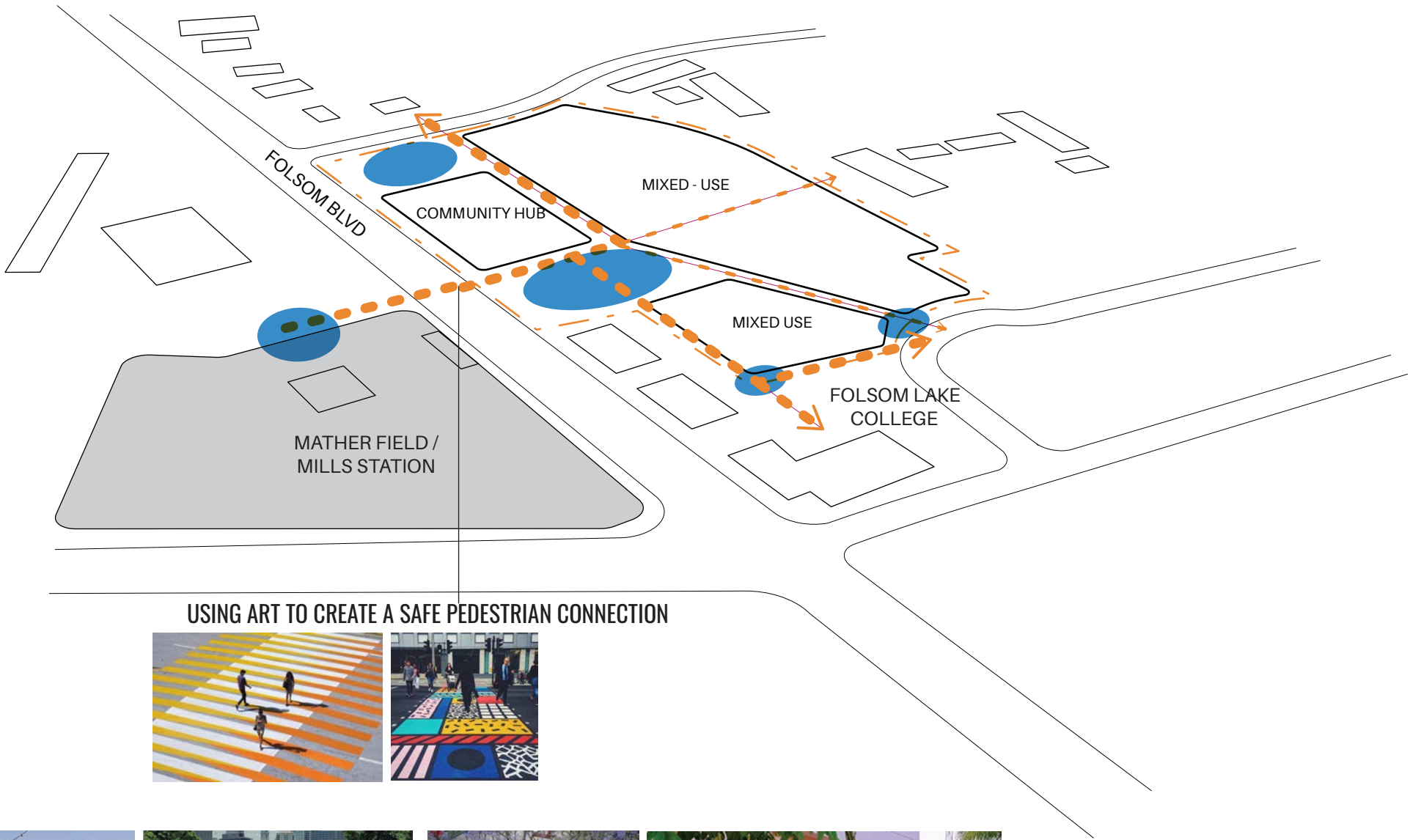


CONNECTING THE COMMUNITY

Connecting to the community and Mather Field/Mills Station is a primary focus for our development. To achieve this, our master plan will engage the community on all sides.

Directly across Folsom Blvd from the station, we envision an inviting and flexible plaza. This will host a variety of events - artistic performances, food truck festivals, and overflow programs from the adjacent community building.

With Folsom Lake College's Rancho Cordova center sharing the site, including its two future phases, we will plan for connections and shared uses that will enrich both development and the College.



USING ART TO CREATE A SAFE PEDESTRIAN CONNECTION



OUTDOOR SPACES THAT ARE FLEXIBLE IN USE AND ENGAGES THE COMMUNITY



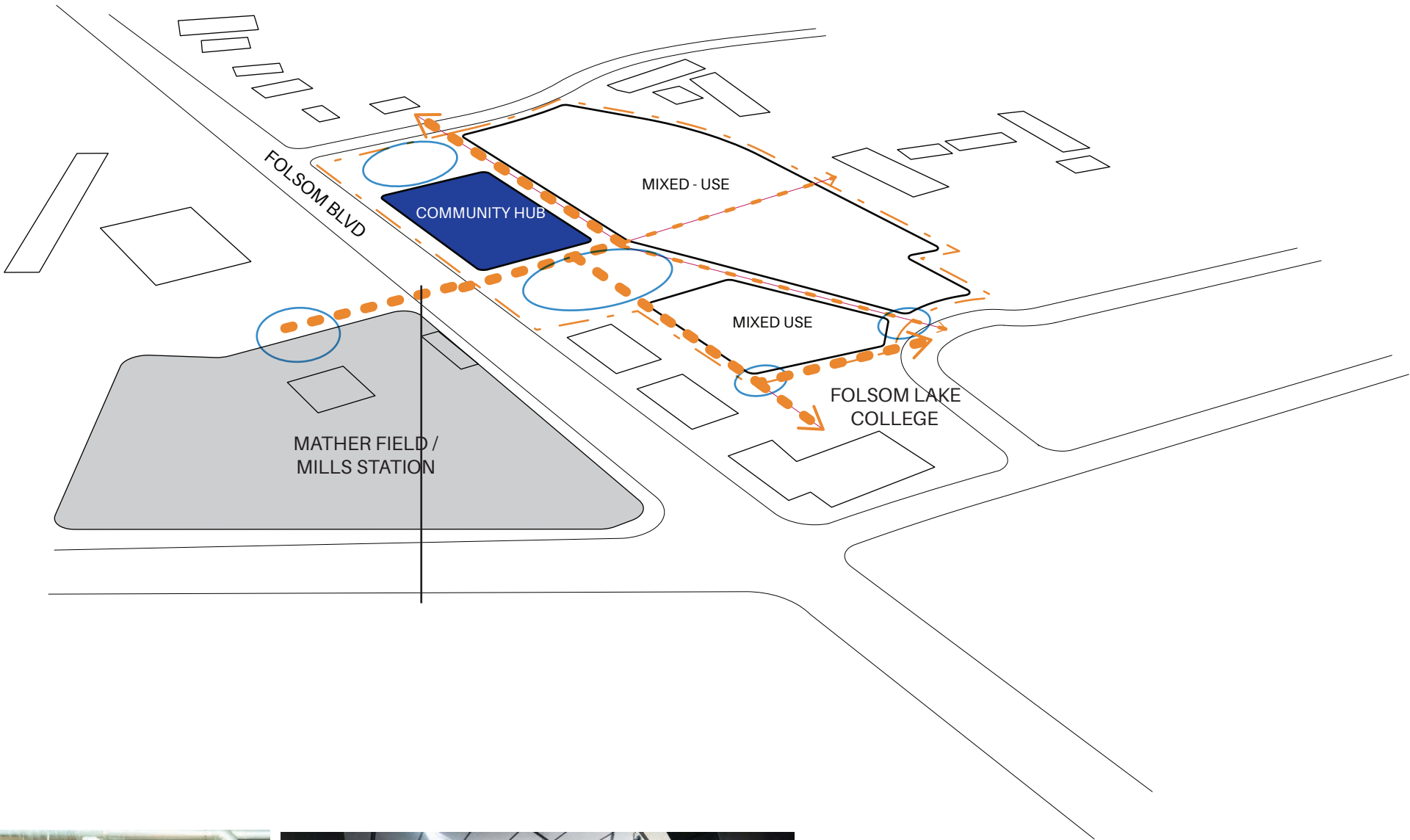
THE “COMMUNITY HUB”

The Anchor of our project is the "Community Hub", a flexible multi-use space to support local culture, performing arts, and recreational programs of the City of Rancho Cordova.

Inside the District Hub we envision a series of spaces such as:

- classroom / study rooms
- black box / performance space
- flexible meeting areas
- local vendor stalls

Our team will work with the City, community groups and neighbors to program this space for the best size and combination of uses, but we believe the most important component is the flexible nature of the spaces. The ability for the Hub to continue to flex with time (short and long-term), to grow and mold itself as the community evolves is an important component to assure the longevity and long-term success of our project.



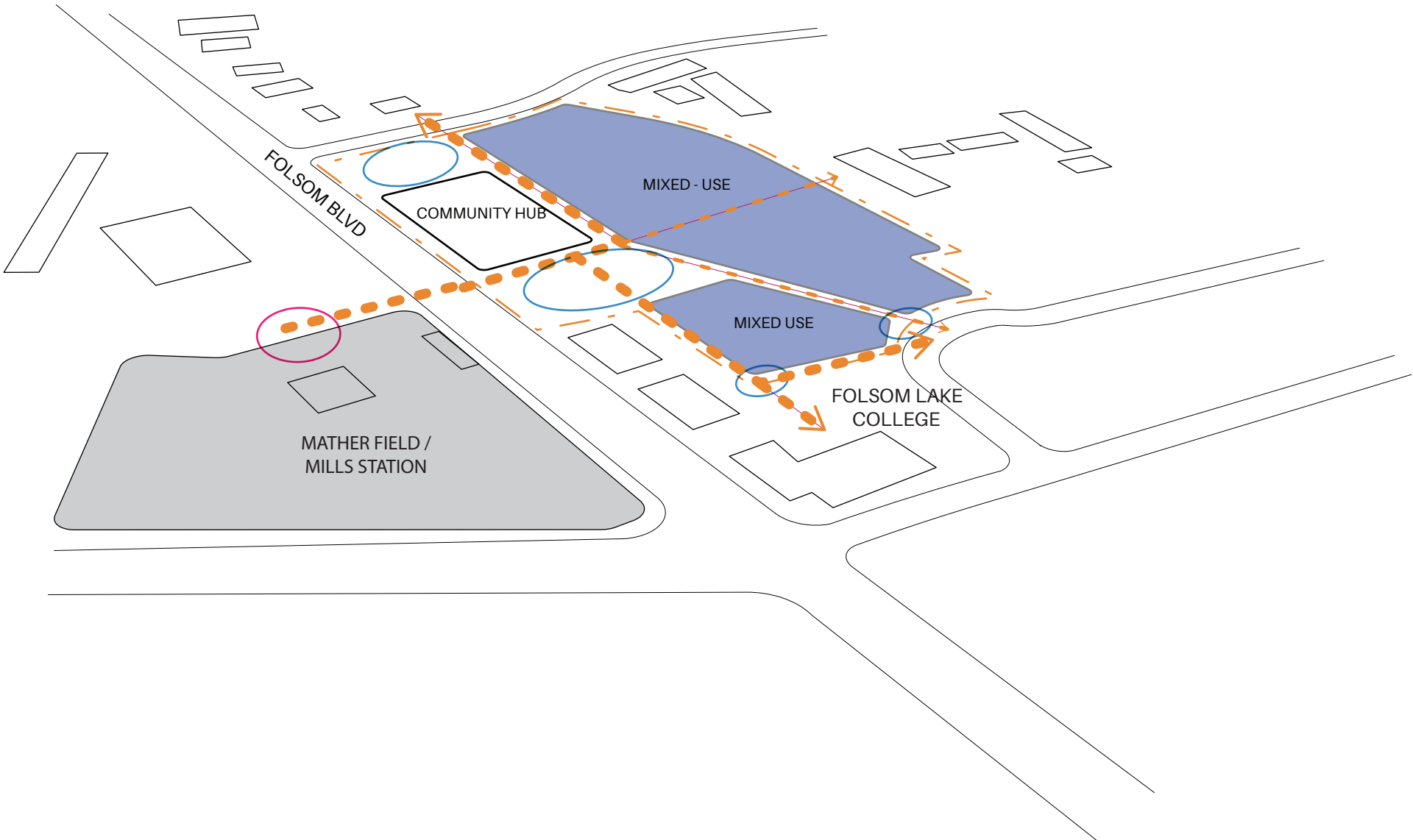
AN INDOOR SPACE THAT IS FLEXIBLE AND SUPPORTS THE LOCAL CULTURE AND ART



THE MIXED-USE COMPONENT

The Mixed-Use component will bring to the site an active ground floor with uses that support the community, as well as residences. Programs such as **cultural, recreational and commercial spaces** will line and activate the ground floor and spill out onto the paseo connectors.

These elements are located back from Folsom Blvd and closer to the existing neighborhood residential to best blend into the community fabric. We plan for the residential scale to decrease to smaller townhome style buildings against the property line to best relate to the neighboring buildings.

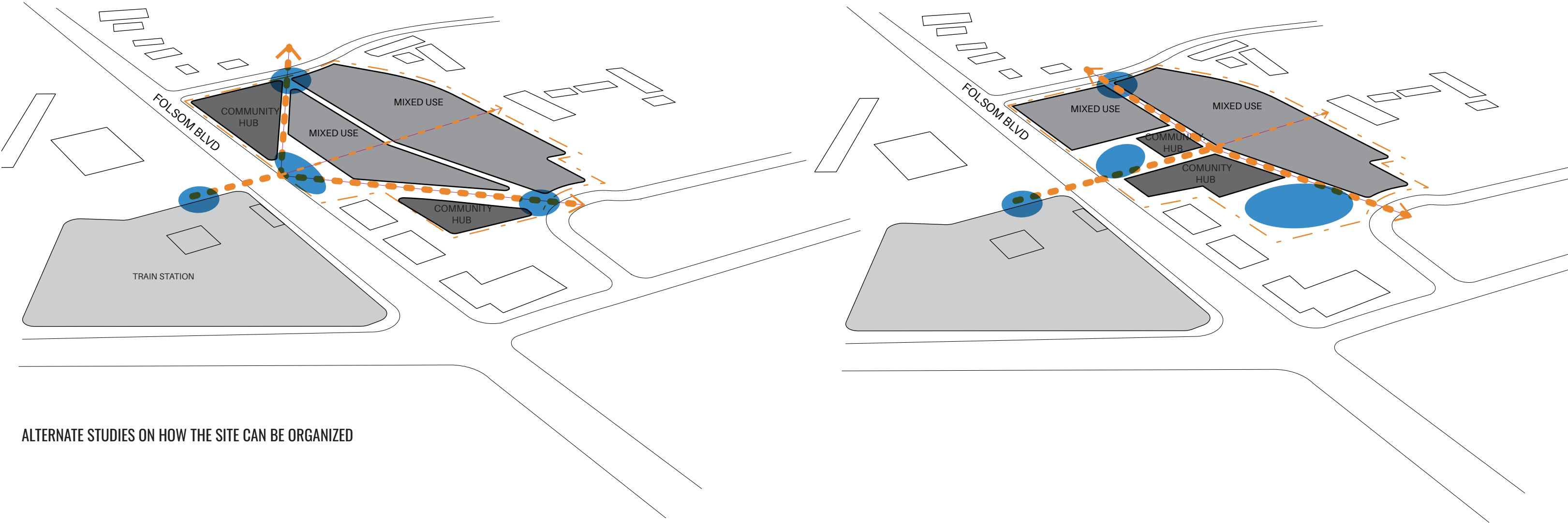


A MIXED-USE COMPONENT WITH ACTIVE PEDESTRIAN EDGES



WORKING WITH THE COMMUNITY

Integral to our team's process will be engaging the City and the Community to find the ultimate program and further develop and polish the Vision for the future of our project.



