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Air Pollution Analysis of Santa Clara County Public Schools Preliminary Results



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May 14 2018




Air pollution and human health

- This project started as Air Quality Research Initiative with SCU's Thriving Neighbors Initiative expanded with the Mapping Health Collaborative.
- Ozone and fine particle pollution (PM 2.5) are the major regional air pollutants of concern in the SF Bay Area. Fine particulates (2.5 microns or smaller), and ultrafine particles (UFPs 0.1 microns and smaller) are linked to asthma, lung cancer, and heart disease, and may be more extensive than previously established.

Effects of Common Air Pollutants

RESPIRATORY EFFECTS



Symptoms:

- Cough
- Phlegm
- Chest tightness

Increased sickness and premature death from:

- Asthma
- Bronchitis (acute or chronic)
- Emphysema
- Pneumonia

Development of new disease

- Chronic bronchitis
- Premature aging of the lungs

- Wheezing
- Shortness of breath

How Pollutants Cause Symptoms



Effects on Lung Function

- Narrowing of airways (bronchoconstriction)
- Decreased air flow

Airway Inflammation

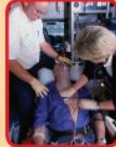
- Influx of white blood cells
- Abnormal mucus production
- Fluid accumulation and swelling (edema)
- Death and shedding of cells that line airway

Increased Susceptibility to Respiratory Infection

Normal Lung with respiratory infection

CARDIOVASCULAR EFFECTS




Symptoms:

- Chest tightness
- Chest pain (angina)
- Palpitations
- Shortness of breath
- Unusual fatigue

Increased sickness and premature death from:

- Coronary artery disease
- Abnormal heart rhythms
- Congestive heart failure
- Stroke



Normal Heart Rhythm
Abnormal Heart Rhythm

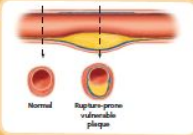
How Pollutants Cause Symptoms

Effects on Cardiovascular Function


- Low oxygenation of red blood cells
- Abnormal heart rhythms
- Altered autonomic nervous system control of the heart

Vascular Inflammation


- Increased risk of blood clot formation
- Narrowing of vessels (vasoconstriction)
- Increased risk of atherosclerotic plaque rupture



Normal Rupture-prone vulnerable plaque

 **Reduce your risk by using the Air Quality Index (AQI) to plan outdoor activities – www.airnow.gov**

| AQI Levels of Health Concern | AQI Values | What Action Should People Take? |
|--------------------------------|------------|--|
| Good | 0-50 | Enjoy Activities |
| Moderate | 51-100 | People unusually sensitive to air pollution: Plan strenuous outside activities when air quality is better |
| Unhealthy for Sensitive Groups | 101-150 | Sensitive Groups: Cut back or reschedule strenuous outside activities <small> Children: People with lung disease, children and older adults and people who are active outdoors Particle Pollution: People with heart or lung disease (including asthma), older adults and children Carbon Monoxide: People with heart disease and possibly infants and fetuses Nitrogen Dioxide: People with lung disease, children and older adults Sulfur Dioxide: Active children and adults with asthma </small> |
| Unhealthy | 151-200 | Everyone: Cut back or reschedule strenuous outside activities Sensitive groups: Avoid strenuous outside activities |
| Very Unhealthy | 201-300 | Everyone: Significantly cut back on outside physical activities Sensitive groups: Avoid all outside physical activities |



Air pollution exposures at school

- Of greatest concern are air pollution concentrations within 500 feet of high traffic street edges, but concentrations can be harmful at distances up to 1320 ft.
- In 2003, the California legislature passed SB 352, prohibiting building new schools within 500 ft of high traffic roadways. SB 352 does not address what action should be taken to reduce the health risks for children at school sites already near high traffic roadways, and the Bill acknowledges that a disproportionate number of low income students attend such schools.



Research Questions

1. What are the demographic and spatial patterns in the distribution and exposure of high concentrations of air pollutants around schools in Santa Clara County?
2. How can we use spatial analysis to assess exposure to roadway emissions?
3. How can Santa Clara University, K-12 schools and community-based partners work together to:
 - a. identify locally preferred mitigation strategies that reduce children's exposure to air pollutants? and
 - b. enhance community health and access to environmental benefits?



