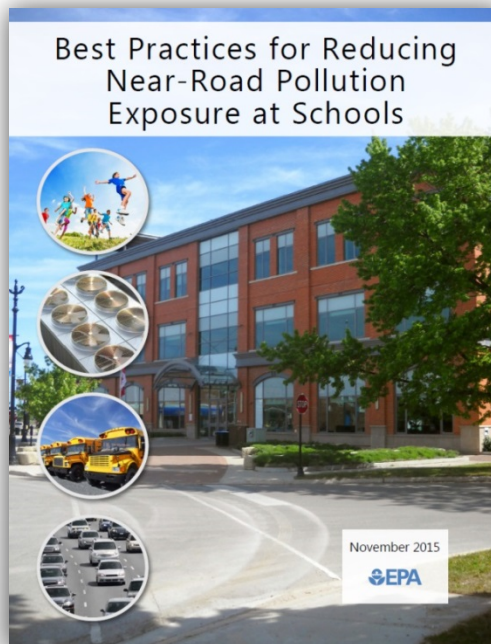
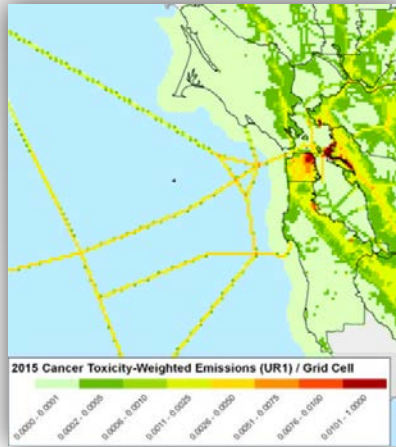


# Environmental Justice: Community Interests and Breakthroughs in Air Quality Management



Douglas Eisinger, PhD  
Fred Lurmann  
Paul Roberts, PhD  
Steven Brown, PhD  
Hilary Hafner

Sonoma Technology, Inc.  
Petaluma, CA

August 2017

# Abstract

Despite a decades-long trend toward improved regional air quality, some U.S. communities lag behind others in realizing clean air. The disparity has been identified as an Environmental Justice (EJ) issue, and has been a concern for many years.

# About This Presentation

This presentation shares items of interest for those supporting EJ communities. The material

- Highlights EJ air quality challenges; and
- Identifies opportunities to address EJ concerns.

The challenges and opportunities material also provides technical insights STI has learned over the years while collaborating with study partners from universities, government agencies, research firms, and others. We hope it facilitates useful discussions to improve air quality.

# Key Messages

1. There is a **wealth of existing data** that can be more fully leveraged to support assessment of air quality in EJ communities.
2. **Lower-cost technologies** can now improve acquisition, management, and analysis of EJ-related air quality data.
3. **A few pollution sources** are often disproportionately responsible for environmental impacts. Strategies that target the most important emitters can cost-effectively assist EJ communities.
4. Air quality **problems are continually changing over time**, due to demographic shifts and control program effectiveness. Research can support air quality improvement strategies that anticipate and respond to these changes.

# Contents

(list is hyperlinked)

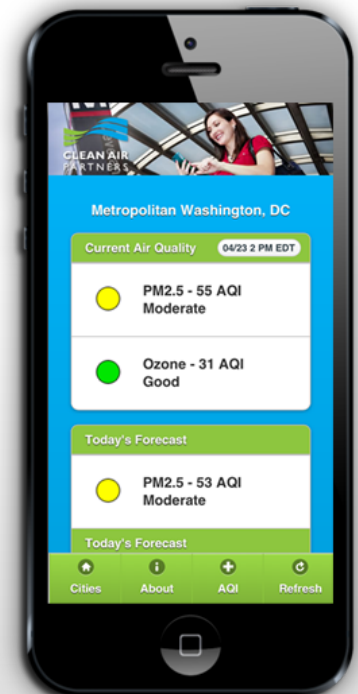
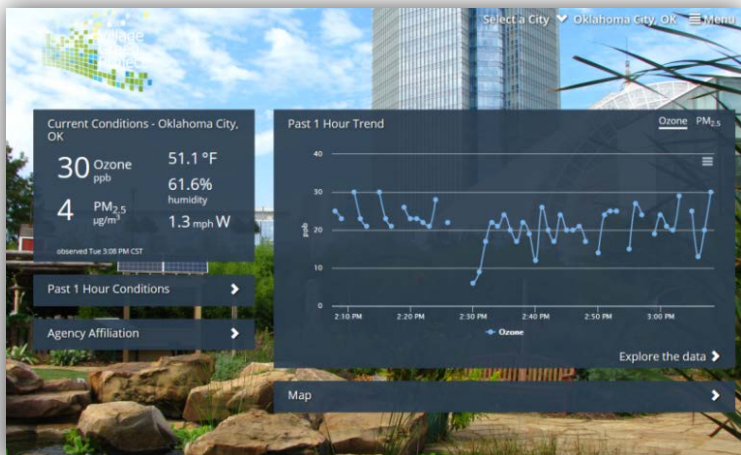
1. Introduction: About STI
2. Context and motivation for discussion
3. Challenge: EJ settings are near pollution sources
4. Challenge: Control programs often fall short of forecasts
5. Challenge: Technology penetration can be slow
6. Implications
7. Opportunity: We can mine a wealth of existing data
8. Opportunity: Technology developments are transformative
9. Opportunity: A small fraction of sources is often key
10. Opportunity: Tomorrow's problems will be different
11. Closing thoughts