ALTERNATE STUDIES ON HOW THE SITE CAN BE ORGANIZED

3.

FINANCIAL CAPACITY



FINANCIAL STRENGTH & CAPACITY

Our many years of experience and leadership in public/private ventures provide a level of confidence relative to what can be accomplished in the area of urban infill mixed-use developments. This is most certainly evident in the area of financing. The Development Team anticipates utilizing its varied resources and associations to structure a capitalization program that maximizes financial returns within the parameters of prudent investment asset allocation. The team will simultaneously explore alternative financing options that might best fit the needs of both the project's individual components and the project in its entirety.

The Civic Partners Development Team is experienced, financially capable, and prepared to create an economically viable project which will attract construction financing and long-term debt. Equity will be provided which, when combined with reasonable debt financing, will comfortably assure the capitalization of all elements of the project, including the residential and income producing commercial components. Civic Partners has a strong history of successfully achieving economically stable developments, many in public/private partnerships and several in a strategic alliance with Hunt principals. The Developer's resume includes multiple examples of various public facilities all of which were successfully financed and completed with optimal public financing techniques. This history of success resulted in many cases from the development team's creative approach to public financing.

Civic Partners has the expertise and a track record in conceiving, creating, and executing creative capital structures to meet challenging financing demands. We would propose utilizing a number of financing tools at our disposal to capitalize on this exciting development opportunity.

FINANCIAL STRATEGY

The process, which molds the project into a viable investment, is the same process that will ensure its economic viability. The project's investment and financing strategy will evolve into final form as its components and parameters become more defined. The financing of each project is based on the individual dynamics of the real estate components. We structure each of our development efforts to match resources with appropriate needs and approach each project as a unique opportunity.

ITEM 12.1.

ATTACHMENT 5

The City's financial and land contributions enhance the opportunity for the Mills Station District Development to become a reality. The Civic Partners Development Team recognizes that sharing of the economic benefits of successful private development may well be required to provide long-term, stabilized support, assuring continuity of the public/community assets that are key elements of the project. In addition to land and other economic contributions of the City, this project will benefit from the site qualifying for extraordinary financial benefits from the Opportunity Zone program, the New Market Tax Credit Area Designation program, and potential resources from Transit Oriented Development programs.

Public financing may also be required to the extent additional resources are needed to capitalize the public components. The financial and legal members of the Civic Partners Development Team are familiar with legislative authority regarding public agency debt and long-term lease commitments. It is understood that Rancho Cordova may recommend and implement alternative long-term financing vehicles. We anticipate the final form of public debt financing, if any, to result from a collaborative effort between the City and our project team with Rancho Cordova making all final decisions.

Our proposal calls for uses which we believe are complementary to the new public facilities and would add significantly to the future enjoyment of the Mills Station District by residents and visitors, alike. The Civic Partners Development Team will aggressively develop portions of this property and potentially other adjacent parcels to enhance the community and be compatible with the public components and the neighborhood in such a way as to provide economic support to the public facilities. In doing so, the Civic Partners Development Team is prepared to either lease or purchase land based on the value of the land, as determined by the compatible uses. We anticipate that the proceeds will be used to offset the cost of the public facilities, and/or assist in its long-term operation.



In many cases, it is more favorable for the Development Team to maximize its performance if the City is able and/or willing to sell the land directly to the Development Team. Generally speaking, capitalization is more efficient with "fee title" ownership versus a long-term ground lease. However, having confronted the issue of public land disposition with previous public projects of a similar nature, the Development Team understands there may be difficulties to an outright sale. Therefore, should it be necessary, the Development Team is prepared to move ahead with the project on a "leased land" basis and will work to minimize any perceived negatives which a lease might present.

If a lease payment structure is established it is the intent of the Civic Partners Development Team to:

- Provide a dependable lease payment in such a way as to optimize the construction and financing of the public facilities, and to develop the private components of the project.
- Structure the payments to reflect the Development Team's success in developing and marketing the private portion of the project. To that end, the Development Team is prepared to price the land to its "highest and best use." Additionally, the City will have input into the private portion of the development which will occur adjacent to the new public components, assuring the City that, as a beneficiary of the Development Team's efforts, the appropriate value is placed on the land.



Based on our team's collective experience, we recommend that the City either sell or lease the land to the Development Team for a price to be determined during the exclusive negotiating period. If a lease scenario turns out to be the optimum land transaction, payments made by the Development Team will be used to offset public facilities ongoing annual costs or perhaps even go towards the cost of construction of the public portion of the development. Should the debt market value the revenue components significantly higher if "fee title" were to be available, an alternate proposal will be made. If considered to be in the City's best interest, the land purchase price would be an offset against the cost of the public facilities.

In order to enhance the sense of place and contribute to the economics of the project, the Development Team envisions growing the footprint of Mills Station in such a way to create a strong identity fitting within the existing neighborhood context while developing a "village" atmosphere. The mixed-use components including additional commercial and residential would provide increased financial stability to the public facilities created on the City provided site.

HOUSING

The Development Team will construct an appropriately sized housing project which meets the needs of the development site, the City, and the community. In determining the needs of all parties, the Development Team will take into consideration the community needs with respect to income restrictions, if any, and a wide variety of potential occupancy types desired for an urban location. It is beneficial to the City and the Development Team to assure the optimum use of the land.

To the extent there is workforce housing in the project, there are two main options available for financing the rental portion, depending on the desire for income restrictions and/or senior occupancy. For example, if a need exists to have a portion of the units reserved for seniors, individuals or families with low, fixed, or moderate incomes, the Development Team would seek to avail themselves of the lower cost tax exempt financing by using multifamily housing revenue bonds. To the extent that the units are market rate units, the Development Team will utilize more conventional debt financing. The Development Team is prepared, subject to receiving a market rate return commensurate with the risk profile of the project, to provide, through its tax credit partner, whatever equity is required to assure financing is available.

The Development Team will provide the City with a known lease or purchase payment for the land and will take total responsibility for the construction and financing of the rental housing portion of the project. The lease payments or purchase price paid for the land will reflect the Development Team's expectations and efforts in successfully developing the housing component.

ITEM 12.1. GENERAL BUSINESS USE

ATTACHMENT 5

Potential business users include the neighboring college, tenants looking to take advantage of the commuter line with its station proximity, local professional businesses and potentially any public agencies. The design/development team would highly encourage further extending the development opportunities to embrace potential expansion of Folsom Lake College or bring other potential education related users into Rancho Cordova. This will expand the critical mass potential of development along Folsom Boulevard.

Otto Construction's history with the Los Rios Community College District (LRCCD) will benefit the development of the Mills Station District. Otto's 20-year relationship with LRCCD has allowed them to develop a deep understanding of LRCCD's needs and their approach to being a community focused partner. Their master plan for the Rancho Cordova site includes growth and expansion by adding two new buildings to the campus in two phases. There are opportunities to partner with them to provide parking, especially as the densities of both sites increase. Otto has built two parking garages for Los Rios: The Cosumnes River College Parking Structure (5 levels, 2,016 stalls); and The Sacramento City College Parking Structure (5 levels, 1,984 stalls). In addition, the campuses share a similarity with Mills Station District and the FLC Rancho Cordova Center, in that they are both located adjacent to Light Rail. We are excited to incorporate Los Rios in our development plans and to have open conversations about opportunities for shared parking, along with retail, living units, and community buildings.



RETAIL SPACE

As in the other project components, the Development Team will finance any retail component of the project conventionally using a combination of debt and equity.

The Development Team will construct the appropriate community and resident serving retail that is also commuter and pedestrian friendly to cater to both the strong local and transient markets. The Transit Oriented Development location of this site already has strong built in customer foot traffic that is expected to take advantage of the convenient restaurants and retail shops that will be adjacent to the Mills Station. This team has experience identifying and attracting specialty restaurants and retailers that will complement but not compete with the existing retail centers on the main Folsom Boulevard thoroughfare.

In summary, the Civic Partners Development Team has the expertise, contacts, resources, and creativity to deliver on the Mills Station District Development, with the various financing structures, which are required for these types of developments.

4. TEAM QUALIFICATIONS



CIVIC PARTNERS

DEVELOPER

CORPORATE PROFILE

Civic Partners, Inc., headquartered in Huntington Beach, California, is a unique development firm recognized for its successful public/private partnering and experience in the area of redevelopment. The principals of Civic Partners and its affiliates have been active in real estate development since the 1970's, with several decades of combined specialized experience in partnering with public agencies.

The company has capitalized on its development expertise and ability to work with various government agencies in creating significant real estate projects through public/private ventures. Civic Partners was founded by Steven P. Semingson in response to a growing demand for experienced firms capable of assisting public agencies in the development of economically viable projects. The company specializes in bringing together public and private interests to deliver what the community desires: high quality development that adds value to the community.

From infill projects to town centers to master planned projects, Civic Partners and principal affiliates have participated in the development of residential, retail, entertainment, mixed-use, institutional and commercial office space, as well as a variety of civic and public use components. The common thread is Civic's ability to create a unique "sense of place" for each of its projects.



Nearly all of its completed projects include components of public buildings and private development that allow public entities to complete facilities with limited investment by using the value of land they already own. Civic Partners applies its expertise in working with local and state entities and advocating for the project at all levels. This includes talking to residents and local stakeholders, listening to their thoughts, and in some cases managing their expectations. These success stories are produced using creative financing structures that combine available public resources and private financing sources to create a program that can be successfully implemented.

Civic Partners coordinates and manages all aspects of the development process, including the responsibility of liaison between each party involved in the project. It provides direction on the planning, design and construction of the project. Civic Partners establishes the financing strategy and handles the budgeting and scheduling for each project. Other tasks include public relations, community involvement, sales and marketing.

In managing the development process, Civic Partners commissions high quality experts to join the team. Project tasks, such as architectural design, engineering, and construction are assigned to proven experts who have demonstrated the ability to work in a team environment. This "team" approach utilizes the experience of company staff, input from project partners, third party consultant support, and appropriate community representation. Consensus on issues is created through our longstanding team approach.

SVA ARCHITECTS, INC.

ARCHITECT



FIRM OVERVIEW

SVA is the natural evolution of decades of innovative and award-winning architecture, master planning, and interior and sustainable design achievements. With a staff of over 50 professionals, SVA is able to consistently utilize our team's resources to provide an array of comprehensive architectural services ranging from commercial, office, and residential to hospitality, educational, and a variety of urban mixed-use and transit-oriented development design.

Recognized as one of California's most innovative and respected architectural firms, SVA is home to an experienced team of planners, architects, sustainable design specialists, and interior designers. With our extensive industry experience, our partners and project team members are able to provide a variety of design services to clients from distinct backgrounds, having established successful partnerships based on expertise, knowledge, and diversity of work.

Within our portfolio is a score of sustainable projects that respond wholly to the needs of their residents as well as the surrounding environment; these projects include the transit-oriented developments of Fruitvale Transit Village in the City of Oakland as well as the 17-story mixed-use and community-oriented Celadon at 9th & Broadway in Downtown San Diego.

Under the direction of Ernesto Vasquez, FAIA, and Robert Simons, AIA, SVA has won many prestigious awards and has been lauded for its planning and design work for several projects. We have designed several affordable housing projects such as El Monte Gateway in El Monte, California, and Jordan Downs in Watts, California. Some of our strengths and assets include:

◆ NEARLY FOUR DECADES OF DESIGN EXPERIENCE

A diverse portfolio of work including new construction, major renovation, and modernization of projects with varying scopes. We are widely known for our award-winning designs on a multitude of project types throughout California and the western United States.

◆ REPUTATION

We enjoy an outstanding professional reputation in the business community and in the architectural/engineering/construction mixed-use fraternity because of the overall leadership, integrity, and experience of our talented staff.

◆ COMMITMENT TO SUSTAINABILITY

We view sustainability as a design practice that is deeply embedded in all of our decisions, from a project's inception to final delivery. Our clients benefit from partnering with a forward-looking firm that can meet the growing demand for sustainable architectural practices and standards.

◆ TECHNICAL EXPERTISE

We are well-regarded and respected for the quality and completeness of our construction documents and related details and our ability to meet the time and budget constraints.

As a team, our sole mission is to adopt our client's objectives and dedicate ourselves to the achievement of the client's goals. SVA cares about the communities we work in; we are dedicated to creating designs that incorporate sustainable features into everyday life while inspiring community growth and vitality.

LIFESCAPES INTERNATIONAL, INC.

LANDSCAPE



For 60 years, Lifescapes International, Inc. has been a forerunner in landscape architecture and design. Founded by our visionary Chairman/CEO, Donald Brinkerhoff, Lifescapes has earned a reputation for professional reliability and developed a distinction for unique, cutting-edge design and creative solutions for casinos, hotels/resorts, mixed use, retail and multifamily projects. Considered an expert in the field, Lifescapes has created some of the most delightful, memorable and iconic environments in both the US and abroad.

DESIGN CONCEPT

From concept through project installation, the principals, associates and additional team personnel work together to oversee and maintain close control over the progress of all projects. Design review sessions are coordinated and attended by all senior principals and project managers, who assist in the technical and design objectives, to ensure efficient cost estimating, thorough construction documents and effective design implementation controls.

Our design team works closely with ownership and/or the development partners to understand the nuances of the project, goals and marketing objectives, and we encourage collaboration with all disciplines and consultants. Once there is consensus-based conceptual design direction and we've weaved together a "story" and vision for the project, we prepare an opinion of probable construction costs to assist in the decision making. Factors such as material selection, consultants, site adjacencies, client marketing objectives and project narratives come into play. With a clear direction, we create comprehensive sketches, graphics, and/or 3-D models to visually demonstrate the design intent.



Our horticultural experts are an integral part of the process, by illustrating the vision through planting design. Our firm is distinctive in that it we take great care in the selection of mature plant specimens, specialty ornamental pottery and other hardscape materials. We have extensive knowledge of nursery sources worldwide and will oversee a project's complete installation to ensure client's expectations are exceeded. The end goal is to achieve a design solution unique to each project, where architecture, interior design and landscape architecture flow together in seamless harmony.

VISION

We provide full-service landscape architectural design services, including concept/theming, schematics, design development and construction docs, through final art direction. Our expertise includes horticultural design, exterior vehicular/pedestrian circulation, site amenities, fountains, pools, roof decks, specialty features, event areas, terraces and courtyards.