Methods

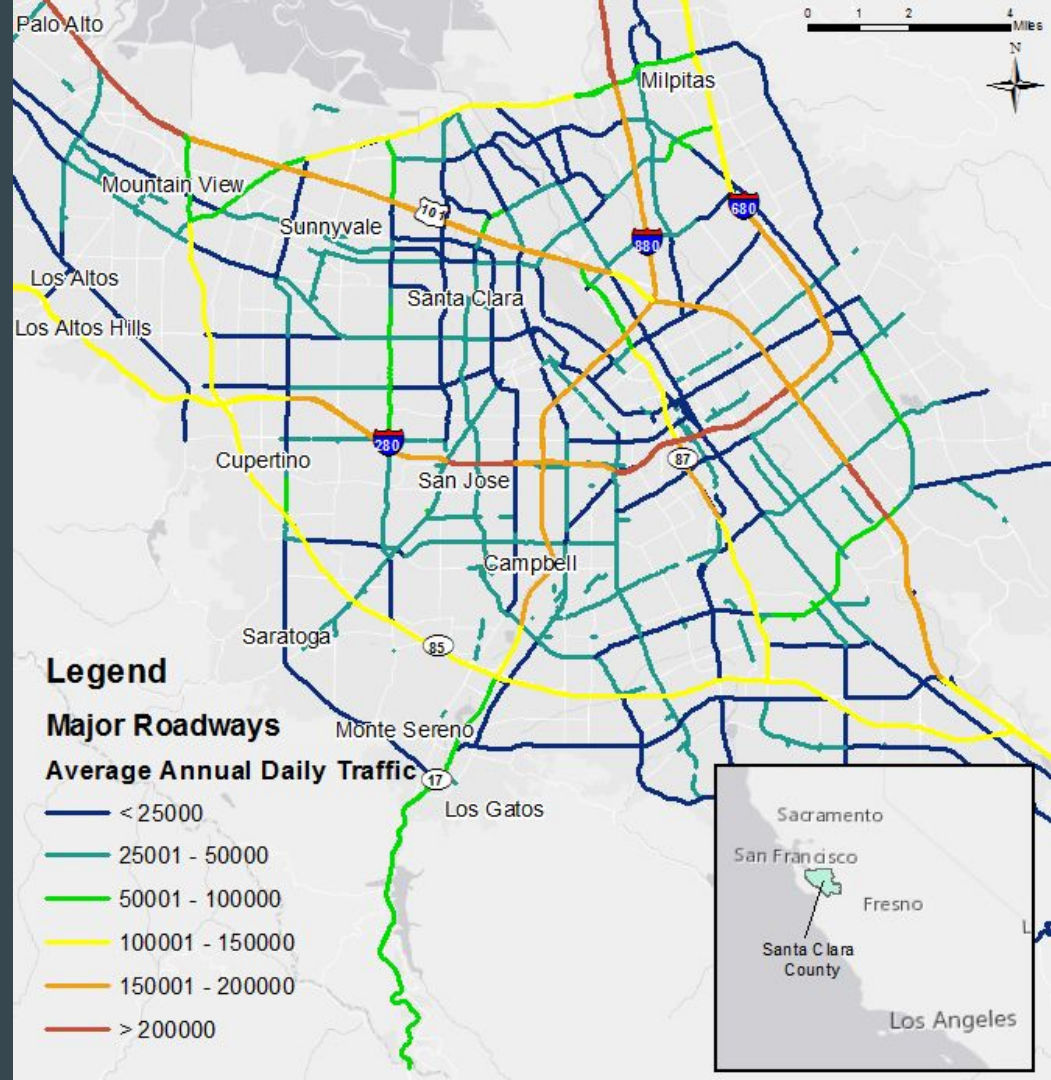
We used community-based air pollution monitoring in a case study area, mapping, and both a focus group and a survey conducted with parents at Washington Elementary School (WES). We integrate these mixed methods through a participatory action research approach.⁵

We used Geographic Information Systems (GIS) to map roads and freeways in relationship to all public schools in SCC. We also conducted 4 sampling campaigns at 5 locations surrounding WES, and measured ultrafine particles using two handheld condensation particle counters (TSI 3007). Community (*promotoras*) and SCU students conducted the sampling with faculty support.

During three 3-week periods, *promotoras* and students collected air quality samples two times per day (in the am and afternoon) on two weekdays per week. We also conducted a survey and focus group in May, 2016 after a *madres* group meeting at WES. Survey questions addressed perceptions of air and noise pollution, and we received 33 completed surveys.