# Introduction: About STI

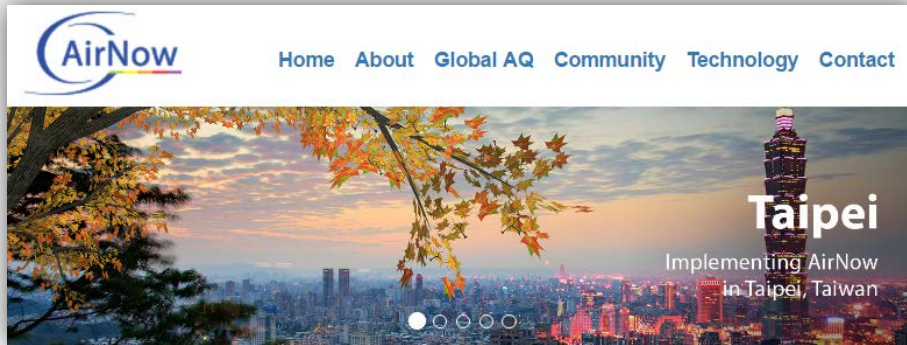
# Sonoma Technology, Inc.

We provide air quality, meteorological, and transportation-related air quality services to clients around the world.

- Founded in 1982, headquarters in Petaluma, California
- Satellite offices in southern California
- Employee-owned and directed

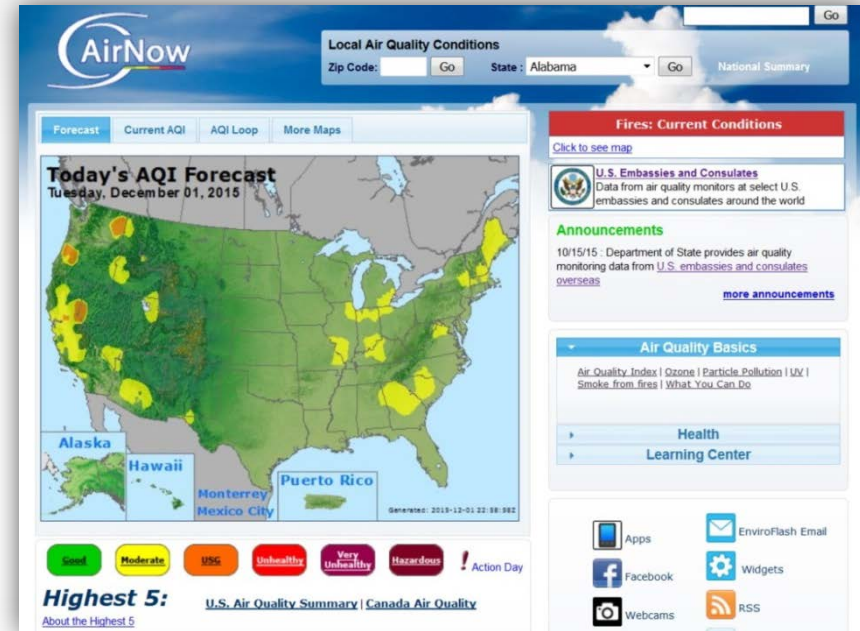


# Real-Time U.S. & International Air Quality



[AirNowGlobal.com](http://AirNowGlobal.com)

- We run the entire U.S. EPA AirNow system.
- We provide real-time air quality and tools for data analysis and forecasting.
- STI also supports EPA's AirNow Global program.