OTTO CONSTRUCTION

CONTRACTOR

FIRM OVERVIEW

After 72 years in business, Otto Construction is still a family-owned business that is proud to call Sacramento home. By establishing an open relationship with project owners, as instilled by our founder John F. Otto in 1947, we have established a history of repeat clients throughout Northern and Coastal California. Whether the contract is \$20,000 or \$80 million, our firm's dedication to quality and integrity ensures that we will have as much pride in your project as you will, resulting in work that exceeds expectations. Utilizing this approach we have turned our clients into project partners.

OFFICES

Sacramento Office (HQ)
1717 2nd Street
Sacramento, CA 95811
T: 916.441.6870

Monterey Office
2150 Garden Road, Suite A-1
Monterey, CA 93940
T: 831.657.9805

SELF-PERFORMED WORK

- ♦ Site and structural concrete
- ♦ Rough and finish carpentry
- ♦ Temporary fencing
- ♦ Installation of frames, doors, hardware, and other miscellaneous specialties

SIGNATORY TO

- ♦ Cement Masons
- ♦ Carpenters
- ♦ Laborers

FIRM LEADERSHIP

Carl Barrett
LEED AP
President

John Hayward
LEED AP, DBIA
Operations Manager

Robert Ussery
CESSWI-QSP, DBIA
General Superintendent

Allison Otto
LEED AP, Assoc. DBIA
Executive Vice President

Natalie Ghilain
LEED AP, Assoc. DBIA
Chief Estimator

Preston Hatch
CPA
Chief Financial Officer





RED STONE TAX EXEMPT FUNDING

FUNDING

FIRM OVERVIEW

Red Stone is one of the nation's leading lenders in affordable multifamily housing. Red Stone's senior executives have successfully sponsored tax-exempt bond investment funds for over 20 years, during which time they have deployed over \$5 billion of investor capital. Since inception in 2002, Red Stone's tax-exempt bond platforms has invested over \$3.5 billion in over 275 properties—comprising over 54,000 affordable rental units—across the United States. Red Stone has managed tax-exempt bond investment funds with capital partners

including Prudential Real Estate Investors and Google, Inc., and has structured its debt investments with financial institutions including Deutsche Bank, Bank of America Merrill Lynch, Mizuho, Wells Fargo, and Freddie Mac. Since the firm's inception in 2002, Red Stone has never experienced a tax-exempt bond default.

Red Stone was founded by David Levine and John Sokolovic and they continue to be major stakeholders of the Red Stone Companies and its affiliated entities. Mr. Levine and Mr. Sokolovic have extensive experience closing private activity bond transactions, having closed over \$7 billion in tax-exempt bond financings throughout their careers. Mr. Sokolovic is responsible for overseeing the day-to-day activities of the firm and strategic direction of Red Stone. This transaction would be led by Red Stone's President, Cody Z. Langeness. Mr. Langeness has worked on the financing of tax-exempt bond investment made by Red Stone since graduating from the University of Wisconsin's Real Estate & Urban Land Economics program.

Red Stone's efficient, flexible, and innovative private-placement platform ("Red Stone Direct") is continuously utilized by private developers, nonprofits, and housing authorities nationwide. Red Stone Direct provides a streamlined closing process, low transactions costs, competitive pricing, and flexibility regarding guarantee and liquidity requirements. Red Stone has financed over \$230 million in tax-exempt bonds to date in 2019, with over \$80 million being invested in properties located in the state of California.

Cody Z. Langeness is President of Red Stone Tax-Exempt Funding LLC, the platform through which all of the Red Stone's tax-exempt bond facilities are managed. As President, Mr. Langeness is responsible for the development of corporate strategy, the implementation of business-development initiatives, and the management of all client and investor relationships. Additionally, Mr. Langeness is responsible for the structuring and closing of tax-exempt bond investments made on behalf of Red Stone's investment partnerships. Mr. Langeness has been employed by Red Stone Companies LLC for more than 12 years, a tenure which has included responsibilities pertaining to the origination, underwriting, structuring, and closing of multifamily debt and equity investments representing deployed investor capital in excess of \$3.0 billion. Mr. Langeness most recently served as Managing Director of Red Stone Tax-Exempt Funding LLC, during which time he raised and managed investor capital more than \$1.5 billion across several facilities which provided debt capital for new construction and acquisition / rehabilitation developments across the United States. Mr. Langeness attended the University of Wisconsin-Madison, from which he received Bachelor of Business Administration degrees in both Real Estate & Urban Land Economics and Finance & Investment Banking. Mr. Langeness is also a member of the Board of Directors of the Wisconsin Real Estate Alumni Association.

HUNT REAL ESTATE CAPITAL

REAL ESTATE

Hunt Real Estate Capital, a wholly owned subsidiary of Hunt Companies, provides financing for commercial real estate throughout the United States.

Founded in 1947, Hunt Companies, Inc. is today a holding company that invests in businesses focused in the real estate and infrastructure markets. The activities of Hunt's affiliates and investees include investment management, mortgage banking, direct lending, loan servicing, asset management, property management, development, construction, consulting and advisory.



Headquartered in New York City, Hunt Real Estate Capital has

25

offices nationwide

241

employees, including

94

originators

67

underwriters

HUNT REAL ESTATE CAPITAL OVERVIEW

- ◊ Leading Small Balance Lender Nationally, with a dedicated small balance team of 51
- ◊ Provide low cost Small Balance Agency Loans, (\$1 – \$7.5 million) with streamlined processing
- ◊ Through its predecessor companies, Hunt Real Estate Capital has been in continuous operation since 1972
- ◊ Current loan portfolio is \$15.1 billion. The firm closed approximately \$3.5 billion in originations in 2017
- ◊ Hunt Real Estate Capital partners with developers, investors, and owners, providing capital to develop, acquire, or rehabilitate commercial real estate assets
- ◊ Hunt Real Estate Capital finances most commercial assets including: conventional and affordable multifamily housing, seniors housing & healthcare, manufactured housing communities, retail, office, industrial, and self-storage
- ◊ Debt products: Fannie Mae, Freddie Mac, FHA, and our Proprietary Lending Group (balance sheet)
- ◊ Hunt Real Estate Capital offers proprietary lending options including: floating rate bridge and fixed rate 7- year loans secured by multifamily, office, retail, industrial, and self-storage assets

AFL-CIO HOUSING INVESTMENT TRUST

FINANCING

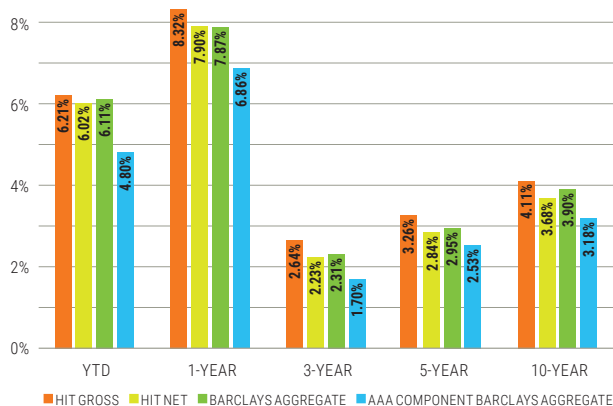
COMPETITIVE RETURNS
UNION CONSTRUCTION JOBS
HOUSING OPPORTUNITIES

HIT AT A GLANCE

- ◇ A \$6.4 billion investment grade fixed-income mutual fund
- ◇ Specializes in the highest credit quality multifamily mortgage backed securities.
- ◇ 35-year history of generating competitive returns for pension funds and labor organizations, such as health and welfare funds, while also providing vital union construction jobs, affordable and workforce housing, and healthcare facilities.
- ◇ 100% union labor requirement for all on-site construction.

TOTAL RETURNS

As of June 30, 2019



BENEFITS OF THE HIT

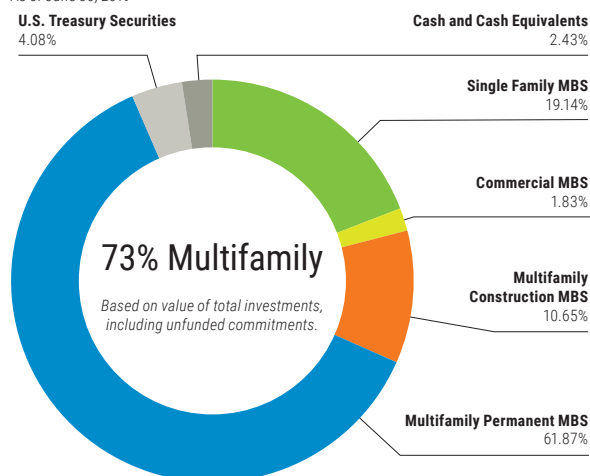
- ◇ Core fixed-income option with a strong performance record.
- ◇ Higher income, a superior credit profile, and similar levels of interest rate risk compared to the benchmark.
- ◇ Ongoing yield advantage positively contributes to its performance relative to the benchmark.
- ◇ High credit quality multifamily securities can make the HIT a lower risk investment than many other fixed-income vehicles.
- ◇ Can complement riskier investments in diversified portfolios.
- ◇ Good source of potential diversification due to concentration in multifamily securities (over 70% of portfolio) and lack of corporate bonds.
- ◇ Directly sources multifamily construction-related investments that have higher yields than other investments of similar duration and credit quality.

STRATEGY: OVERWEIGHT MULTIFAMILY MBS

- ◇ Construct and manage a portfolio with higher credit quality, higher yield, and similar interest rate risk relative to the Bloomberg Barclays US Aggregate Bond Index benchmark.
- ◇ Investment in high credit quality multifamily mortgage securities that can provide an income advantage for the HIT that contributes to its relative performance versus the benchmark.

PORTFOLIO DISTRIBUTION

As of June 30, 2019



RISK COMPARISON

As of June 30, 2019

	HIT	Barclays
Credit Profile		
U.S. Government/Agency/AAA/Cash	95.9%	72.2%
A & Below	0.0%	24.4%
Yield		
Current Yield	3.23%	3.08%
Interest Rate Risk		
Effective Duration	5.55	5.92
Convexity	0.08	0.13
Call Risk		
Call Protected	79%	73%
Not Call Protected	21%	27%

Source: HIT and Bloomberg Barclays US Aggregate Bond Index

AFL • CIO

**HOUSING
INVESTMENT
TRUST**

September 19, 2019

Chang Suh
Chief Executive Officer &
Co-Chief Portfolio Manager

Thalia Lankin
Chief Operating Officer

Erica Khatchadourian
Chief Financial Officer

Nicholas C. Milano
General Counsel

Mr. Steven P. Semingson
Chief Executive Officer
Civic Partners
7777 Center Avenue, Suite 230
Huntington Beach, CA 92647

RE: Rancho Cordova RFQ (Mills Station) – Letter of Interest
Rancho Cordova, CA

Dear Mr. Semingson:

The American Federation of Labor and Congress of Industrial Organizations Housing Investment Trust (the “Trust”) is pleased to have the opportunity to express its interest in joining with you to participate in the financing of Rancho Cordova RFQ – Mills Station (the “Project”) located in Rancho Cordova, California.

With approximately \$6.6 billion in net assets, the Trust provides capital for new construction, substantial rehabilitation and preservation of affordable and market-rate multifamily projects nationwide, using 100% union labor. The Trust focuses its investments in housing projects that provide competitive returns to our union and public pension fund investors, create union jobs and help strengthen local communities.

The Trust has extensive experience working on the West Coast. The Trust has invested over \$440 million in 27 projects in California, the last five of which included projects in San Francisco, San Jose and Salinas. We have the experience and capacity to work with Civic Partners to finance this exciting project.

Despite our interest in being involved in this transaction, at this time this letter does not constitute a commitment from the Trust to provide financing for the Project. Any commitment must follow a deliberative process which would articulate the general terms and conditions upon which the Trust would consider providing financing. The actual terms and conditions of any commitment issued by the Trust would be dependent upon the results of the Trust’s review and analysis of the underwriting and due diligence for the Project, as well as Trust Investment Committee approval. Any such commitment would be in writing and clearly identified as a commitment.

Thank you for your consideration of the Trust’s capabilities as you move forward with this major endeavor. If you have any questions, please feel free to contact me at 626-660-4155 or at tchandler@afcio-hit.com.

Best Regards,



Ted Chandler
Managing Director of Regional Operations

2401 Pennsylvania Avenue, NW • Suite 200 • Washington, DC 20037

Tel: 202.331.8055 Fax: 202.331.8190

www.afcio-hit.com

KEY PERSONNEL

4. Team Qualifications



**EDUCATION**

BS, University of
Wisconsin

MBA, California
State University

STEVEN P. SEMINGSON

CHIEF EXECUTIVE OFFICER

Mr. Semingson is the founder and Chief Executive Officer of Civic Partners. He provides leadership to the company on real estate projects through all phases of development and ownership. Mr. Semingson has successfully established a reputation of excellence for Civic Partners in redevelopment and public/private partnering. He has the unique skills needed to work closely with public agencies to identify economically viable civic development opportunities that provide the local citizenry with commercial/retail projects and either affordable or market rate residential units. From the development of his first apartment building to the current development of a 3,000-acre master-planned community, most of Mr. Semingson's projects have been located within redevelopment areas and many have been processed in partnership with multiple public agencies.

Mr. Semingson has a thorough understanding of financial markets and the skill of combining public and private funds to create mutually beneficial real estate developments. He has contributed to the creation of several new financing vehicles for public/private development projects within the State of California. Prior to founding Civic Partners, Mr. Semingson was employed by the County of Los Angeles and a local municipality. He is also a former faculty member at California State University, Long Beach.

**EDUCATION**

Business
Administration,
California State
University

MIKE WINTER

CHIEF OPERATING OFFICER

Mike Winter is the Chief Operating Officer for Civic Partners known for the sustainable and award winning communities it has planned and developed throughout the Western United States. Mr. Winter is responsible for the coordination of land acquisition activities, entitlements, project feasibility, forward planning, design oversight, construction and development budgets, marketing coordination, securing necessary governmental approvals, capital investors, and resolution of pertinent policy issues that supports the company's objectives. Mr. Winter is also the liaison with the architects, engineers, governmental agencies, contractors, marketing team, lenders, development and equity partners. Mr. Winter provides the leadership, management and vision necessary to ensure that Civic Partners has the proper operational controls, administrative and reporting procedures, people systems and resources in place to effectively grow the organization and to ensure financial strength and operating efficiency. Mr. Winter currently oversees the acquisition, development, construction, sales, leasing or disposition operations of several multi-use developments with a potential build out of over 5,000 homes along with major commercial components.

Prior to rejoining Civic Partners, Mr. Winter was affiliated with other industry leading real estate development companies including AMCAL, Irvine Company and Sares-Regis Group. With over thirty years of experience in the real estate development business he has managed the development and construction of several million square feet of commercial properties, completed several large land developments and built over twenty-eight thousand homes.

Mr. Winter is a licensed California General Contractor since 1982 and started in the real estate development business in 1975. Mr. Winter served on the Executive Committee and held several Board positions for California and local Building Industry Associations along with memberships in the Urban Land Institute and NMHC.