Traffic in SCC

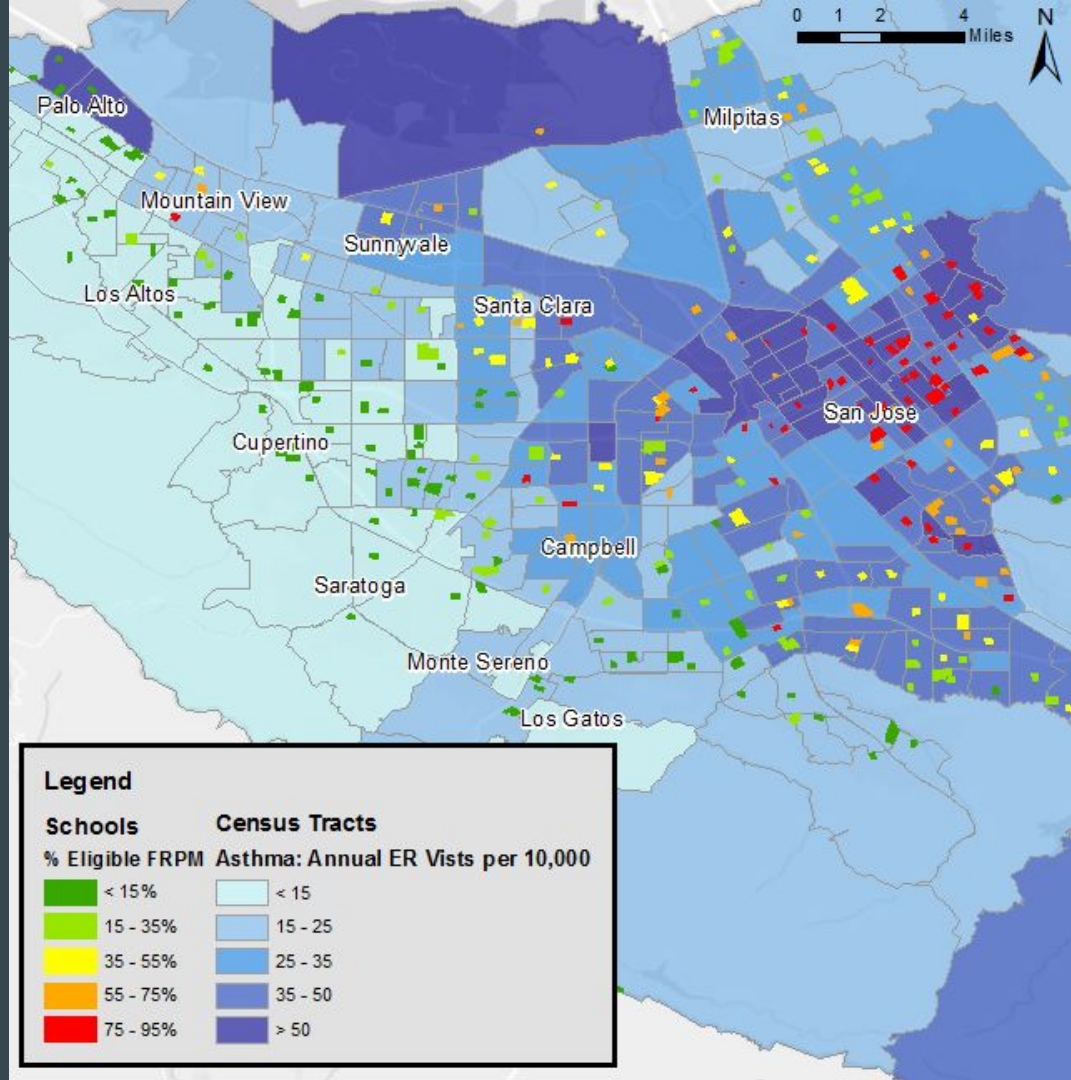
Traffic counts for major roadways in SCC serve as a proxy for vehicle emissions that impact children's health.



Poverty and Environmental Health

This map shows the association between asthma and poverty.

The red schools have the highest percentage of students eligible for free or reduced price meals (FRPM), an indicator of poverty.