[AirNow.gov](http://AirNow.gov)



# Children's Health Study



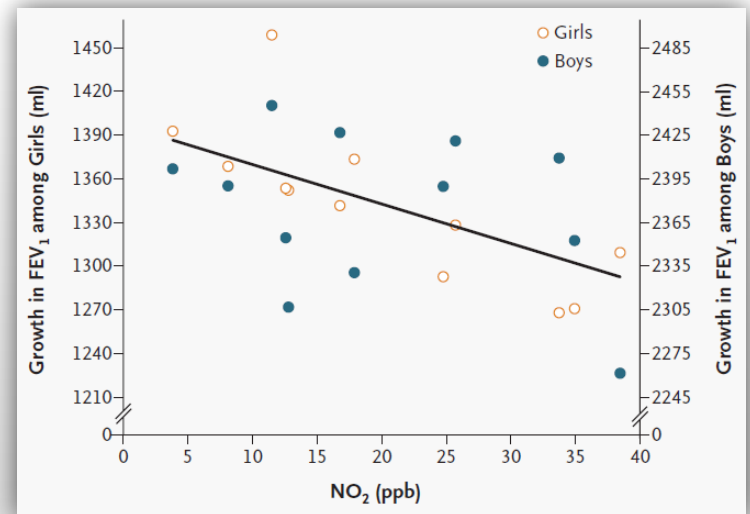
## The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age

W. James Gauderman, Ph.D., Edward Avol, M.S., Frank Gilliland, M.D., Ph.D., Hita Vora, M.S., Duncan Thomas, Ph.D., Kiros Berhane, Ph.D., Rob McConnell, M.D., Nino Kuenzli, M.D., Fred Lurmann, M.S., Edward Rappaport, M.S., Helene Margolis, Ph.D., David Bates, M.D., and John Peters, M.D.

## Association of Improved Air Quality with Lung Development in Children

W. James Gauderman, Ph.D., Robert Urman, M.S., Edward Avol, M.S., Kiros Berhane, Ph.D., Rob McConnell, M.D., Edward Rappaport, M.S., Roger Chang, Ph.D., Fred Lurmann, M.S., and Frank Gilliland, M.D., Ph.D.

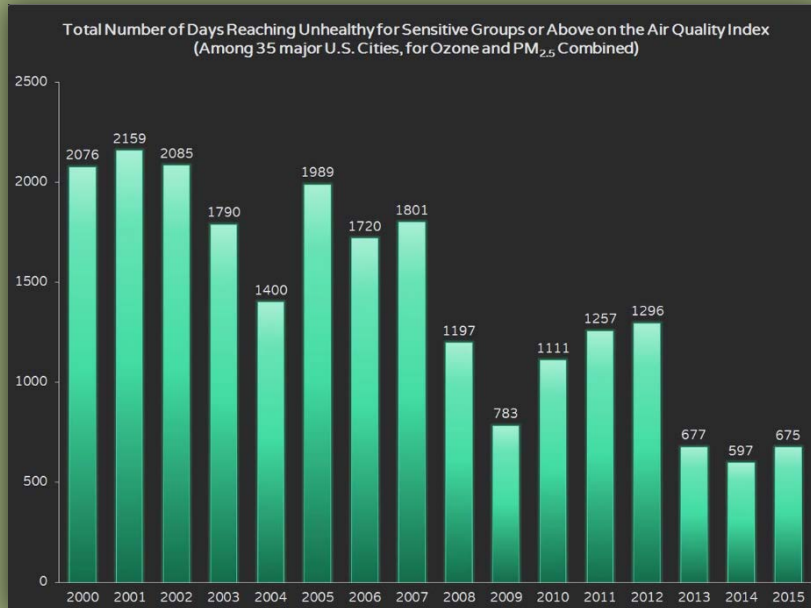
- STI has worked with USC and other organizations for over 25 years to assess air quality's effect on children's health.
- The collaboration's landmark publications have been cited over 1,000 times worldwide.



# Context and Motivation for Discussion

Sustained regional air quality improvements...