**EDUCATION**

Bachelor of
Economics, University
of California,
San Diego

TINA L. ALEXANDER

DEVELOPMENT MANAGER

Ms. Alexander's position with Civic Partners includes the management of projects from visioning through construction. She is responsible for the coordination of all project activities. As a Civic Partners' Development Manager, Ms. Alexander works diligently with all team members to meet the project scheduling and financial goals. She is a key member of Civic Partners' management team for the 3,000-acre master planned community project in the City of Lake Elsinore, California. Components of this project include a residential golf community consisting of single-family and multifamily residential units, a town center, retail and recreational facilities. With 10 years of expertise in residential development from highly acclaimed home building firms, including Akins Companies, Catellus Residential and R.S. Myers Company, Ms. Alexander is a key company resource for the residential development ventures in which Civic Partners participates. Her experience in the home building industry includes project management, on-site field management and supervision, project scheduling, bidding, estimating and tracking of construction budgets.

**EDUCATION**

Bachelor of
Engineering,
Vanderbilt University

MBA, University of
Cincinnati.

JEFFREY C. POMEROY, P.E.

PROJECT EXECUTIVE

Mr. Pomeroy has over 30 years of engineering and facility construction experience. His expertise includes strategic planning, joint venture and team building, project development, operations management, engineering, estimating, and structural and civil design. Mr. Pomeroy provides leadership on all construction and engineering matters for the Company. He is also a registered professional engineer in Arizona, Ohio, Tennessee, Kentucky and with the NCEE. Prior to joining Civic Partners, Mr. Pomeroy was President of the HNTB Design/Build subsidiary of HNTB, and international design firm. With HNTB he was responsible for projects for both the public and private sector with a constructed value in excess of \$1 billion. He has successfully managed projects that include: large transportation and infrastructure, institutional and education, sports and recreation, commercial and industrial and mixed use residential. For Civic Partners, he has completed entitlement of a public golf course and more than 1300 residential lots, a 4-building complex that includes a county courthouse, 2 mixed use retail/residential buildings, a state office building, and two parking structures, one above grade and the other subterranean.

**EDUCATION**

Bachelor of Business
Economics and
Psychology,
University of California,
Santa Barbara

SHELLY LA RUFFA

FINANCIAL MANAGER

Ms. La Ruffa is responsible for the financial aspects of corporate affairs, including project financing and asset management. Her areas of focus are in creative financing and facilitating complex real estate transactions. She provides experience in public improvement bonds, tax increment financing, gap financing, low-income housing tax credits, land entitlement, and public/private partnerships. She also manages all office administration, human resources, and information technology. She supervises the Company's administrative team and a variety of consultants that assist her in carrying out those responsibilities. For each development project, Ms. La Ruffa offers expertise in the areas of banking, budgeting and accounting. She works closely with the Project Management Team in developing proformas and determining project financing strategies. She applies her practical experience and analytical knowledge to the day-to-day affairs of the company throughout all phases of the development process.



ERNESTO M. VASQUEZ, FAIA, NCARB

PARTNER-IN-CHARGE

Since SVA Architects' establishment, Mr. Vasquez has brought creativity and expertise to the team, which has garnered the firm recognition throughout the building industry as innovators in both residential and mixed-use design. He has guided design teams on more than 1,000 major projects which have been recognized with prestigious national design and planning awards.

TITLE
CEO & Partner

EDUCATION
Bachelor of Architecture, with
Honors, California Polytechnic
State University, San Luis
Obispo

LICENSE
California - 09135

AFFILIATIONS
American Institute of Architects,
Urban Land Institute, National
Council of Architectural
Registration Board, BRIDGE
Housing Board of Directors,
Board Member of National Parks
Foundation, Chairman for The
Wooden Floor After School
Program in Santa Ana, California

EMAIL
evasquez@sva-architects.com



- ◇ **FRUITVALE/BART TRANSIT VILLAGE, OAKLAND, CALIFORNIA**
A key 10-acre project incorporating 30,000 sq. ft. of retail and 12,000 sq. ft. community resource center, plus 60,000 sq. ft. of commercial/office, a large 40,000 sq. ft. health clinic, a 5,000 sq. ft. library, and 47 affordable residential live/work units.
- ◇ **CELADON 9TH & BROADWAY AFFORDABLE MIXED-USE TOWER, SAN DIEGO, CALIFORNIA**
The project includes retail and commercial spaces above 2 1/2 floors of below grade parking and with sixteen stories of mixed residential apartments above. The project achieved LEED Gold Certification.
- ◇ **THE UPTOWN, OAKLAND, CALIFORNIA**
A dynamic 14-acre urban renewal project including 60,000 sq. ft. of retail/commercial space, 1,200 mixed-income apartments, as well as 400-units of off-campus graduate housing and 900 market-rate condominiums. It is LEED Silver Certified.
- ◇ **COMM 22, SAN DIEGO, CALIFORNIA**
This is a planned mixed-use, transit-oriented development that provides 197 affordable family apartments and senior housing options. The project is LEED Gold Certified.
- ◇ **PLEASANT HILL BART TRANSIT VILLAGE, PLEASANT HILL, CALIFORNIA**
A mixed-use transit-oriented development on a large 18-acre site featuring 45,000 sq.ft. of retail space, 290,000 sq. ft. of commercial office space, and 550 residential units.
- ◇ **AVALON WALNUT CREEK BART TRANSIT VILLAGE, WALNUT CREEK, CALIFORNIA**
Avalon Walnut Creek is home to 5,000 residents. It features 423 rental townhomes and flats over street-level retail and includes 20% affordable housing units. The market-rate podium housing units are three-to-five stories over 45,000 sq. ft. of retail space with 100 for-sale units of podium housing over parking.
- ◇ **FRUITVALE PHASE IIB, OAKLAND, CALIFORNIA**
Fruitvale Village Phase II will bring 92 affordable and 183 market rate housing units within minutes of a bustling commercial district and close to public transit and amenities.



NATHAN HERRERO, AIA, LEED AP BD + C

PROJECT MANAGER

Nathan Herrero is one of the principal managers of our Oakland branch and the studio director for all mixed-use and multifamily projects in Northern California. He manages assignments from conception and the programming phase to construction administration. Mr. Herrero's many strengths include his expertise in Building Information Modeling (BIM) and related design software programs such as Revit.

TITLE

Senior Associate Partner

EDUCATION

Bachelor of Architecture,
Yale University

LICENSE

California - 33048

AFFILIATIONS

American Institute of Architects,
United States Green Building
Council - Leader in Energy
and Environmental Design
Accredited Professional

EMAIL

nherrero@sva-architects.com



ARCHITECTS

◇ FRUITVALE PHASE IIB, OAKLAND, CALIFORNIA

Fruitvale Village Phase II will bring 92 affordable and 183 market rate housing units within minutes of a bustling commercial district and close to public transit and amenities.

◇ TWIN RIVERS REDEVELOPMENT BLOCKS A + B, SACRAMENTO, CALIFORNIA

The Twin Rivers low-income housing project will be completely destroyed and rebuilt to accommodate more units and a variety of income levels. The current 218 units will eventually become 498 units, most of which will be low-income with a mix of market-rate units.

◇ UC DAVIS WEST VILLAGE THE RAMBLE, DAVIS, CALIFORNIA

1,860 beds of three-story walk-up apartment and townhome style units. This project will feature a variety of amenities including a leasing center with game room, fitness center and pool. This Zero Net Energy project has LEED Platinum Certification.

◇ THE RESIDENCES AT BERKELEY PLAZA, BERKELEY, CALIFORNIA

The new residential destination proposes a mixed-use building with approximately 355 for-rent residential units adjacent to the BART Station in the central core of downtown. This project is targeting a LEED Gold certification.

◇ EL MONTE GATEWAY MASTER PLAN AND PHASE I, EL MONTE, CALIFORNIA

This master planned project will be a model for transit-oriented developments, offering a multitude of affordable and residential units over three phases with a variety of open spaces that encourage pedestrian usage and interaction. Parcel 1, The Exchange at El Monte, has delivered 132 affordable units in a four-story building on podium over one level of parking.

◇ KAPOLEI MIXED-USE PROJECT, KAPOLEI, HAWAII

The Kapolei Mixed-Use project consists of four eleven-story residential towers sitting on top of a two-story mixed-use building base that fronts the city streets on all four sides of the building. On the perimeter of level one is a mix of uses including approximately 18,900 sq. ft. of retail, a child daycare center, community spaces, entry lobbies for each residential tower, and supporting office space for the residential uses above.



ERICA CARVALHO, ASSOC. AIA

SENIOR DESIGNER

Ms. Carvalho has over a decade of experience on high-end complex projects around the world. She brings a wide breath of architectural and planning experience, combined with an efficient BIM lead process and delivery, and she brings to our team her profound experience and talent in design, sustainability, technology, and technical aptitude.

TITLE

Senior Designer

EDUCATION

Masters of Architecture,
University of Detroit Mercy

Bachelor of Architecture,
University of Detroit Mercy

AFFILIATIONS

American Institute of Architects

EMAIL

ecarvalho@sva-architects.com



ARCHITECTS

◇ OAKLEY SENIOR LIVING COMMUNITY, OAKLEY, CALIFORNIA

This project is a 100% affordable senior housing community on a 5.85-acre site. The 132-unit development is comprised of 80% one-bedroom units and 20% two-bedroom units. The Oakley Senior apartments offer a walkable, affordable living option for Oakley's senior community.

◇ DENNY APARTMENTS, LOS ANGELES, CALIFORNIA

Located in the North Hollywood Arts District, the Denny Apartments will become a positive and inspiring addition to a diverse and thriving community. With its historical theaters, modern art scene, sound studios, and casual cafe, the NoHo Arts District is well served by both Metro Rail Red Line and the Metro Orange Line bus rapid transit, providing the future residents of the Denny Apartment Community with easy connectivity to the greater Los Angeles area.

◇ ONE SAN PEDRO, SAN PEDRO, CALIFORNIA

Redevelopment of a 21-acre public housing complex into a thriving mixed-income residential community that integrates retail and community services.

◇ SANTA FE SPRINGS HOUSING DEVELOPMENT, SANTA FE SPRINGS, CALIFORNIA

100% Affordable 85 unit master plan with an attached 85 unit bridge housing development supporting families and children, this development's main focus is the health and well-being of the community while providing ample spaces for children to play and supportive programmatic spaces for families.

◇ PALO ALTO EDUCATOR HOUSING, PALO ALTO, CALIFORNIA

With the goal of bridging the cost of living and attracting talent, this four-story building, includes 3-stories of residential over a ground floor podium and underground parking garage and a total of 100 residential units. The ground floor is open and provides resident's and community services.

◇ LAKESIDE LIBRARY, LAKESIDE, CALIFORNIA

A 17,000 square feet community library for the city of Lakeside, CA, this Library is envisioned to become a civic and social hub for the community.



CARL BARRETT, LEED AP

PRESIDENT

Carl began his career at Otto Construction in 1993. As a member of the senior management team, Carl fully participates in all aspects of the management of the company. This includes strategic and tactical business planning, decision making in regard to operations, corporate policies and procedures, and staffing issues. He sets the tone and is in charge of reflecting the corporate culture of Otto Construction. Carl provides leadership and expertise to the project team and develop and maintain positive relationships with all team members, including trade partners, consultants, engineers, owners, and the design team.

EDUCATION

California Polytechnical State
University, San Luis Obispo
B.S. Construction Management

LICENSE

LEED Accredited Professional



- ◇ **NORTH NATOMAS COMMUNITY CENTER & AQUATICS CENTER, SACRAMENTO, CA**
\$35.4M | Lease-Leaseback
- ◇ **POWERHOUSE SCIENCE CENTER, SACRAMENTO, CA**
\$39.2M | Design-Build
- ◇ **L STREET LOFTS, SACRAMENTO, CA**
\$29.8M | Design-Build
- ◇ **COSUMNES RIVER COLLEGE COLLEGE CENTER EXPANSION, SACRAMENTO, CA**
\$21.2M | Design-Bid-Build
- ◇ **TURLOCK IRRIGATION DISTRICT PALM STREET COMPLEX RENOVATION, TURLOCK, CA**
\$8.1M | CM@Risk



ALLISON OTTO, LEED AP, ASSOC. DBIA

EXECUTIVE VICE PRESIDENT

As Executive Vice President, Allison oversees the strategic direction of Otto Construction, including client outreach and negotiation, identifying and acquiring new clients, maintaining relationships with current and past clients, and overseeing projects from an executive standpoint. She has a proven record of maintaining and expanding relationships with clients, architects, consultants and other business and community organizations.

EDUCATION

University of Southern California
B.S. Business Administration
UC Davis Extension
Construction Management

LICENSE

LEED Accredited Professional
Designated Design-Build
Professional (DBIA)



- ◇ **POWERHOUSE SCIENCE CENTER, SACRAMENTO, CA**
\$39.2M | Design-Build
- ◇ **GREER ELEMENTARY SCHOOL NEW CONSTRUCTION & MODERNIZATION, SACRAMENTO, CA**
\$37.3M | Design-Build
- ◇ **CSU MONTEREY BAY ACADEMIC III, SEASIDE, CA**
\$32M | Design-Build
- ◇ **CALIFORNIA STATE UNIVERSITY, STANISLAUS LIBRARY RENOVATION, TURLOCK, CA**
\$46.2M | Design-Build
- ◇ **NORTH NATOMAS COMMUNITY CENTER & AQUATICS CENTER, SACRAMENTO, CA**
\$35.4M | Lease-Leaseback

PROJECT EXPERIENCE

4. Team Qualifications





THE CORRIDOR

Boise, Idaho

The Corridor project is a major mixed-use project adjacent to Boise's historic downtown. Civic Partners led the development team in building the community's vision of an exciting new "gateway" to downtown.

The entire project showcases a mixed-use, urban master plan that, upon completion, created a vibrant and expanded downtown destination. The project includes a county courthouse and county administrative center as its focal point. The master plan also incorporated privately owned office buildings, retail shops, restaurants, a parking structure, and residential dwellings. The various uses are linked together with a beautifully designed "pedestrian paseo," courtyards, landscaped arcades and open space corridors.

The master plan incorporates these uses into the rich mixture of the traditional urban lifestyle found in Boise, while creating exciting new streetscapes designed to strengthen the city's established grid system and its downtown area.



TYPE	Mixed-Use
SCOPE	Civic Center, Office, Residential, Retail
SIZE	14 acres
ONGOING CONTRIBUTIONS	Fully Funded at Predevelopment and Construction



TENTH STREET PLACE

Modesto, California

Tenth Street Place is a pedestrian-oriented, mixed-use project in the heart of downtown Modesto. This project is the centerpiece of the redevelopment efforts of the City of Modesto.

The project includes office, retail, and entertainment components that bridge the gap between a hotel/convention center and the most vibrant existing commercial areas. The main portion of the project consists of administrative offices for Stanislaus County and the Modesto City Hall. Additionally, the project includes an 18-screen cinema and approximately 48,000 square feet of retail space, in three phases. A 750-space parking structure has also been built as part of the project.

The project has received top state and national awards for successful downtown revitalization. These include the James Howland Gold Award for Urban Enrichment from the National League of Cities and the National Economic Development Partnership Award from the National Council for Urban Economic Development.



TYPE	Mixed-Use
SCOPE	Public Office, Retail, Private Office, Entertainment
SIZE	4 acres
ONGOING CONTRIBUTIONS	Fully Funded at Predevelopment and Construction



LAKE ELSINORE MASTER PLAN

Lake Elsinore, California

This master planned community is a redevelopment project located within the City of Lake Elsinore, California. The property for this project was previously undevelopable flood plain located on the edge of the city's recreational lake known as Lake Elsinore.