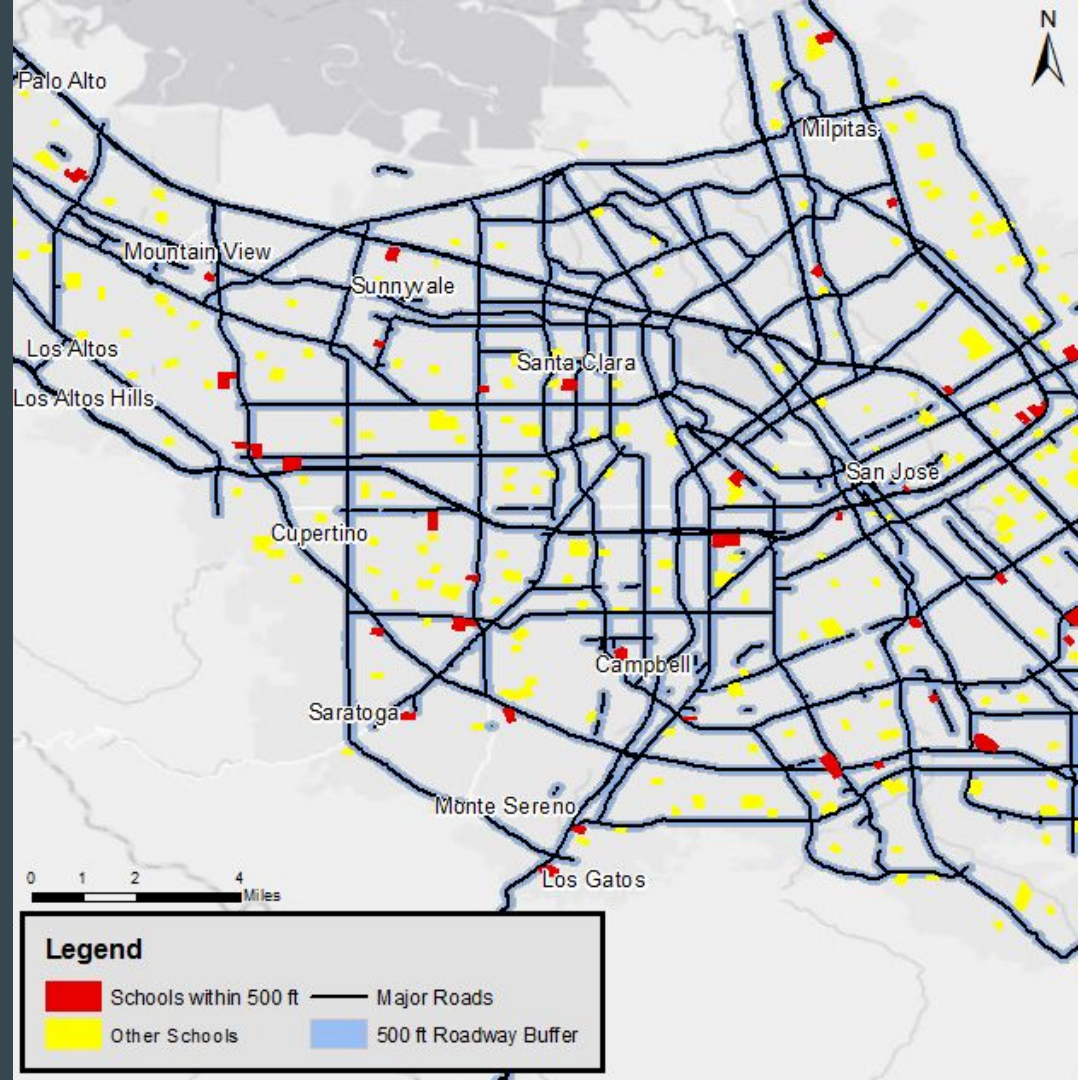


Proximity of Schools to Major Roadways

14% of public schools in SCC are located within 500 feet of a major road with over 30,000 vehicles per day.

This is slightly higher than the national average of 9%.¹

¹Hopkins, J.S. 2017. The invisible hazard afflicting thousands of schools. Center for Investigative Reporting, Feb 20.

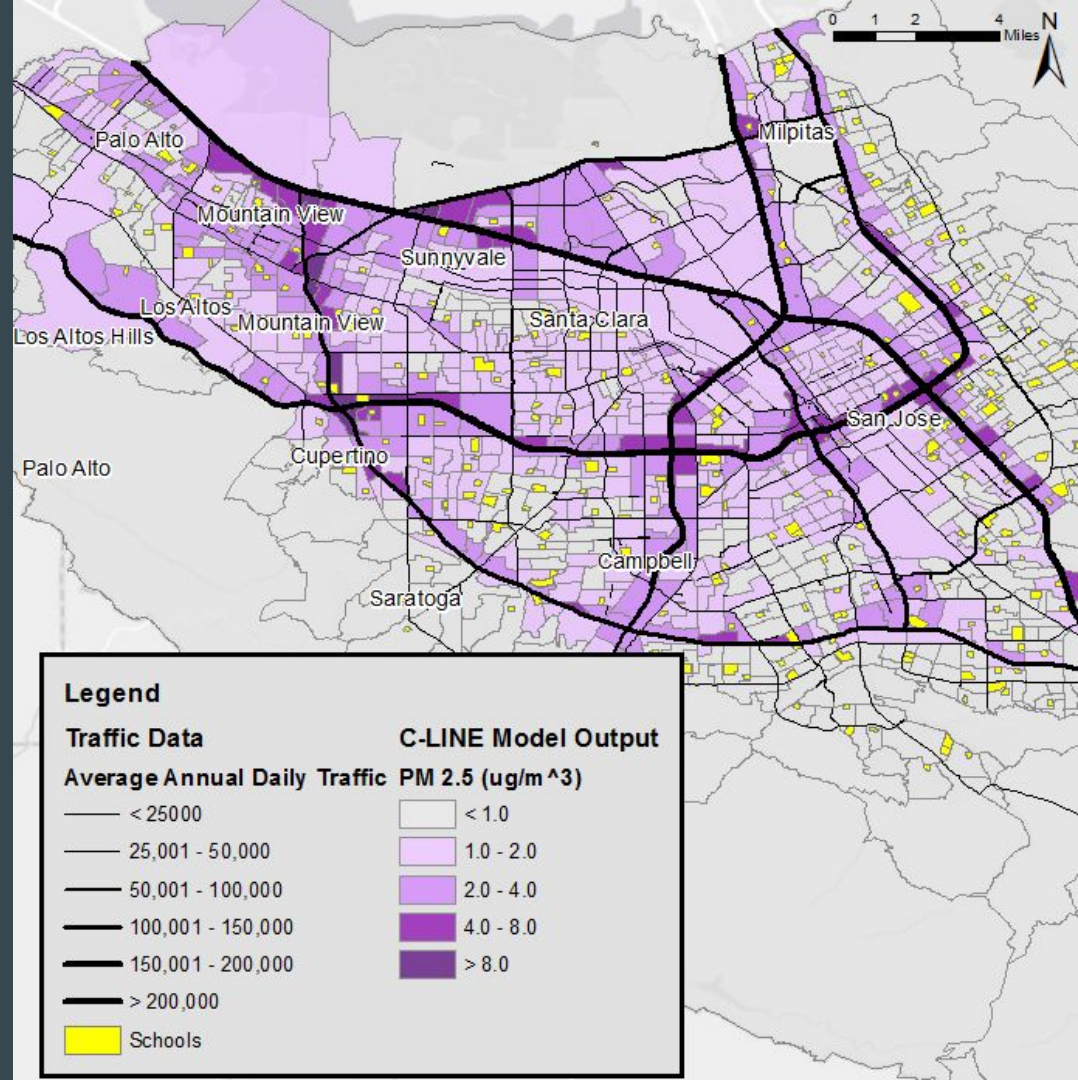


Comparing Data to Model Outputs

C-LINE model provides communities with a free and user-friendly model to analyze roadway air pollution.