...but areas still at risk

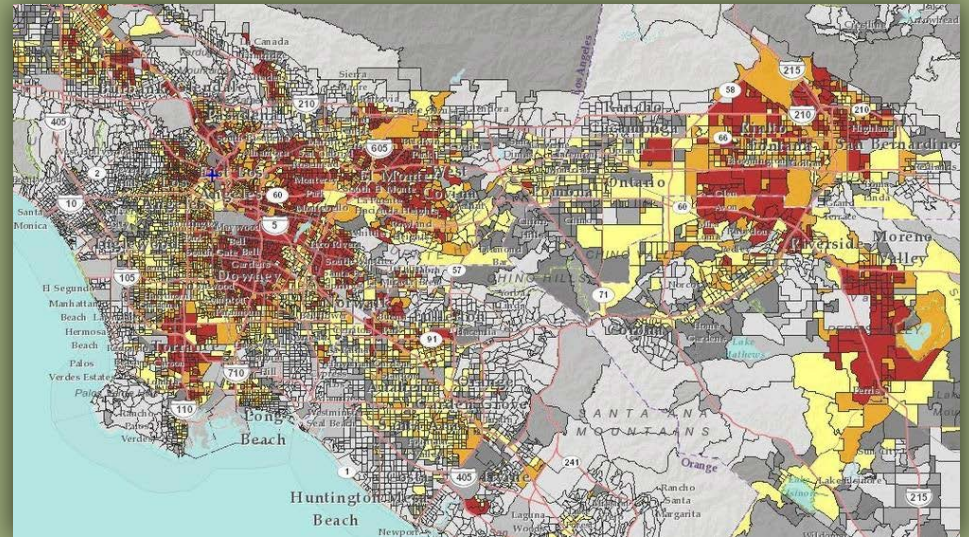


National trend 2000–2015

Source: EPA

## Los Angeles Times

EPA 'environmental justice' map highlights California's pollution ills

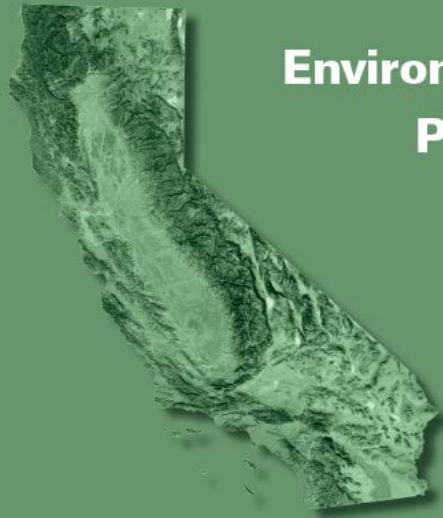


2015 LA Times article; data source: EPA, EJSCREEN

June 2016



## Environmental Justice Program Update



“Too many communities in the state continue to bear a disproportionate share of environmental pollution...”

Matthew Rodriguez  
California Secretary for  
Environmental Protection  
June 2016



FINAL 2017 CLEAN AIR PLAN



ADOPTED APRIL 19, 2017

## Overlap between socio-economic status and pollution

"...there are still disparities in health risk from air pollution among Bay Area communities..."

BAAQMD, April 2017  
Clean Air Plan

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT



## Final Socioeconomic Report

2016 AIR QUALITY MANAGEMENT PLAN



March 2017

## Overlap between socio-economic status and pollution

“...Many Basin residents live, work, and play in areas with poorer air quality than others, and are often more economically disadvantaged...”

SCAQMD, March 2017  
2016 AQMP Socioeconomic Report

# Challenge: EJ Settings are Often Near Pollution Sources

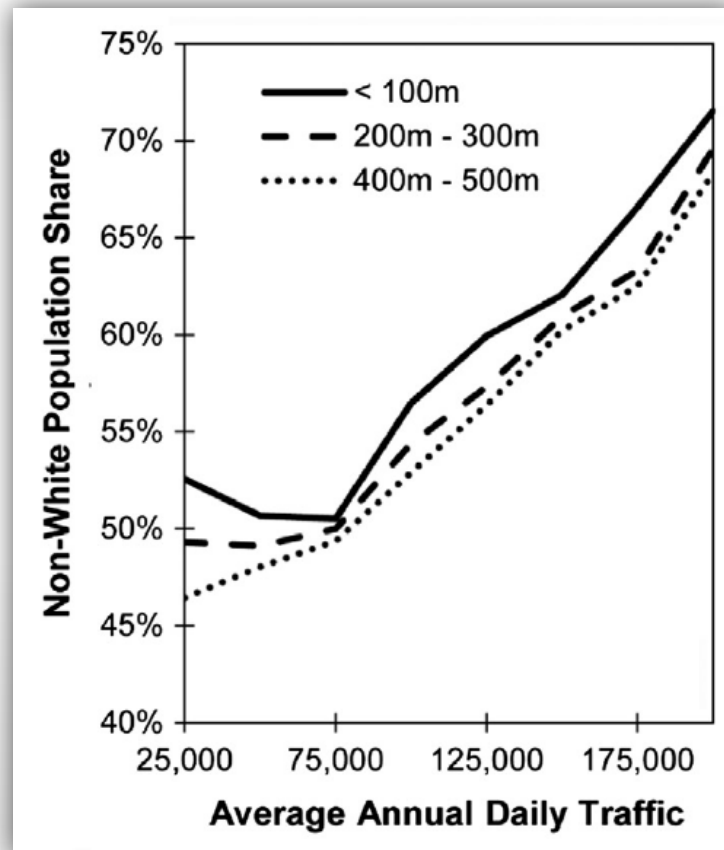
EJ settings are often:

- Near major roads
- Near ports and other inter-modal facilities
- Near industrial pollution sources



# Near-Road Settings

"...minority and low-income households are on average more likely to live near a high volume road or in an area with higher traffic density."