Upon completion, this sizeable recreational resort community will contain a mix of residential product types, a golf course, a motorsports track facility, commercial, hotels and village retail with office and restaurant uses.

The Lake Elsinore Redevelopment Agency selected a Civic Partners' affiliate as the master developer of this lakefront property. Civic Partners is under construction on a 143-unit workforce housing project and, in partnership with a multi-billion dollar Real Estate Investment Trust, is under construction on a 700+ acre master planned community of approximately 1,700 homes. Additional land will be developed to meet the market demand for commercial, retail and additional housing.



TYPE	Master Planned Community
SCOPE	Residential, Commercial, Recreation, Retail/Entertainment, Hospitality
SIZE	3,000 acres
ONGOING CONTRIBUTIONS	Tax Increment Dedicated Through 2038



SUMMERLY GOLF COURSE COMMUNITY

Lake Elsinore, California

Nestled against the 18 fairway Links at Summerly championship golf course and within a project area that encompasses the largest fresh water lake in Southern California sits the master planned community of Summerly. At completion, there will be approximately 1,700 detached homes constructed by multiple merchant builders.

Summerly is a joint venture between Civic Partners and a multi-billion dollar California Real Estate Investment Trust.

This community is being created through a public/private venture with the City of Lake Elsinore. It was the goal of the city to see what was once a 3,000 acre floodplain developed to its highest and best use. The Summerly community and the Links golf course utilize 700+ acres and Civic Partners is identified as the master developer of the balance of the land.



TYPE	Residential Golf Community
SCOPE	Single Family Detached Homes & 18-Hole Golf Course
SIZE	700 acres, 1,700 units (of which 1,200 have been built)
ONGOING CONTRIBUTIONS	Tax Increment Dedicated Through 2038



ARTISAN ALLEY AT THE DIAMOND

Lake Elsinore, California

As the master developer of a 3,000-acre lakefront property in the City of Lake Elsinore, Civic Partners is moving forward with development of The Diamond project.

Artisan Alley at The Diamond is an 11-acre project that at completion will include a hotel and collection of businesses specializing in the production of craft goods, including beer makers, bakery, coffee roaster, along with a mix of additional artisan food providers and specialty shops. There will be a mix of industrial, retail and restaurant spaces to accommodate the manufacturing, tasting and purchasing of these goods.

The site is within the 87-acre Diamond Specific Plan which at build out will include hospitality, residential, and approximately 900,000 square feet of retail, office, and sports venues all surrounding the Diamond Stadium. The mission is to create a vibrant community atmosphere within the Ballpark District to complement the adjacent 1,700 home Summerly Golf Course Community.



TYPE	Mixed-Use
SCOPE	Retail/Entertainment, Industrial, Hospitality
SIZE	11 acres
ONGOING CONTRIBUTIONS	Tax Increment Dedicated Through 2038



COTTAGES AT MISSION TRAIL

Lake Elsinore, California

The Cottages at Mission Trail is a workforce housing project under construction on approximately 19.5 acres of property within the Lake Elsinore Master Plan for which Civic Partners is the master developer.

At completion, there will be 143 two- and three-bedroom units in detached, duplex and triplex structures. In addition to the rental units, the project will include a 2,200 sq. ft. community building within a park area consisting of a basketball court, picnic tables, tot lot, and open turf area.

The units will be limited to households earning between fifty and sixty percent of Riverside County Area Median Income. This Low Income Housing Tax Credit (LIHTC) project is being developed as a nonprofit workforce housing community with AOF/Pacific Affordable Housing Corp.



TYPE	Residential Housing Community
SCOPE	Workforce Housing
SIZE	19.5 acres
ONGOING CONTRIBUTIONS	Tax Increment Dedicated Through 2038, Low and Moderate Income Housing Assets Funds, In Lieu Fees



VISTA VILLAGE

Vista, California

Vista Village is a 30-acre master planned redevelopment project centrally located in downtown Vista, California. The City of Vista invested over \$80 million in land acquisitions and site improvements.

Vista Village is a regionally oriented retail/entertainment project exceeding 400,000 square feet and serves the communities of North San Diego County.

The project encircles the City's aquatic facilities that service all of the local scholastic organizations and the community at large. This retail/entertainment project is anchored by a state-of-the-art, 15-screen, all stadium theater. The project also includes full service restaurants, casual dining, fast food establishments and a variety of retail businesses.

The "Main Street" appeal of the design and construction blends into the existing downtown to the South, enhancing the pedestrian retail/entertainment experience.



TYPE	Retail/Entertainment
SCOPE	Cinema, Retail
SIZE	30 acres
ONGOING CONTRIBUTIONS	Fully Funded at Predevelopment and Construction



TWIN RIVERS

Sacramento, California

Twin Rivers replaces an existing deteriorated public housing project with a new mixed-income development in Sacramento's River District. The project consists of a variety of building types from two-story townhomes to three-story garden apartments to four-story apartment buildings. The project offers various unit sizes and caters to different income levels (market rate, tax-credit affordable, and public housing), to create a truly integrated community. Primary entries face the street with parking hidden internally, allowing front doors and porches to have a pedestrian-friendly aesthetic.

The design uses sustainable materials, and borrows from the agricultural culture of the Sacramento Region with simple shed roofs and gable forms. New streets enhance the connectivity and safety. A partial grid encourages families to share streets with periodic street parking, similar to old districts of Sacramento. It also includes a public park, pools, playgrounds, walking paths, and a splash pad. The site is adjacent to a future SacRT station along 12th Street, with a future phase of the project to be built at the station. Twin Rivers includes a variety of building types to create a vibrant visual experience and blends modern design with historical references and materials to create a new vision for the River District.



TYPE	Residential
SCOPE	Full Architectural Services
SIZE	14.1 Acres
ONGOING CONTRIBUTIONS	N/A



THE UPTOWN

Oakland, California

Uptown Oakland Development is a true urban renewal project incorporating a mix of retail/commercial, entertainment, and residential uses. Located between San Pablo and Telegraph just north of the recently renovated Civic Center and adjacent to the BART stations, Uptown Oakland includes 60,000 sq.ft. of retail/commercial space, 1,200 mixed-income apartments, 400 off-campus graduate student housing units for U.C. Berkeley and 900 condominiums when completed. The low-rise rental units and urban loft-style apartments are located between 21st and 18th Streets, with ambling paseos linking the lofts and residential towers to the vibrant entertainment district.

The high-rise towers along Telegraph are for-sale residential units with lobbies and retail activities on street level. Lofts were created by renovating the existing buildings, thereby maintaining the historical significance of the overall site. The entertainment district has become a major focal point, connecting retail and restaurant uses. The Telegraph Corridor between the Paramount Theater and the future Fox Theater renovation provides live events, a food court, and a revitalized skating rink. Uptown Oakland exemplifies what can be achieved by turning older, under-utilized parking lots into an urban community bringing people back downtown while revitalizing the existing BART Transit.

Uptown Oakland Development received LEED Silver certification in 2008.



TYPE	Mixed-Use Residential
SCOPE	Full Architectural Services
SIZE	14 acres
ONGOING CONTRIBUTIONS	N/A



EL MONTE GATEWAY

El Monte, California

SVA has developed a master plan for a new transit-friendly mixed-use development. El Monte Gateway is anchored by the newest and largest regional transit hub in the MTA network. The new, larger El Monte Station serves more than 35,000 daily users, and is considered one of the largest transit centers in the Western United States. This station is the cornerstone of the development that will later grow to include commercial and regional shopping development in its second phase.

The Gateway's first phase opened in October 2015, with 132 affordable family apartment units. Construction is underway for the El Monte Gateway project's second phase, which will include retail offerings and 208 apartments. Once complete, this segment of the Gateway is set to include 25,000 square feet of retail and dining space, a community center and a four-story apartment building with two levels of underground parking. The project's third phase is set to add 212 apartments.

El Monte Gateway Phase I features a central courtyard with barbecue/picnic areas, a tot lot, outdoor seating areas, and bike storage in the garage to promote exercise and a healthy lifestyle. Other amenities include a 3,350 square-foot community center with computer lab, fitness center and tutoring/arts and crafts room. The development is LEED Platinum certified. This lowers energy consumption, provides a cost-saving benefit and promotes the health of residents.



TYPE	Mixed-Use Residential
SCOPE	Master Planning, Full Architectural Services
SIZE	14.27 acres
ONGOING CONTRIBUTIONS	N/A



POWERHOUSE SCIENCE CENTER

Sacramento, California

The new Powerhouse Science Center, an adaptive reuse of the historic 1912-era PG&E Power Station, will be the region's premiere science center and serve as a hub for science education and exploration. The historic power station will undergo stabilization and complete rehabilitation with construction of a new floor level inside and a new intermediate floor for exhibit space. A new two-story, 22,000SF addition will be built on the east side of the existing building containing an entry lobby, classrooms, offices, a café and a 110-seat planetarium.



TYPE	Educational
SCOPE	Construction
SIZE	48,132 sq. ft.
ONGOING CONTRIBUTIONS	N/A



L STREET LOFTS

Sacramento, California

Standing eight stories high, the L Street Lofts is surrounded by coffee houses, night clubs, restaurants, art galleries, live theatres, boutiques, and churches. The basement and first two levels offer 128 parking stalls for residents, along with retail and restaurant space. Levels three through seven are comprised of 80 lofts, with 4 different floor plans named after local theatres: the Alhambra, the Tower, the Majestic, and the Crest. The 12 penthouses are located on the eighth level and offer two-story views of the growing Sacramento skyline. With hardwood floors, granite countertops, European cabinetry, and 10-18 foot ceilings, the L Street Lofts are located in the heart of the city, towering over midtown's most popular cultural and social destinations.



TYPE	Multifamily
SCOPE	Construction
SIZE	190,000 sq. ft.
ONGOING CONTRIBUTIONS	N/A



CAPITOLA BRANCH LIBRARY

Capitola, California

This project consists of the demolition of the existing library and construction of a new 11,700SF library. The new building will be flexible and modern, incorporating quiet outdoor reading spaces and better connections to its surroundings with features such as a pedestrian walkway to the nearby creek. With a serene, light-filled reading room, a vibrant children's area, a community porch and meeting room, the new library is designed to bring people together and nurture engagement.



TYPE	Institutional
SCOPE	Construction
SIZE	11,700 sq. ft.
ONGOING CONTRIBUTIONS	N/A

PUBLIC AGENCY REFERENCES



CIVIC PARTNERS

Tenth Street Place

Mike Herrero
Economic Development Director, City of Modesto
T: 209-505-8171
E: mherrero600@gmail.com

Lake Elsinore Master Plan

Barbara Zeid Leibold
City Attorney, Leibold McClendon & Mann
T: 949-585-6300
E: barbara@CEQA.com

Ada County Corridor

Michael F. Reuling
Past Chairman, Capital City Development Corp.
(Boise Redevelopment Agency)
T: 208-761-5003
E: reuls@cableone.net

Lake Elsinore Master Plan

Grant Yates
City Manager, City of Lake Elsinore
T: 951-674-3124 x204
E: gyates@lake-elsinore.org

Lake Elsinore Master Plan

Kim Cousins
President, Lake Elsinore Valley Chamber of Commerce
T: 951-245-8848
E: kim@lakeelsinorechamber.com

Lake Elsinore Master Plan

Jim Stroffe
Freidman, Stroffe & Gerard
T: 949-265-1103
E: jstroffe@fsglawyers.com

Vista Village

Rita Geldhert
City Manager (retired), City of Vista
E: rlgeldhert@cox.net

SVA ARCHITECTS

La Habra Civic Center

Roy Ramsland, Planning Manager
City of La Habra
T: 562-383-4100
E: rramslan@lahabraca.gov

San Ysidro Library

Jasiah Neff, Associate Engineer
City of San Diego
T: 619-533-7462
E: jneff@sandiego.gov

Quartz Hill Library

Vache Keledjian, Capital Projects Manager
County Of Los Angeles
T: 562-940-8421
E: vkeledjian@library.lacounty.gov

Great Park Administration Building

Rebecca Bridgeford, Project Administrator
City of Irvine
T: 949-724-7308
E: rbridgeford@cityofirvine.org



www.civicpartners.com / www.sva-architects.com

**EXCLUSIVE NEGOTIATING RIGHTS
AGREEMENT**

This Exclusive Negotiating Rights Agreement (this "Agreement") is entered into effective as of _____ (the "Effective Date") by and between the City of Rancho Cordova, a municipal corporation ("City"), and _____, a _____ ("Developer"). City and Developer are referred to herein individually as "Party" and collectively as "Parties".

RECITALS

A. City owns fee simple title in that certain property consisting of approximately 9.85 acres located in the City, and more particularly described in Exhibit A attached hereto (the "Civic Center Property"). The Civic Center Property is located within the Folsom Boulevard Specific Plan Area, Mather Mills Opportunity Site and transit-oriented development overlay.

B. The City has conducted an extensive visioning process between March 2018 and April 2019 with community input to determine preliminary use concepts for the Civic Center Property. The City seeks the development of the Civic Center Property consistent with relevant City plans and development standards as a central gathering place. Specifically, the City seeks development of the Civic Center Property as a mix of event, activity, art, performance, wellness, retail, housing, and open spaces.

C. The City issued an Offering Memorandum for this site on July 19, 2019 and Developer submitted a statement of interest on September 20, 2019 highlighting its expertise in Public, Private Partnerships, Housing and Mixed-Use Development and Financial Strength, Flexibility among other strengths. The statement of interest included a team of qualified organizations in respective fields needed to execute the development of the Civic Center Property and proposed additional use concepts.

D. The City and the Developer desire to further explore and analyze designs and financial feasibility of multiple development alternatives ("Development Alternatives"), and for the City Council to determine which (if any) best accomplishes the City's goals for the Civic Center Property.

E. If the City Council selects a preferred Development Alternative, the City and the Developer desire to then commence the negotiation of the business terms of the preferred development (the "Proposed Development Terms"). The Proposed Development Terms may include, without limitation, the City's sale, ground lease and/or other conveyance of portions of the Civic Center Property to the Developer or other parties; the construction and development of a theater and event space, wellness center, public plaza, restaurant, retail, residential units, gymnasium, public and private parking, and other public and private uses on the Civic Center Property; the analysis and remediation of the environmental condition of portions of the Civic Center Property; the terms of public and private financing of the

development; and such other terms and conditions which are necessary for the successful development and redevelopment of the Civic Center Property.

F. If the City and the Developer mutually agree upon the Proposed Development Terms for a preferred Development Alternative, the City and the Developer desire to initiate exclusive negotiations to negotiate diligently and in good faith the terms and conditions of a Disposition and Development Agreement (“DDA”) or other agreement with respect to the development of some or all of the Civic Center Property, which, if agreed and executed by the Parties, will specify the rights, obligations and method of participation of the Parties with respect to the disposition and development of the Civic Center Property (the “Project”).

NOW, THEREFORE, in consideration of the mutual covenants and agreements set forth herein and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Parties agree as follows.