Our next step will be comparing these model outputs to our index-based approach.

Source: Community Modeling and Analysis System, UNC



14% of schools in SCC are potentially exposed to harmful amounts of traffic-related air pollution

Disadvantaged schools may be more at risk

Table 1: Percent of Schools within 500 feet of high-traffic roadways

| | |
|--------------------|-----------------|
| Santa Clara County | 14% |
| National Average | 9% ³ |

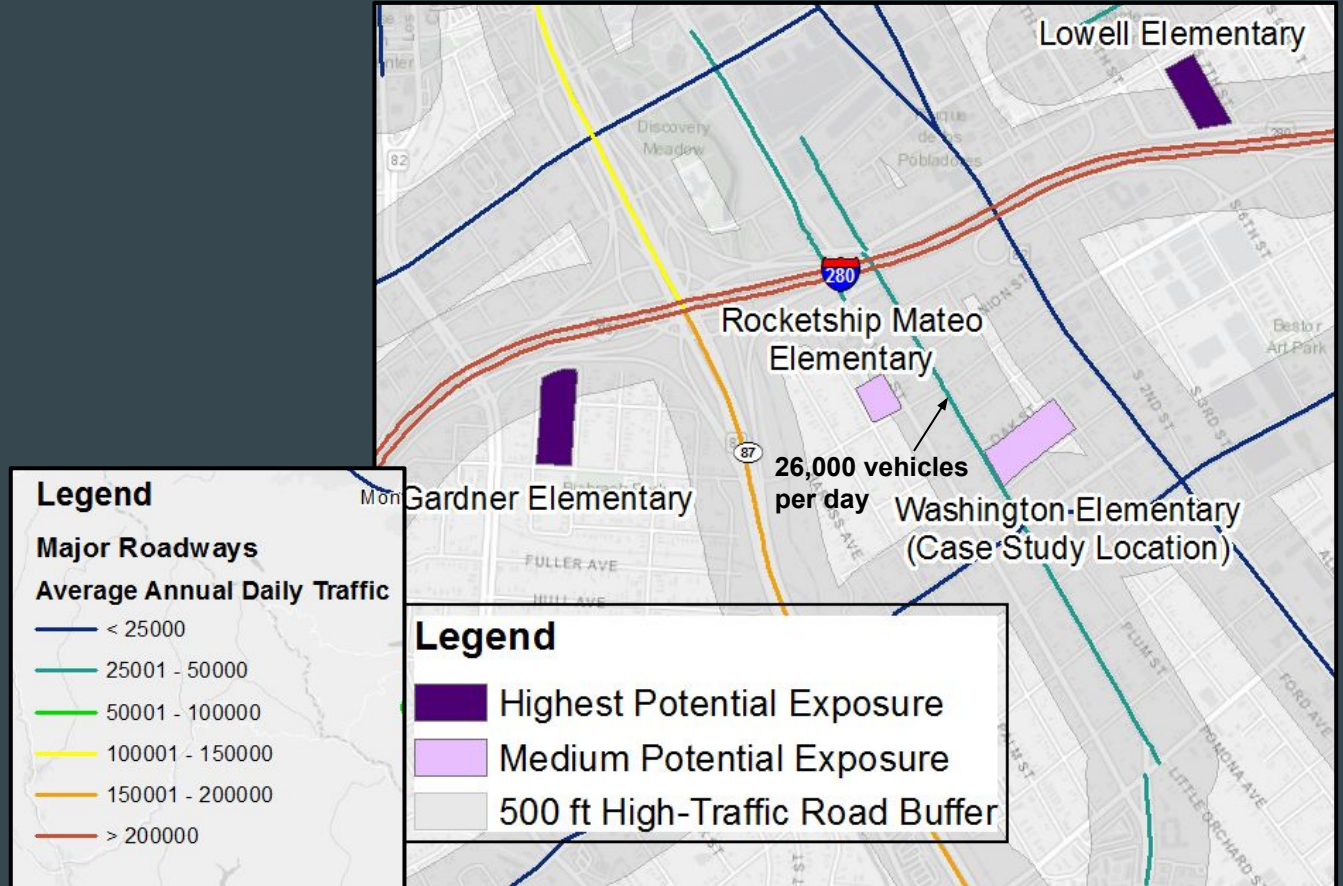
Table 2: Average % of students eligible for Free and Reduced Price Meals

| | |
|--|-----|
| Schools within 500 feet of major roads | 45% |
| Schools over 500 feet from major roads | 38% |