*Source: A census of the US near-roadway population: public health and environmental justice considerations (G.M. Rowangould, 2013, Univ. of N. Mexico)*

# STI Monitoring (NDOT): Fyfe Elementary

Fyfe Elementary, near US 95, Las Vegas (one of several schools studied)



Before widening



After widening

Sources: Roberts et al., 2010; McCarthy et al., 2013, Brown et al., 2014

*EJ Insight.* During school hours, black carbon (BC) concentrations at schools along US 95 were 2-3 times greater than background.



# Near-Road Air Quality: Worldwide Synthesis

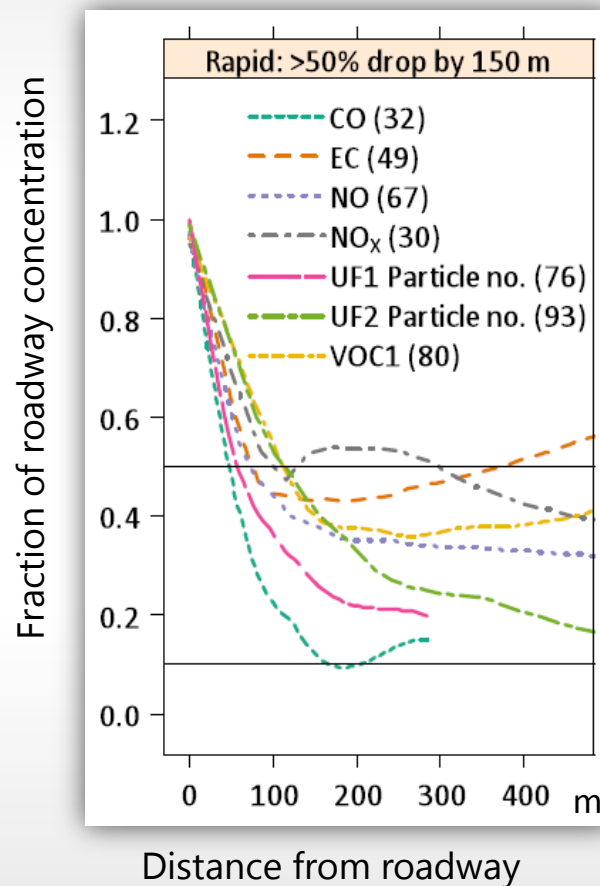
U.C. Davis and STI evaluated measured concentrations spanning 41 studies, 13 countries, 30 years.

Key findings, by distance from road:

- 150 m – rapid (50%) decline
- 400 m – most at background
- 600 m – nearly all at background

(nighttime exceptions)

Source: Karner, Eisinger, and Niemeier (2010)  
*ES&T*, 44, 5334-5344.



*EJ Insight*. Near-road problems are relatively uniform throughout the world; concentrations are highest within a few hundred meters of major roads.

# Near-Port Settings

Areas "...immediately north of the Ports of Los Angeles and Long Beach... have historically been exposed to high levels of air pollution... [They] comprise minority residents and have higher poverty rates..."

Demographic Factor	Port Area	LA Cty.
Hispanic	65%	45%
Non-Hispanic white	8%	31%
Income < poverty level	29%	18%
Education < high school	52%	30%

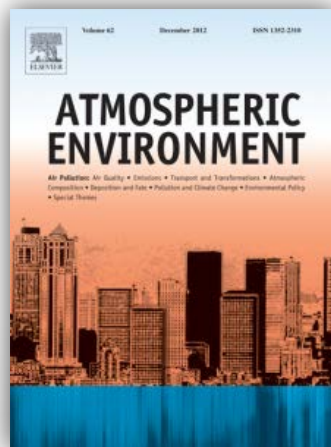
*Source: Diesel Truck Traffic in Low-Income and Minority Communities Adjacent to Ports: Environmental Justice Implications of Near-Roadway Land Use Conflicts (D. Houston et al., 2008, UCLA)*