1. Good Faith Efforts to Negotiate. The Parties shall use their best efforts to successfully negotiate a Preferred Development Alternative, Development Terms, and a DDA that shall describe the terms and conditions governing disposition of the Civic Center Property and development of the Project. The Parties shall pursue such negotiations diligently and in good faith.
2. Analysis of Development Alternatives. The Parties shall meet and confer as necessary to formulate several Development Alternatives and undertake the following activities during the period beginning on the date of this Agreement, and return to the City Council for discussion no later than the end of January, 2021.

2.1 Developer Submissions. Within ninety (90) days from the date of this Agreement, Developer shall submit the following to the City for each of the formulated Development Alternatives:

2.1.1. Narrative description of each Development Alternative describing the role of the Developer, other builders, and the City.

2.1.2. Site plan and conceptual elevation drawings of each Development Alternative.

2.1.3. Development program and phasing plan for the Development Alternative, including gross building area, leasable area, list and sizes of public components including mix of residential unit sizes, retail tenants, other commercial spaces, public or private parking, and sequencing of development.

2.1.4. Preliminary financing plan for each component within the Development Alternative. The plan should include: (1) a summary of all costs and sources of funding, such as debt; equity, CFD, City contribution, and other funding sources; (2) the terms for all debt and equity and the City’s contribution (interest rate, term, return requirements, waterfall), (3) a land development cost pro forma,

(4) details for shell costs, land costs, FF&E, parking costs, tenant improvements, soft costs, financing costs, developer fee, etc., (5) a stabilized net operating income projection for each development component, and (6) a cash flow projection for each component showing net cash flow before and after debt service,

2.1.5. List and schedule of due diligence studies to be undertaken by the Developer before execution of a DDA.

2.2 City Obligations.

2.2.1. City shall provide to Developer copies of all documents in the City's possession that would assist the Developer with the due diligence activities described in this Agreement.

2.2.2. City shall provide to Developer copies of any environmental studies it has of the Civic Center Property and information and documents regarding the scope of any environmental remediation work needed to be performed upon the Civic Center Property and the City's discussions with regulatory agencies related thereto.

2.2.3. The City shall conduct a pre-application consultation with the Developer pursuant to Section 15060.5 of the California Environmental Quality Act ("CEQA") Guidelines to consider what level of CEQA review of the DDA will be required, if any. The pre-application consultation may, but is not required to, include the preparation of an environmental checklist form and/or initial study.

3. Selection of a Preferred Development Alternative. Following the January 2021 meeting with the City Council, or such further meetings with the City Council as required, the Parties will focus on formulating the Development Alternative preferred by the City Council ("Preferred Development Alternative"), which shall be considered for approval by the City Council not later than May 2021, prior to negotiating the terms of a DDA as detailed in Section 4. While formulating the Preferred Development Alternative, the following items shall be submitted by the Developer:

3.1 Letters of interest from prospective lenders and equity partners demonstrating that pro forma projections for each land use component are reasonable and acceptable.

3.2 Development cost pro formas for the horizontal land improvements and the vertical improvements of each land use component that reflect cost estimates prepared by an independent cost estimator or general contractor.

4. Disposition and Development Agreement. Once the City Council selects a Preferred Development Alternative the Parties will then initiate exclusive negotiations to negotiate diligently and in good faith the terms and conditions of a DDA.

5. Term. The term of this Agreement (the "**Term**") shall commence on the Effective

Date and shall terminate on the one-year anniversary of the Effective Date, unless extended or earlier terminated as provided herein. The City Manager is authorized to extend the Term by up to an additional six months upon the mutual written agreement of the Parties without further approval of the City Council.

6. Exclusivity and City's Retention of Discretion.

6.1 Developer's Exclusive Right to Negotiate. The City agrees that during the term of this Agreement the City shall not negotiate or enter into an agreement with any other person or entity regarding development of the Civic Center Property. The obligation to negotiate in good faith requires the respective Parties to communicate with each other with respect to those issues for which agreement has not been reached, and such communication to follow reasonable negotiation procedures, including meetings, telephone conversations, and correspondence. The Parties understand that final accord on all issues may not be reached. It is also understood that: (1) neither Party is under any obligation to reach agreement on a Preferred Development Alternative, Proposed Development Terms or a DDA, and (2) the City Council reserves the right to approve or reject the Preferred Development Alternative, Proposed Development Terms or DDA, in its sole discretion, as more particularly set forth in this Section 6.

6.2 Review and Approval by the City of all Discretionary Findings and Conclusions. The duty of the City to dispose of the Civic Center Property shall be conditioned upon the successful review and approval of all necessary findings and conclusions which the City Council, Planning Commission, Design Review and other City commissions are required to make, including all necessary findings and determinations required under CEQA, state and local laws relating to the City's disposition of real property, and state and local land use provisions. As to any matter which the City may be required to exercise its unfettered discretion in advancing the Project to completion, neither anything contained herein, nor to be contained in the Proposed Development Terms, shall obligate the City to exercise its discretion in any particular manner, other than in good faith and fair dealing and any exercise of discretion reserved hereunder or required by law, shall not be deemed to constitute a breach of the City's duties under this Agreement.

6.3 No Pre-Commitment by the City. By its execution of this Agreement, until such time as one or more DDAs are agreed to and executed by the parties, the City is not committing itself to or agreeing to undertake any activity requiring the subsequent exercise of discretion by the City, or any department thereof including, but not limited to, the approval of a Development Alternative; the proposal, amendment, or approval of any land use regulation governing the Civic Center Property; the provision of any financial assistance for the development of any public or private interest in real property; the acquisition of real property; or any other such activity. The City retains the absolute sole discretion to (i) modify the transaction, create and enter into transactional documents, and modify the Project as may, in its sole discretion, be necessary to comply with CEQA, (ii) select other feasible alternatives to avoid significant environmental impacts, (iii) balance the benefits of the Project against any significant environmental impacts prior to taking final action if such significant impacts

cannot otherwise be avoided, and/or (iv) determine not to proceed with the Project. The City does not make any representations or warranties with respect to its authority under applicable state and local laws to convey any or all of the Civic Center Property to Developer. No legal obligations will exist unless and until the parties have negotiated, executed and delivered mutually acceptable agreements based upon information produced from the CEQA environmental review process and on other public review and hearing processes, subject to all applicable governmental approvals. In the event that additional time is required for either or both parties to comply with the requirements of CEQA, the times for performance hereunder shall be extended as necessary.

6.4 No Property Disposition Required. This Agreement does not constitute a disposition of property or exercise of control over property by the City and does not require a public hearing. Each Party's execution of this Agreement is merely an agreement to enter into a period of preparation and submission of development plans and exclusive negotiations according to the terms hereof, reserving final discretion and approval by each Party.

7. Relationship of Parties. The Parties agree that nothing in this Agreement shall be deemed or interpreted to create between them the relationship of lessor and lessee, seller and buyer, principal and agent, or partners or joint venturers.

8. Effect of Termination. Upon termination of this Agreement as provided herein, or upon the expiration of the Term and any extensions thereof without the Parties having successfully negotiated a DDA, this Agreement shall forthwith be void, and there shall be no further liability or obligation on the part of either of the Parties or their respective officers, employees, agents or other representatives, except for such provisions as are expressly stated to survive such termination or expiration.

9. Developer Reports and Studies. During the Term, Developer shall use its commercially reasonable good faith efforts to prepare, at Developer's expense, any studies, surveys, plans, specifications and reports ("Developer's Studies") it deems necessary or desirable to determine the suitability of the Civic Center Property for the Project. Developer shall be responsible for obtaining City's advance written permission for access to the Civic Center Property as necessary to prepare the Developer's Studies. In connection with entry onto the Civic Center Property, Developer shall and does agree to indemnify the City and its elected and appointed officials, employees, agents, consultants and contractors (the "Indemnitees") from and against all claims resulting from or arising in connection with such entry by Developer or Developer's agents, employees, consultants or contractors, but excluding any existing environmental or hazardous material conditions. Prior to such entry on the Civic Center Property, Developer shall provide City with proof of insurance in accordance with City's requirements, and shall maintain such insurance throughout the Term. This indemnification shall survive the termination or expiration of this Agreement.

10. Miscellaneous.

10.1 Notices. Formal notices, demands and communications between the Agency

and the Developer shall be sufficiently given if, and shall not be deemed given unless, dispatched by certified mail, postage prepaid, return receipt requested, or sent by express delivery or overnight courier service, to the office of the Parties shown as follows, or such other address as the Parties may designate in writing from time to time:

City: The City of Rancho Cordova
2729 Prospect Park Drive
Rancho Cordova, CA 95670
Attention: City Manager

Developer: Developer
Address
Attention

With a copy to: Designated Entity
Address
Attention

Such written notices, demands, and communications shall be effective on the date shown on the delivery receipt as the date delivered or the date on which delivery was refused.

10.2 Waiver of Lis Pendens. The Parties expressly understand and agree that no lis pendens shall be filed against any portion of the Civic Center Property with respect to this Agreement or any dispute or act arising from it. This waiver will terminate upon the execution of a DDA.

10.3 Costs and Expenses. Except as otherwise expressly provided in this Agreement, each Party shall be responsible for paying all of its own costs and expenses, including any payments to third parties, pertaining to any activities and negotiations undertaken in connection with this Agreement, and the performance of each Party's obligations under this Agreement.

10.4 Assignment of Plans. If this Agreement expires or is terminated for any reason other than a material default or default hereunder by the City, the City may, in its sole and absolute discretion, request that the Developer assign and transfer Developer's rights to any or all Developer plans identified by the City for the Project, provided that the City shall pay to Developer, as consideration for such plans, Developer's out of pocket cost for such plans. Upon such request, the Developer shall deliver to the City copies of all plans requested by the City together with a bill of sale therefor, provided that Developer makes no representations, warranties or guarantees regarding the completeness or accuracy of the plans, and Developer does not covenant to convey the copyright or other ownership rights of third parties thereto. Such plans shall thereupon be free of all claims or interests of Developer or any liens or encumbrances. Upon the City acquiring the Developer's rights to any and all of the Plans for the Project, the City shall be permitted to grant, license, or other dispose of said plans to any

person or entity for development of the Civic Center Property or any other purpose, provided, however, that Developer shall have no liability whatsoever to the City or any transferee or title to the plans in connection with the use of the plans.

10.5 No Commissions. Each Party represents and warrants that it has not entered into any agreement, and has no obligation to pay, any real estate commission in connection with the transactions contemplated by this Agreement and any resulting DDA. If a real estate commission is claimed through either Party in connection with the transactions contemplated by this Agreement or any resulting DDA, then the Party through whom the commission is claimed shall indemnify, defend and hold the other Party harmless from any liability related to such commission. The provisions of this Section shall survive termination or expiration of this Agreement.

10.6 Defaults and Remedies. Failure by either Party to negotiate in good faith as provided in this Agreement shall constitute an event of default hereunder. The non-defaulting Party shall give written notice of a default to the defaulting Party, specifying the nature of the default and the required action to cure the default. If a default remains uncured ten (10) days after receipt by the defaulting Party of such notice, the non-defaulting Party may exercise the remedies set forth in this Section. In the event of an uncured default by the City, the Developer may seek an order of specific performance but shall not be entitled to seek damages. In the event of an uncured default by the Developer, the City's sole remedies shall be to terminate this Agreement or to seek specific performance. Without limiting the generality of the foregoing, neither Party shall have the right to seek an award of damages as a result of termination of this Agreement or default hereunder.

10.7 Attorneys' Fees. The prevailing party in any action to enforce this Agreement shall be entitled to recover attorneys' fees and costs in addition to any remedies to which such Party is entitled.

10.8 Governing Law. This Agreement shall be governed by and construed in accordance with the laws of the State of California without regard to principles of conflicts of laws.

10.9 Entire Agreement; Amendments. This Agreement, together with Exhibit A, constitutes the entire agreement of the Parties regarding the subject matter hereof and supersedes all prior written or oral agreements pertaining thereto. This Agreement may not be modified or amended except by a written instrument executed by the Parties.

10.10 Counterparts. This Agreement may be executed in counterparts, each of which shall be deemed an original but all of which together shall constitute one and the same instrument.

10.11 Assignment. Developer may not transfer or assign any of its rights or obligations under this Agreement except with the prior written consent of the City, which consent may be granted or withheld in the City's sole discretion, and any such attempted

transfer or assignment without the prior written consent of City shall be void.

10.12 No Third-Party Beneficiaries. This Agreement is made and entered into solely for the benefit of the City and the Developer, and no other person or entity shall have any right of action under or by reason of this Agreement.

10.13 Action by the City. Whenever this Agreement calls for or permits the approval, consent, authorization or waiver of the City, the approval, consent, authorization, or waiver of the City Manager shall constitute the approval, consent, authorization or waiver of the City without further action of the City Council.

10.14 Interpretation This Agreement has been negotiated at arm's length and between persons sophisticated and knowledgeable in the matters dealt with in this Agreement. Accordingly, any rule of law or legal decision that would require interpretation of any ambiguities in this Agreement against the party that has drafted it is not applicable and is waived.

10.15 Severability. If any term or provision of this Agreement is held by a court of competent jurisdiction to be invalid or unenforceable under applicable law, the invalid or unenforceable term or provision shall be ineffective to the extent of such invalidity or unenforceability and shall have no effect on the remaining terms and provisions of this Agreement.

10.16 Captions. The titles and headings of the sections in this Agreement are intended solely for reference and do not modify, explain, construe, define or limit any provision of this Agreement.

10.17 Waivers. No waiver or breach of any provision of this Agreement shall be deemed, or constitute, a waiver of any other provision, whether or not similar, nor shall any waiver be valid unless it is in writing and executed by the waiving Party. No extension of time for performance of any obligation or act shall be deemed an extension of time for any other obligation or act.

10.18 Time of the Essence. Time is of the essence in this Agreement and every provision contained herein.

10.19 Indemnification. Developer hereby covenants, on behalf of itself and its permitted successors and assigns, to indemnify, hold harmless, and defend the Indemnitees, from and against all liability, loss, cost, claims, demand, action, suit, legal or administrative proceeding, penalty, fine, damage and expense, including without limitation reasonable attorneys' fees and costs of litigation, arising out of or in connection with this Agreement or the activities contemplated hereby; provided, however, Developer shall have no indemnification obligation with respect to the gross negligence or willful misconduct of any Indemnitee. Developer's indemnification obligations shall survive the termination or expiration of this Agreement and shall not be obviated by Developer's

ITEM 12.1.

ATTACHMENT 6

provision of insurance as required by the City.

IN WITNESS WHEREOF, this Exclusive Negotiating Rights Agreement has been executed as of the date first written above.