Almaden:
26,000 vehicles / day

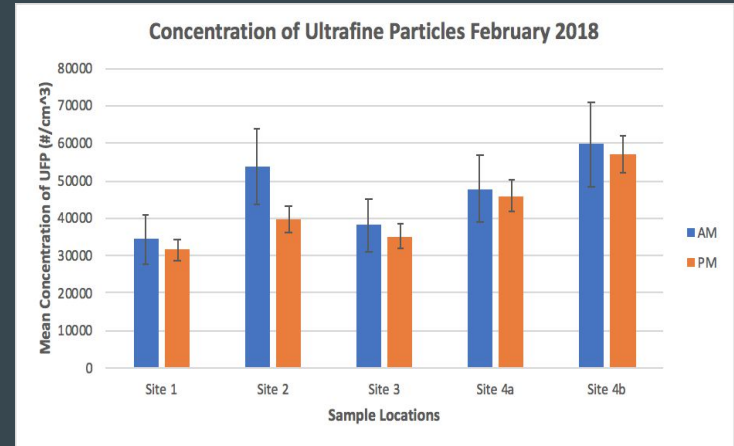
1st St
<25,000 vehicles / day

280
> 200,000 vehicles / day



Case Study at Washington Elementary

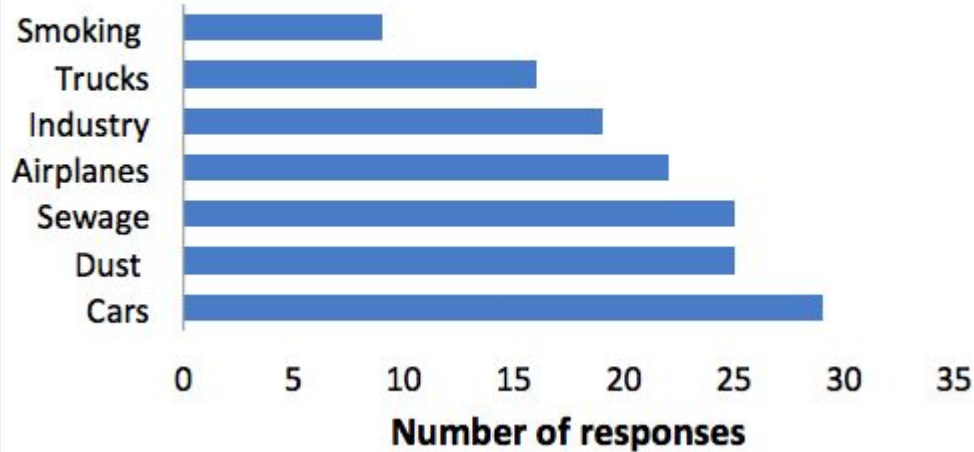
- Sites 4a and 4b are within 500 feet of I-280 and show the highest levels of air pollution.
- Site 2 shows elevated levels of particles due to its location next to a principal arterial. This is located next to the playground and athletic fields, which may expose children to high levels of air pollution and may be a potential site to focus mitigation.



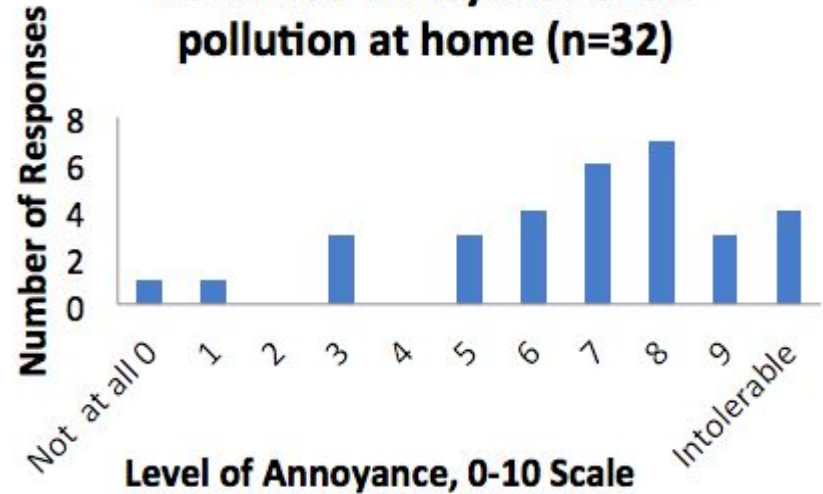
Residents also concerned about pollution exposure at home

Perceived air pollution sources

(multiple responses)



Perceived annoyance of air pollution at home (n=32)



Air pollution, one of several environmental hazards

Focus group responses from 2016: “My concern is that all our kids and all of the mothers who have children in this area are affected by air quality in one way or another.”

“I live near 280. The air quality there is definitely worse because of how close it is to the freeway, and by two major streets... But it doesn’t seem like that big of a concern for many people, because the consumption of marijuana is incredibly prevalent, and the rise of this problem was not incremental, it was dramatic.”

“You walk and see all of the things that have been used and disposed of lying in the streets. Additionally, all of the people who were squatting [in “the Jungle”] have been displaced and are sleeping in their cars.”