# PM Near Ports of LA & Long Beach

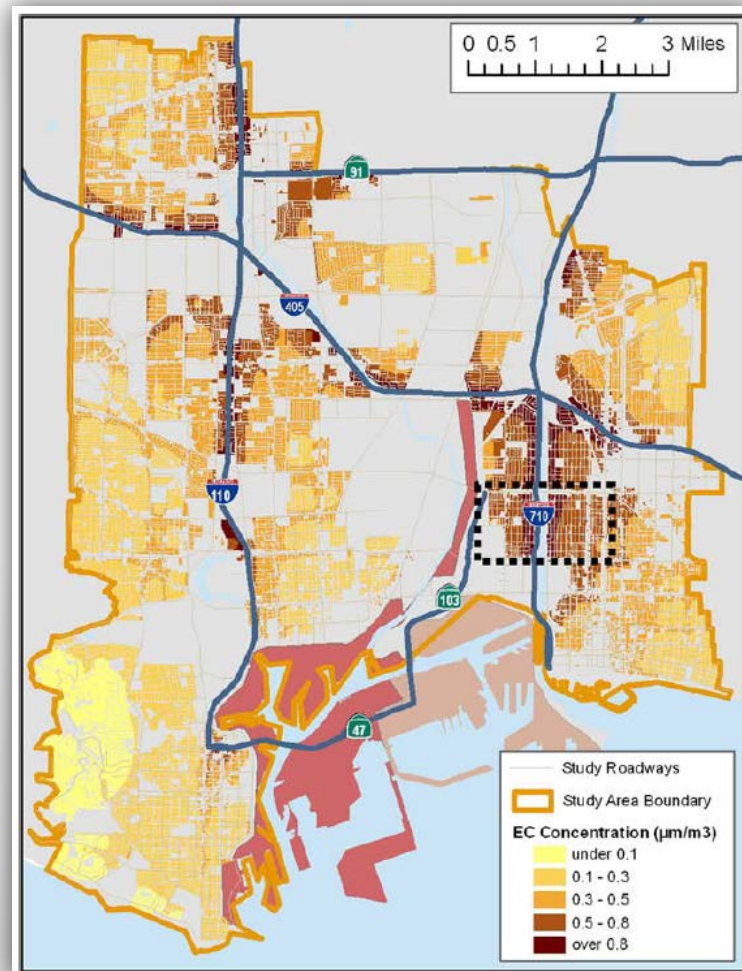
Exposure of PM<sub>2.5</sub> and EC from diesel and gasoline vehicles in communities near the Ports of Los Angeles and Long Beach, California

Jun Wu<sup>a</sup>, Douglas Houston<sup>b, d</sup>, Fred Lurmann<sup>c</sup>, Paul Ong<sup>b</sup>, Arthur Winer<sup>d</sup>

STI, UCLA, and U.C. Irvine assessed PM<sub>2.5</sub> and EC in port areas impacted by diesel trucks.

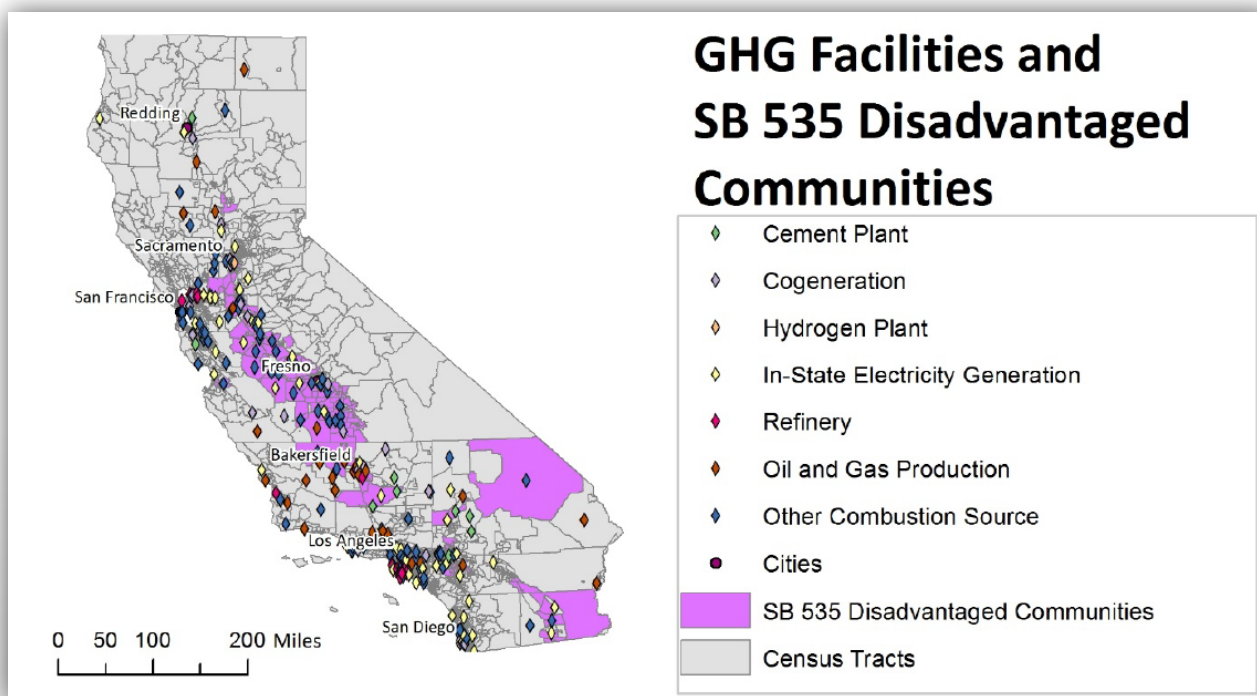


*EJ Insight:* Exposure was influenced by surface streets and freeways, and by light- and heavy-duty diesel vehicles.