DEVELOPER:

Company:

By:

Its:

CITY:

City of Rancho Cordova, a California
municipal corporation

By: _____

Cyrus Abhar, City Manager

Attest:

Stacy Leitner, City Clerk

Approved as to form:

Adam Lindgren, City Attorney

3550684.1

Exhibit A

THE CIVIC CENTER
PROPERTY

(Attach Legal Description)

Civic Center Master Developer Selection



July 6 Council Direction

Staff Presented the Final 3 Development Teams

- Griffin Swinerton / Related / Mogavero Architects
- SKK / C2K Architects
- Civic Partners / SVA Architects

Council Direction

- Weigh the potential for catalyzing further development
- Include additional details for the staff recommendation
- Provide more information on financial capacity and background of each finalist
- Consider local aspects of the development teams
- Maintain primary focus on the community amenities to be developed

Evaluation Committee and Staff Recommendation

- Griffin Swinerton / Related California / Mogavero Architects

ERN Main Points/Timeline

Term

- 12-month initial term (anticipated August 2020 – August 2021)
- City Manager authorized to make one 6-month extension

By January 2021

- Staff and Developer will analyze multiple development alternatives
- Present to Council for discussion and direction

By May 2021

- Staff and Developer will refine a preferred alternative
- Return for Council selection or additional direction

Before End of ERN Term

- Once a preferred alternative is selected, Developer and staff will negotiate a Disposition and Development Agreement (DDA)
- Present to Council for execution of DDA

Financial capacity

- 3 Letters of support submitted to substantiate financial capacity
- Strongest ability to leverage the largest diversity of funding sources
- Related California controls \$400 million Opportunity Zone fund
- Site concept includes adjacent opportunity parcels for discussion

Stronger experience with community facilities/amenities

- Over \$600 million in projects underway using P3 Partnerships
- Direct experience with arts and culture centers, community and recreation centers, and meeting spaces

Development team includes local team members

- Swinerton builders has a local Sacramento office
- Mogavero Architects located in Sacramento
- Statement of Interest proposes partnering with local artisan organizations such as Hacker Lab



Council Discussion

Questions for staff?

Staff recommends approval of the Resolution selecting the Griffin Swinerton Development Team as the master developer for the Civic Center Project.



MEMORANDUM



ITEM 12.2.

DATE: July 20, 2020
TO: Honorable Mayor and Council Members
FROM: Adam Lindgren, City Attorney
SUBJECT: **DISCUSSION AND POTENTIAL DIRECTION REGARDING TOBACCO REGULATIONS IN THE CITY**

RECOMMENDATION

Receive information and provide direction.

RESULT OF RECOMMENDED ACTION

No formal action is requested of Council at this time. Staff is requesting Council insight and/or direction regarding tobacco regulations in the City.

BACKGROUND

At its November 4, 2019 City Council meeting, Council directed staff to report back on federal action regarding electronic smoking devices and flavored tobacco products. At that time, the federal government had announced that it was considering a prohibition on flavored electronic smoking product sales. On January 2, 2020, the U.S. Food and Drug Administration Agency issued a federal guidance regarding its enforcement priorities of Electronic Nicotine Delivery Systems (ENDS) which was subsequently revised in April 2020 (FDA Guidance).

DISCUSSION

The FDA Guidance prohibits the sale of flavored cartridge-based ENDS products, except cartridge-base END product flavors that are menthol or tobacco based. Because the FDA Guidance only applies to cartridge-based ENDS products, self-contained disposable electronic smoking devices are not covered by the FDA Guidance, meaning that those products are still allowed to sell flavored products. Additionally, flavored e-liquids that are designed for refillable electronic smoking devices are also not covered by the FDA guidance.

The City currently regulates its tobacco retailers, by requiring each retailer to obtain a "Tobacco Retailer License" from the City (RCMC Chapter 4.07). Under state law, the City is permitted to regulate tobacco sales within its jurisdiction, so long as those regulations do not pertain to state

taxes (Bus. & Prof. Code §§ 22970 *et seq.*)

Based upon actions that have been undertaken at the federal level as well as those throughout the state, staff has prepared several options for Council consideration, feedback and direction regarding the potential regulation and/or prohibition of flavored tobacco sales within the City.

Additionally, staff is presenting options for potential enforcement considerations the sale of tobacco.

FISCAL IMPACT AND FUNDING SOURCE

There is no Fiscal Impact.

ATTACHMENT(S)

None

MEMORANDUM



ITEM 12.3.

DATE: July 20, 2020
TO: Honorable Mayor and Council Members
FROM: Adam Lindgren, City Attorney
SUBJECT: **CONSIDERATION AND FEEDBACK ON DRAFT MULTIFAMILY RESIDENTIAL PROPERTY SMOKING PROHIBITION ORDINANCE**

RECOMMENDATION

Provide feedback on proposed draft Ordinance.

RESULT OF RECOMMENDED ACTION

Based upon Council feedback, the draft Ordinance will be finalized and placed as a consent public hearing item on a future Council agenda for adoption.

BACKGROUND

The City of Rancho Cordova has previously adopted ordinances which regulate the smoking of tobacco, tobacco products, and cannabis within the City. At its regular meeting on February 3, 2020, the Council was presented with potential options to consider regarding smoking regulations. At the direction of Council, staff prepared this draft Ordinance, which prohibits smoking in and around multifamily residential properties within the City. Based upon preliminary staff outreach from with various stakeholder groups, staff have not received opposition to the draft Ordinance.

ANALYSIS

Exposure to secondhand smoke remains a serious public health risk, and the U.S. Surgeon General has concluded that there is no risk-free level of exposure to secondhand smoke and neither separating smokers from nonsmokers nor installing ventilation systems effectively eliminates secondhand smoke exposure and its public health risks. Both the U.S. Environmental Protection Agency (U.S. EPA) and the California Air Resources Board (ARB) have found secondhand smoke to be a dangerous air pollutant, with the U.S. EPA designating secondhand smoke as a Group A carcinogen and ARB designating it has a toxic air pollutant, which is the same category as the most toxic automotive industrial air pollutants.

Additionally, exposure to secondhand smoke is a leading cause of preventable death in the U.S., killing over 41,000 non-smokers each year, including over 7,000 deaths from lung cancer. It is estimated that exposure to secondhand smoke causes as many as 300,000 children in the U.S. to suffer from lower respiratory infections, asthma, and other ailments, many of which have life-long adverse health impacts.

Under California Health and Safety Code section 118910, the City is explicitly authorized to regulate or ban the smoking of tobacco, the City Council has previously adopted ordinances which regulate the smoking of tobacco, tobacco products, and cannabis within the City, all of which is codified in Chapter 6.84 "Regulation of Smoking Ordinance" of the Rancho Cordova Municipal Code.

The City currently prohibits smoking in all indoor common areas of multifamily residential properties, including any indoor area on the property which residents of more than one unit are entitled to enter and/or use, including but not limited to halls, lobbies, courtyards, elevators, stairs, community rooms, gym or health facilities, indoor swimming pool areas, storage areas, shared restrooms, shared laundry rooms, shared cooking facilities, and shared eating areas.

The Ordinance furthers the City's commitment to protecting its residents and the general public from the adverse health impacts of secondhand smoke. As proposed, the Ordinance would prohibit smoking inside and outside multifamily residential properties within the City, except for a designated smoking area(s) and revise the City's definition of "Multifamily residential property."

The revised "Multifamily residential property" definition is a "residential property containing two or more total units with one or more shared walls, floors or ceilings, including but not limited to rental complexes, apartments, residential cooperatives, condominium complexes, senior citizen residences, assisted living complexes and skilled nursing facilities" The definition of "Multifamily residential property" specifically excludes the following: (1) A hotel or motel that meets the requirements of Civil Code § 1940(b)(2); (2) A mobile home park; (3) A campground; (4) A single-family residence; (5) A single-family home with a detached in-law or second unit when permitted pursuant to a City ordinance and/or applicable state law.

Additionally, the Ordinance permits property owners or property managers the ability to designate a smoking area or areas on the Multifamily residential property so long as those area(s) meet the following requirements: (1) Is located more than thirty (30) feet away from any operable entrance/doorway, window, playground, pool, or other non-smoking communal area used by residents; (2) Does not include, and is at least 30 feet from, unenclosed areas primarily used by children and unenclosed areas with improvements that facilitate physical activity including playgrounds, swimming pools, and school campuses; (3) Is an unenclosed area; (4) Is marked by conspicuous signage clearly denoting the area as a designated smoking area; and (5) Has receptacles designed for and primarily used for disposal of tobacco waste and is maintained free of tobacco related litter including but not limited to cigarette butts.

Lastly, the Ordinance will be phased-in over the course of 12 months. A Multifamily residential property unit with an existing lease agreement as of the effective date of the Ordinance, is exempt from prohibition until the date the existing lease agreement expires or twelve months after the effective date of the Ordinance, whichever is sooner.

FISCAL IMPACT AND FUNDING SOURCE

There is no Fiscal Impact.

ATTACHMENT(S)

1. Draft Ordinance - Multifamily Residential Property Smoking Prohibition

CITY OF RANCHO CORDOVA**ORDINANCE NO. XX-2020**

**AN ORDINANCE OF THE RANCHO CORDOVA CITY COUNCIL AMENDING CHAPTER 6.84
OF THE RANCHO CORDOVA MUNICIPAL CODE RELATED TO SMOKING IN AND
AROUND MULTIFAMILY RESIDENTIAL PROPERTIES WITH THE PURPOSE OF
UPDATING THE CITY'S CLEAN INDOOR AND OUTDOOR AIR AND HEALTH PROTECTION
REGULATIONS TO BETTER PROTECT INDIVIDUALS FROM THE NEGATIVE EFFECTS OF
SECONDHAND SMOKE**

THE CITY COUNCIL OF THE CITY OF RANCHO CORDOVA DOES ORDAIN AS FOLLOWS:

Section 1. Purpose and Declarations.

WHEREAS, according to the Center for Disease Control, scientific studies have concluded that cigarette smoking causes chronic lung disease, coronary heart disease, stroke, cancer of the lungs, larynx, esophagus, mouth, and bladder, and contributes to cancer of the cervix, pancreas, and kidneys; and

WHEREAS, the U.S. Surgeon General has concluded that there is no risk-free level of exposure to secondhand smoke and neither separating smokers from nonsmokers nor installing ventilation systems effectively eliminates secondhand smoke; and

WHEREAS, the United States Environmental Protection Agency (EPA) has found secondhand smoke to be a risk to public health, and has classified secondhand smoke as a Group A carcinogen, the most dangerous class of carcinogen to humans; and

WHEREAS, the California Air Resources Board has categorized secondhand smoke as a toxic air contaminant, putting it in the same category as the most toxic automotive and industrial air pollutants; and

WHEREAS, more than 450,000 people die in the United States from tobacco-related diseases every year, making it the nation's leading cause of preventable death; and

WHEREAS, exposure to secondhand smoke is a leading cause of preventable death in this country, killing over 41,000 non-smokers each year, including more than 7,000 deaths from lung cancer; and

WHEREAS, secondhand smoke exposure adversely affects fetal growth with elevated risk of low birth weight, and increased risk of Sudden Infant Death Syndrome (SIDS) in infants of mothers who smoke; and

WHEREAS, according to the American Lung Association, secondhand smoke exposure causes as many as 300,000 children in the United States to suffer from lower respiratory tract infections, such as pneumonia and bronchitis, exacerbates childhood asthma, and increases the risk of acute chronic middle ear infection in children; and

WHEREAS, California Health and Safety Code section 118910 explicitly authorizes a local entity to regulate or completely ban the smoking of tobacco; and

DRAFT - Ordinance

WHEREAS, the City of Rancho Cordova ("City") has adopted an Ordinance for the Regulation of Smoking ("Regulation of Smoking Ordinance") which has been codified as Chapter 6.84 of the Rancho Cordova Municipal Code; and

WHEREAS, the City has since amended the Regulation of Smoking Ordinance to more effectively regulate smoking and protect public health within the City; and

WHEREAS, multifamily residential properties are becoming increasingly common and are a critical tool in providing housing to Rancho Cordova residents; and

WHEREAS, the City desires to amend the Regulation of Smoking Ordinance in order to further protect the health and welfare of its residents and visitors.

Section 2. Amendment of Code. Section 6.84.020 "Definitions" of the Rancho Cordova Municipal Code is hereby amended to add the following definition:

"Multifamily residential property," for purposes of this Chapter, means residential property containing two or more total units with one or more shared walls, floors or ceilings, including but not limited to rental complexes, apartments, residential cooperatives, condominium complexes, senior citizen residences, assisted living complexes and skilled nursing facilities. "Multifamily residential property" does not include:

- (1) A hotel or motel that meets the requirements of Civil Code section 1940(b)(2);
- (2) A mobile home park;
- (3) A campground;
- (4) A single-family residence;
- (5) A single-family home with a detached in-law or second unit when permitted pursuant to a City ordinance and/or applicable state law.

Section 3. Amendment of Code. Section 6.84.040 "Regulation of smoking at multifamily residential properties" of the Rancho Cordova Municipal Code, is hereby amended to read as follows:

6.84.040 Regulation of Smoking at Multifamily Residential Properties

A. Owners and property managers of multifamily properties may adopt policies imposing stricter smoking regulations than those enacted by this Chapter.

B. Smoking is prohibited inside and outside all multifamily residential properties, except in designated smoking area(s) as defined by Section 6.84.040(D). A multifamily residential property unit with an existing lease agreement as of the effective date of this Ordinance, are exempt from this prohibition until the date the existing lease agreement expires or twelve months after the effective date of this Ordinance, whichever is sooner.

C. Smoking is prohibited within indoor common areas at multifamily residential properties. "Indoor common areas" means any indoor area on the property which residents of more than one

DRAFT - Ordinance

unit are entitled to enter and/or use, including, but not limited to halls, lobbies, courtyards, elevators, stairs, community rooms, gym or health facilities, indoor swimming pool areas, storage areas, shared restrooms, shared laundry rooms, shared cooking facilities, and shared eating areas.

D. Owners or property managers may designate a common area or areas of a multifamily residential property as a designated smoking area(s), provided that the designated smoking area(s) comply with the following requirements;

1. Shall be located more than thirty (30) feet away from any operable entrance/doorway, window, playground, pool, or other non-smoking communal area used by residents;
2. Shall not include, and shall be at least 30 feet from, unenclosed areas primarily used by children and unenclosed areas with improvements that facilitate physical activity including playgrounds, swimming pools, and school campuses;
3. Shall be an unenclosed area;
4. Shall be marked by conspicuous signage clearly denoting the area as a designated smoking area; and
5. Shall have receptacles designed for and primarily used for disposal of tobacco waste and shall be maintained free of tobacco related litter including but not limited to cigarette butts.

E. Owners or property managers of multifamily residential properties within the City must disclose to all rental applicants the City's multifamily residential property smoking prohibition.

Section 4. CEQA. Approval of the amendments in this Ordinance is exempt from further environmental review under the general rule in California Environmental Quality Act (CEQA) Guidelines section 15061(b)(3) that CEQA only applies to projects that have the potential for causing a significant effect on the environment. As a series of text amendments and additions, it can be seen with certainty that there is no possibility that this Ordinance will have a significant effect on the environment.

Section 5. Severability. If any provision of this Ordinance, or the application thereof to any person or circumstance, is held invalid, the remainder of the Ordinance, including the application of such part or provision to other persons or circumstances, shall not be affected thereby and shall continue in full force and effect. To this end, provisions of this Ordinance are severable. The City Council hereby declares that it would have passed each section, subsection, subdivision, paragraph, sentence, clause or phrase hereof irrespective of the fact that any one or more sections, subsections, subdivisions, paragraphs, sentences, clauses, or phrases be held unconstitutional, invalid or unenforceable.