Air pollution, one of several environmental hazards

“For me, all of the garbage bothers me a lot. The sound is especially bothersome, it doesn’t let you sleep at night.”

“What can we do? Well, I think the best thing would be to find alternative routes for cars to commute. Putting signs up encouraging use of public transportation might be helpful along with no smoking.”

Mitigation measures

Los resultados claves del “Technical Advisory”:

El lenguaje científico respalda siete estrategias efectivas que se dividen en tres categorías:



Estrategias que reducen las emisiones del tráfico

1. Mecanismos de reducción rápida que incluyen las rotondas
2. Mejor uso de las señales de tráfico
3. Reducciones del límite de velocidad en las autopistas (>55 mph)



Estrategias que reducen la concentración de la contaminación del tráfico

4. Diseño urbano que promueve el flujo de aire y reduce la concentración de la contaminación en las calles y corredores
5. Uso de barreras sólidas como las paredes que reducen el ruido
6. Vegetación que reduce la concentración de la contaminación



Estrategias que remueven la contaminación de los interiores

7. Filtros de alta eficiencia que remueven la contaminación del aire

Possible mitigations - Sound walls and vegetation



Sample layouts for a large land parcel with a school and other land uses. A less desirable layout (left) with the school located close to the highway is compared to an improved layout (right) with the school more than 500 feet from the highway (red dotted line).

Best Practices for Reducing Near-Road Pollution Exposure at Schools



November 2015



Planting trees on campus to reduce air pollution exposure and generate other ecosystems services

Trees and vegetative barriers generate key ecosystem services for kids on campus, including:

1. air pollution control
2. noise reduction
3. temperature regulation, and
4. shading to school children.

* Analysis to prioritize the areas with most ecosystem services

Endreny, T., Santagata, R., Perna, A., De Stefano, C., Rallo, R. F., & Ulgiati, S. (2017). Implementing and managing urban forests: A much needed conservation strategy to increase ecosystem services and urban wellbeing. *Ecological Modelling*, 360, 328-335.

doi:10.1016/j.ecolmodel.2017.07.016

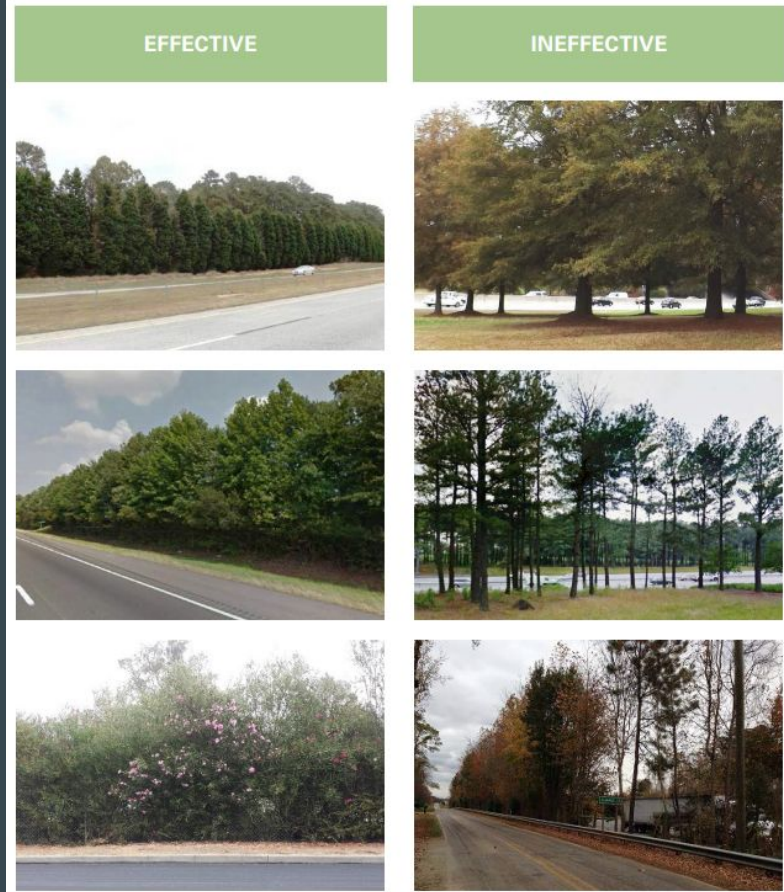
A recent study published in the online journal *Ecological Modelling* reported that in 10 megacities studied, tree-based ecosystem benefits had a median annual value of \$505 million.



Best practices for using vegetative barriers to reduce air pollution exposure



Figure 6. Examples of effective and ineffective vegetative barriers. Image: U.S. EPA 2016.



This document also highlights a variety of non-air quality related considerations that should be weighed when considering planting trees or vegetation to mitigate pollution near high-volume roadways. One important consideration is what to install and where to install it order to minimize potential negative impacts, including allergen production, water need, cost, and safety hazards. The overarching best management practice for urban forestry is to plant a diversity of species in accordance with the 30/20/10 rule: no more than 30 percent of trees should be species within the

Starting a Discussion about Proposed Mitigation Sites at WES

Site 1 is located next to a high traffic road and should be considered the highest priority



Possible Mitigation - Invest to improve indoor air quality

What can be done to mitigate children's air pollution exposures at schools?