# Near-Industry Settings

“More than half of these facilities are located in or near disadvantaged communities.”

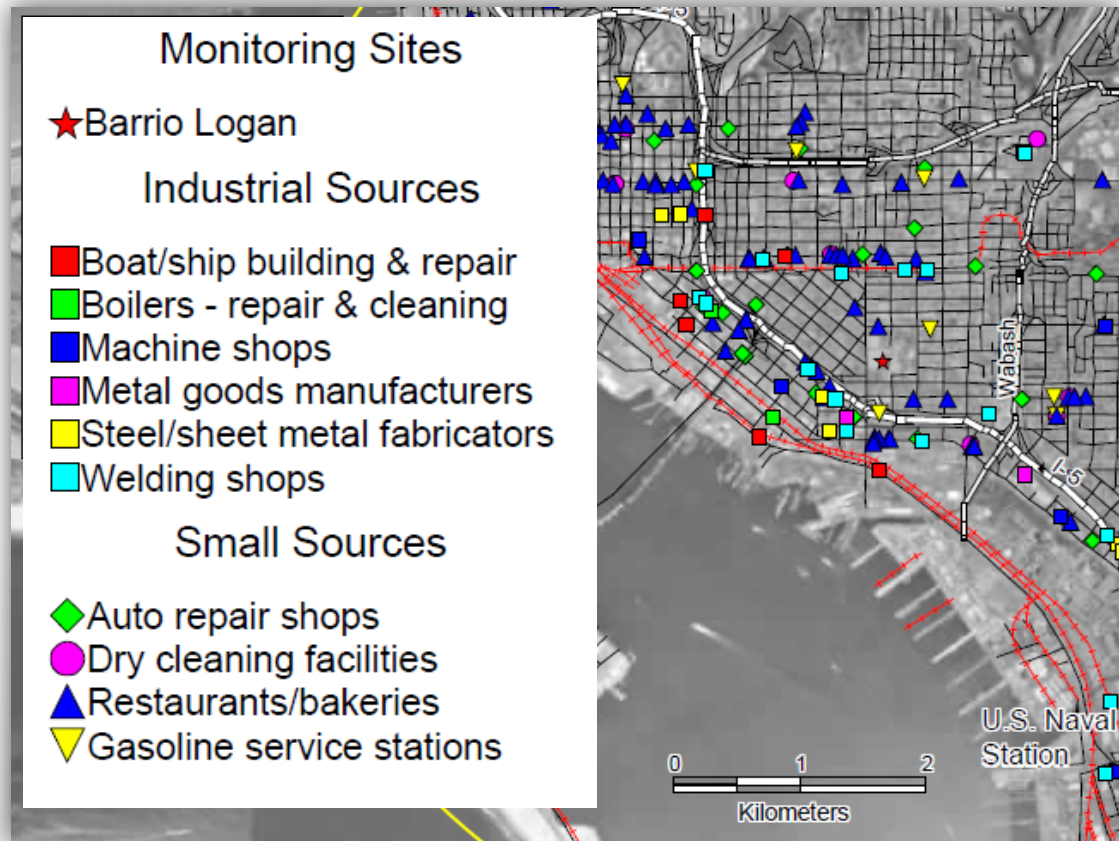


Source: OEHHA, *Tracking and Evaluation of Benefits and Impacts of Greenhouse Gas Limits in Disadvantaged Communities* (February 2017)

# Barrio Logan Air Toxics Analysis

Sponsored by San Diego Air Pollution Control District

- STI compared a San Diego EJ area (Barrio Logan) to two other areas.
- Concentrations of molybdenum, nickel, antimony, tin, were higher.
- Other concentrations were generally similar or lower.



*EJ Insight:* Residents of EJ communities may live close to various business-related emissions sources (early EJ work finished 2001).

# Challenge: Control Program Effects Often Fall Short of Forecasts

There is often a difference between forecasted and actual control program effectiveness.