Section 6. Effective Date. Within fifteen (15) days after adoption, a Summary of this Ordinance shall be published once in the Grapevine Independent, or the Sacramento Bee, a newspaper of general circulation printed and published in Sacramento County and circulated in the City of Rancho Cordova, in accordance with Government Code section 36933. This Ordinance shall take effect thirty (30) days after its adoption.

PASSED AND ADOPTED by the City Council of the City of Rancho Cordova on the ____ day of ____, 2020, by the following vote:

ITEM 12.3.

DRAFT - Ordinance

ATTACHMENT 1

AYES:

NOES:

ABSENT:

ABSTAIN:

David M Sander, Mayor

ATTEST:

Stacy Leitner, CMC,
City Clerk

MEMORANDUM



ITEM 12.4.

DATE: July 20, 2020
TO: Honorable Mayor and Council Members
FROM: Albert Stricker, Public Works Director
SUBJECT: **STAFF PRESENTATION ON DEFERRED PAVEMENT
MAINTENANCE AND 2020-2021 ROAD REHABILITATION
PROJECTS**

RECOMMENDATION

Receive staff presentation summarizing deferred pavement maintenance and 2020-2021 road rehabilitation projects and provide input.

RESULT OF RECOMMENDED ACTION

Staff will return to Council at a later date with a request for approval of construction contracts as outlined below.

BACKGROUND

Pavement rehabilitation performed by the City results in safer, smoother roads. The work also adds to the aesthetic appeal of neighborhoods. Staff will provide a presentation summarizing deferred pavement maintenance and an update on 2020-2021 rehabilitation projects.

Pavement rehabilitation focused projects are scheduled as follows:

- Sunrise Blvd, White Rock Road to Folsom Boulevard – Currently under construction. Construction completion scheduled for end of 2020. Mather Field Road, Folsom Boulevard to International Drive – Staff scheduled to request Council approval of Construction contract Fall 2020. Construction completion summer 2021.
- Vineyards Phase 1 Residential Collectors – Staff scheduled to request Council approval of Construction contract Winter 2020. Construction completion summer 2021. The work will include Aramon Drive.

FISCAL IMPACT AND FUNDING SOURCE

Funding for the rehabilitation work includes Community Enhancement Fund, Measure A, Gas

Tax, SB-1 and grant funding.

ATTACHMENT(S)

1. Deferred Maintenance Presentation

City of Rancho Cordova

Infrastructure Maintenance Update



July 20, 2020

- **Citywide pavement evaluation performed**
- **Staff presented recommended prioritization to Council October 2019**
- **Based on Council direction, staff proceeded with design for 2020 and 2021 construction seasons**

- **Provide background on pavement condition**
- **Consider options for future maintenance funding**
- **Update Council on 2020 and 2021 pavement resurfacing**



• 240 centerline miles

Pavement Condition Index Definition

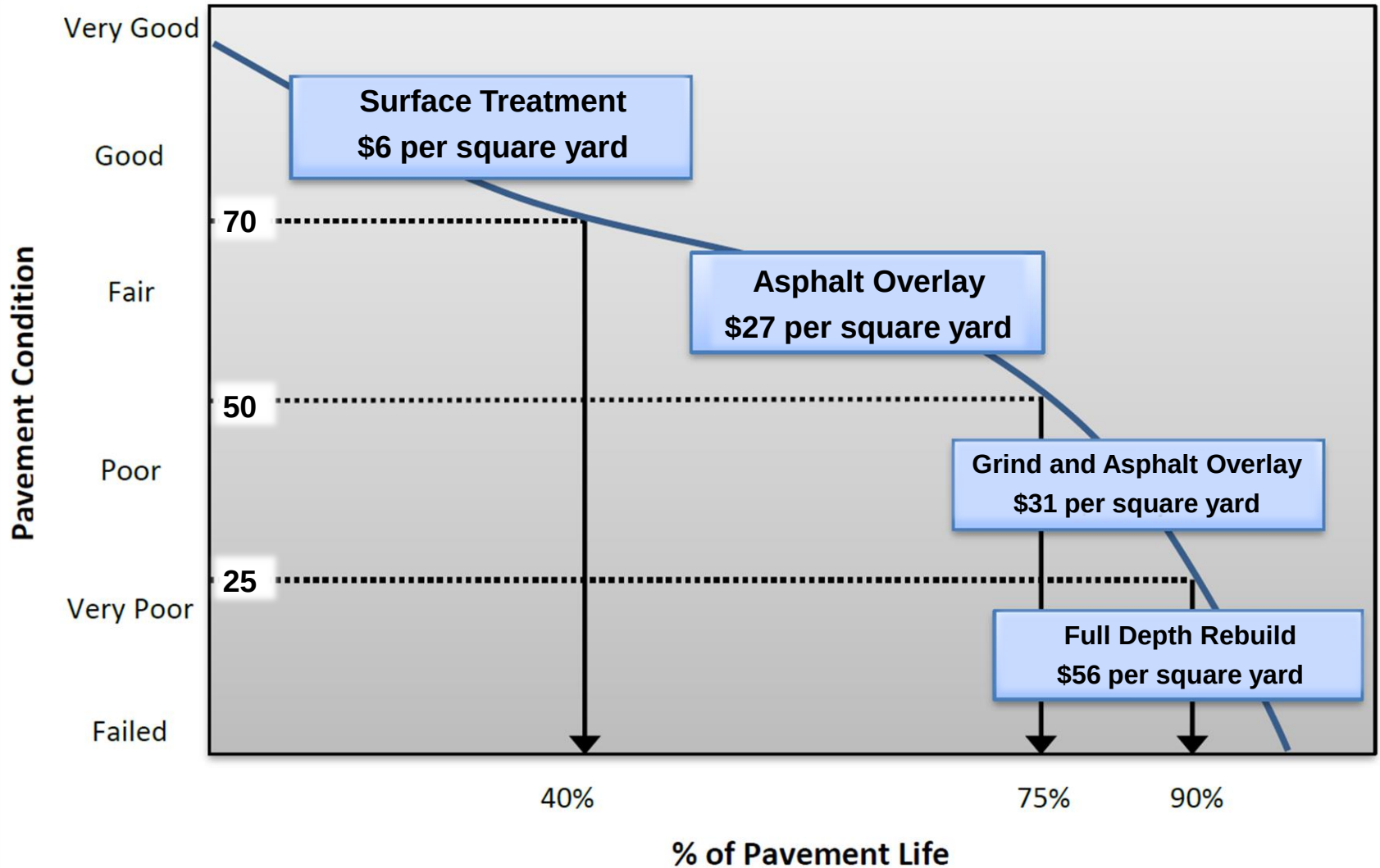
- The pavement condition index represents the state of the road, 0 to 100

I	Good/Very Good		100
II/III	Fair (non-load)	Fair (load-related)	70
IV	Poor		50
V	Very Poor/Failed		25
			0
Condition Category	Pavement Condition		PCI

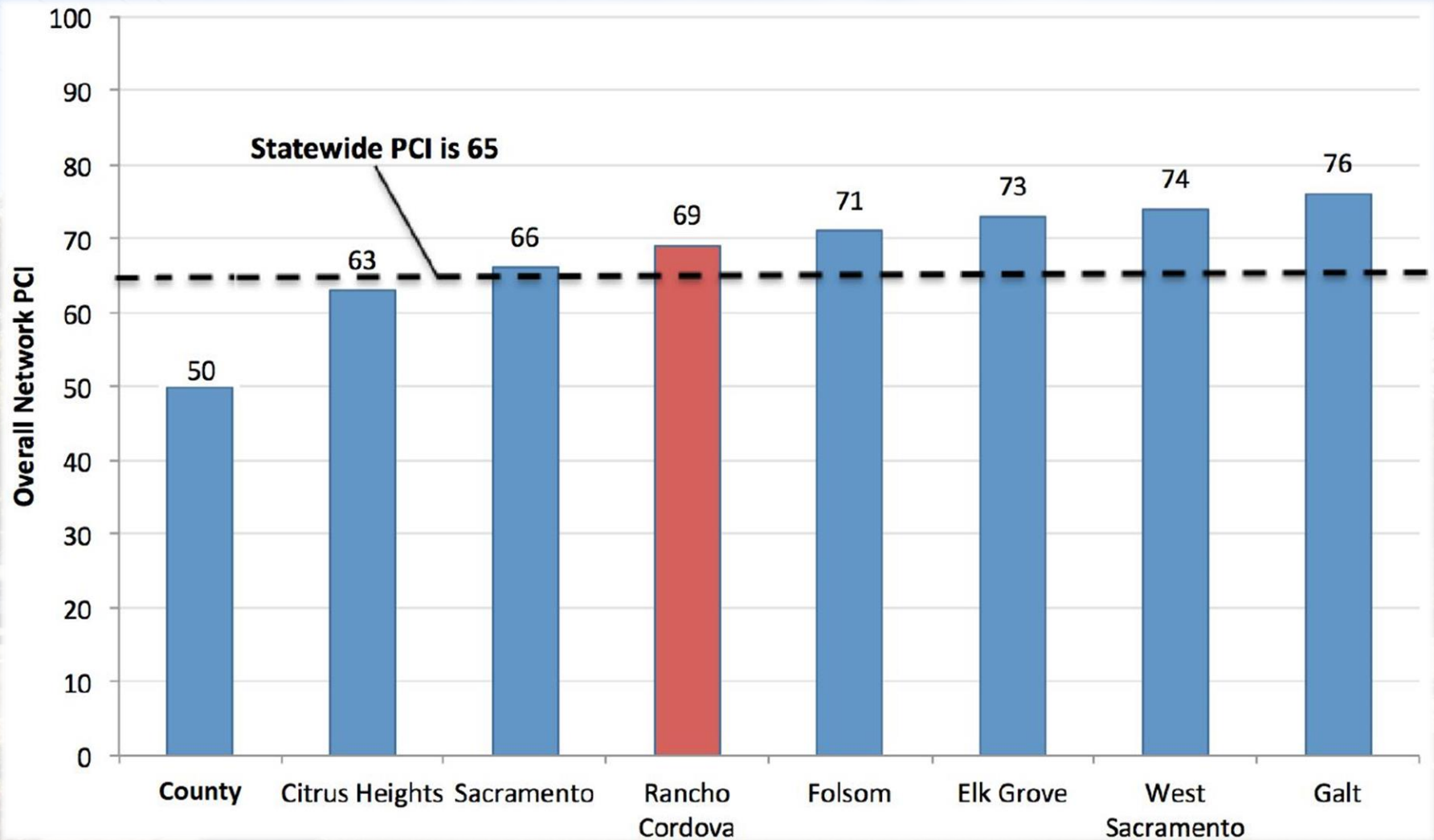
Pavement Condition Index Identification



Pavement Condition Index Treatment



Pavement Condition Index Regional Comparison



Pavement Condition Index Rancho Cordova Distribution

Failed, 1.4%

More Expensive
to Maintain

Poor, 18.0%

Fair, 23.1%

Good/Very Good,
57.5%

Less expensive
to Maintain

Pavement Condition Index – Comparison

ITEM 12.4.

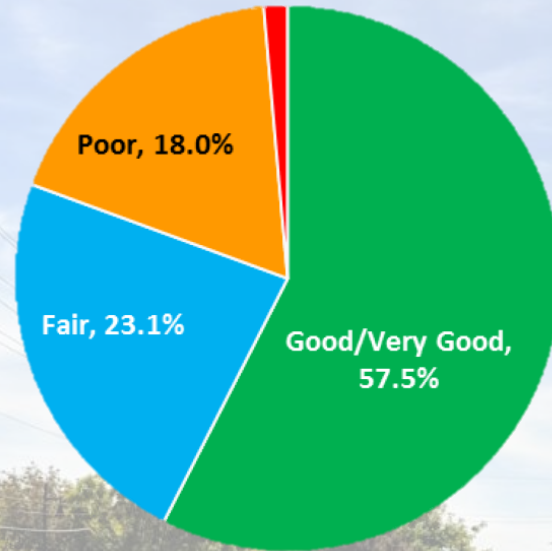
ATTACHMENT 1

Note: All figures in 2020 dollars

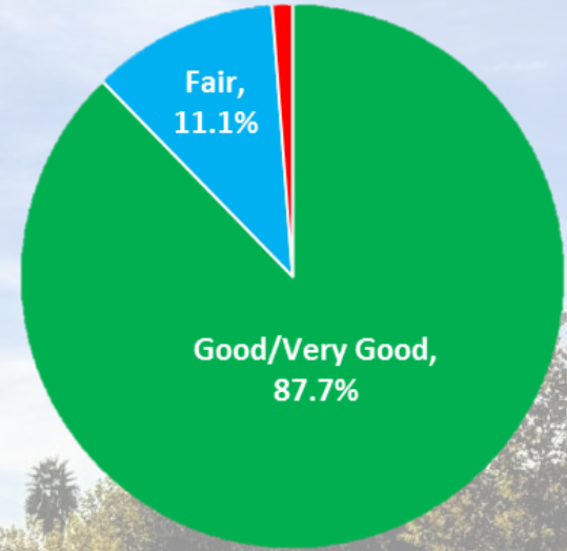
Includes minor sidewalk repair

Does not include grants

**Today
Average = 69**



**2030 Option
Average = 80**



Avg. PCI	Pavement Condition = 69	Pavement Condition = 80
Annual Revenue Stream	\$4 million per year - Current	\$4 million per year - Current
Annual Cost 2020 to 2030	\$10 M (\$6 M/yr gap) \$50 M Deferred Maint	\$14 M (\$10 M/yr gap) \$17 M Deferred Maint
Ongoing Annual Maint. 2030 to 2050	\$7 million (\$3 M/yr gap) \$48 M Deferred Maint 8% roads failed	\$7 million (\$3 M/yr gap) No Deferred Maint No roads in failed category

Pavement Condition Index – Comparison

ITEM 12.4.

ATTACHMENT 1

- More failed roads
- +/- Deferred maint steady
- + Smaller gap
- + Reduced commitment

- Add'l \$40 M cost first 10 yr
- \$100 M gap first 10 yr
- + Eliminates deferred maint
- + Eliminates failed roads
- + ROI starts in 2040

Avg. PCI	Pavement Condition = 69	Pavement Condition = 80
Annual Revenue Stream	\$4 million per year - Current	\$4 million per year - Current
Annual Cost 2020 to 2030	\$10 M (\$6 M/yr gap) \$50 M Deferred Maint	\$14 M (\$10 M/yr gap) \$17 M Deferred Maint
Ongoing Annual Maint. 2030 to 2050	\$7 million (\$3 M/yr gap) \$48 M Deferred Maint 8% roads failed	\$7 million (\$3 M/yr gap) No Deferred Maint No roads in failed category

Road Rehabilitation Update

- **Sunrise Blvd – Construction completion scheduled for end of 2020**
- **Mather Field Road – Staff scheduled to request Council approval of Construction contract Fall 2020**
- **Vineyards Phase 1 Residential Collectors – Staff scheduled to request Council approval of Construction contract Winter 2020**

- Short- and long-term impacts of pandemic
- More efficient vehicles reduce traditional revenue sources
- Proposed Countywide Measure A tax will not be pursued
- Additional deferred maint. includes missing sidewalk and deferred storm maintenance
- New infrastructure including roads, landscaping and trails increases costs along with inflation
- Explore additional options for federal, state and local funding.
- Questions and Input