In Los Angeles and Boston, stakeholders have partnered to reduce air pollution exposures, and funded larger studies and direct investments, such as:

1. Upgrades to central heating, ventilation, and air-conditioning (HVAC) systems.
2. Filtration systems to reduce UFPs from indoor and outdoor sources.

Other potentially useful policies

Assembly Bill 758 (2009) required the CEC and the CPUC to develop a comprehensive program to reduce energy consumption in existing buildings.

Safe routes to Schools and Safe routes to Transit could address all Pollutants
Provide funds for the regional Safe routes to School and Safe routes to Transit Programs.

County Offices of Education and Community Colleges seeking funding under the California Clean Energy Jobs Act (Proposition 39) may now apply for technical assistance under the Bright Schools Program (see next slide

<https://www.dgsapps.dgs.ca.gov/DSA/SustainableSchools/sustainabledesign/energy/hvacsystems.html>

Another recommendation

If not done already, partner with Bright Schools program for free audit to plan investments that improve air quality and reduce energy use



HOW CAN ENERGY EFFICIENCY BENEFIT YOUR SCHOOL?

NOW IS THE TIME TO UPGRADE EXISTING SCHOOLS WITH ENERGY EFFICIENT EQUIPMENT AND START SAVING MONEY. The Bright Schools program provides technical assistance services to identify ways for your school to reduce energy use and costs. These services are provided by highly qualified engineering consultants at no cost to you!

Savings typically reduce annual energy costs by an average of 15–20 percent. With the availability of Proposition 39 funding there is no better time to start saving than now. Let us help you identify cost-effective energy efficient upgrades. The Bright

Typical Services Include:

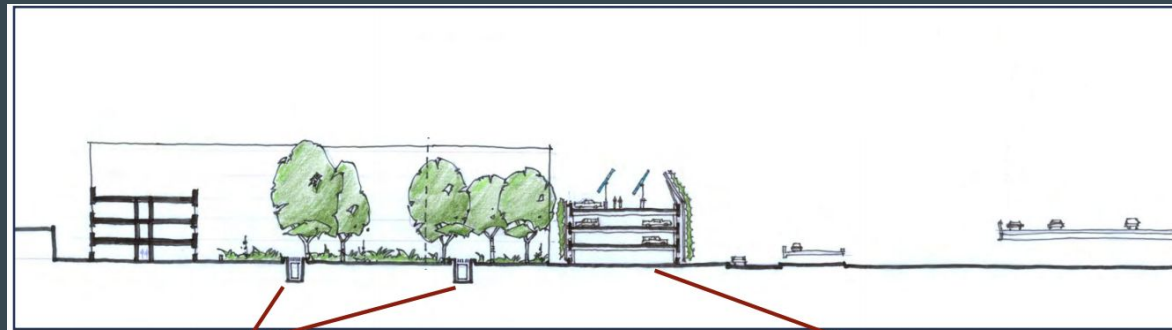
- » Identify energy efficiency and clean self-generation measures for Proposition 39 funding
- » Conduct energy audits and prepare targeted energy feasibility studies
- » Review existing project proposals including proposals for energy efficiency measure retrofits, power purchase agreements, and solar photovoltaic projects
- » Develop equipment performance specifications
- » Review contractor bids

What services does the Bright Schools program offer?

There is no cost to participate in the Bright Schools program. Program participants will receive a grant of services. With this grant of services, the Energy Commission will provide up to \$20,000 of consultant costs to provide technical assistance services to identify potential energy savings projects. The Energy Commission has a team of highly qualified engineering consultants that

Possible Mitigation - Building & Road Design

- Strategies to reduce traffic emissions
 - Reduce vehicle speed through road design
 - Roundabout intersections, speed limit reductions (avg speed range = 35-55 mph)
- Building design on-campus: Multi-story parking garage (w vegetative barrier)
 - Could act as a barrier for highway
 - Multi-purposeful: place to put cars AND serve as tool to decrease emissions



Protected ventilation air intakes

Parking as pollution barrier
(with vegetative barrier)

Table 1

Summary of expected effectiveness of different tactics.

| | Effectiveness | | |
|-----------------|---|--|--|
| Location | Good | Moderate | Inconclusive |
| On-Site | <ul style="list-style-type: none"> • Filtration • Air intake location • Sound proofing | <ul style="list-style-type: none"> • Healthy placement of buildings and parking structures • Trees and Plantings | <ul style="list-style-type: none"> • Healthy vegetables |
| Off-Site | <ul style="list-style-type: none"> • Park locations • Land use buffers | <ul style="list-style-type: none"> • Built or vegetative barriers • Active travel locations • Decking over highways | |

Next steps

- Gather asthma data and related respiratory-illness data from schools within 500 ft. and 1320 ft. to major roadways in order to conduct correlational analyses.
- Conduct additional quantitative demographic analysis to assess environmental justice in SCC
- Determine best mitigation strategies for the schools we collaborate with and how to finance said mitigation measures based on feedback from school site council.

Acknowledgements

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