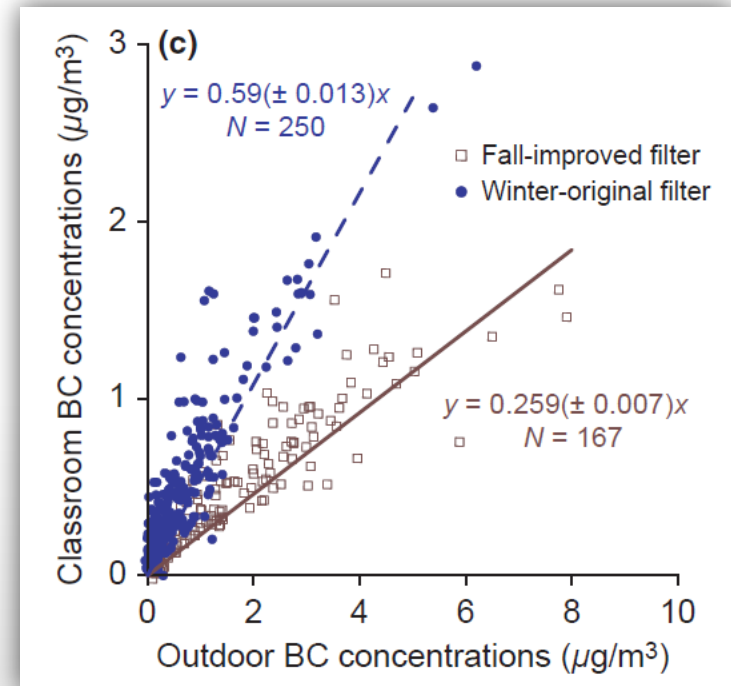
Therefore, we need sustained evaluation over time to assess implementation progress and identify the need for additional actions.

# School HVAC Filtration

## Next to US 95 in Las Vegas (BC Removal Data)

### HVAC Filtration Efficiency Part 1 (Short-Term)

Source: McCarthy et al. (2013) Filtration effectiveness of HVAC systems at near-road schools. *Indoor Air*, 23(3), 196-207. (STI work sponsored by Nevada DOT.)



*EJ Insight.* Improved HVAC filters cut indoor (classroom) BC concentrations, compared to outdoors, by up to 97% (in short term).

# School HVAC Filtration

## Next to US 95 in Las Vegas (BC Removal Data)

### HVAC Filtration Efficiency Part 2 (Long-Term)

School	Original Efficiency (old filters)	Upgraded Efficiency (2008, new filters installed)	2013 Efficiency (5 Years later)
Adcock Elem.	66%	97%	<b>91%</b>
Fyfe Elem.	50%	72%	<b>50%</b>

Sources: McCarthy et al., 2013; Roberts et al., 2013

Note: Original filter rating of MERV 6 was used in these schools. Upgrades installed MERV 15 filters to outdoor air intakes. MERV = Minimum Efficiency Reporting Value, per ASHRAE. This is a rating for typical efficiency of particle removal in the size range of 0.3 to 10 microns in diameter.

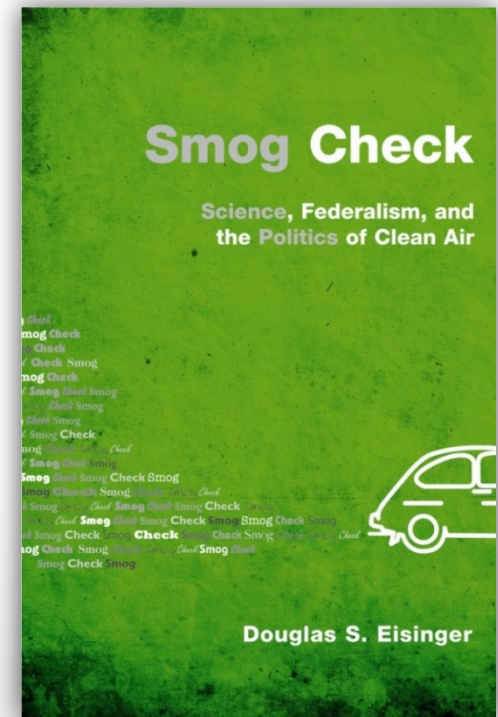
*EJ Insight:* Long-term success depends on technology (HVAC filters) and human factors; e.g., opening outside door at Fyfe reduced filtration effects.



# Clean Air Act (CAA) Implementation: Smog Check



- STI evaluated U.S. vehicle inspection and maintenance (I/M) implementation.
- Peer-reviewed book published by RFF Press; Foreword by Mary Nichols.
- Lessons: real-world program benefits fell short of expected outcomes; better political and technical consensus needed.



*EJ Insight.* When mitigation benefits fall short of forecasts, contingency plans are needed to help meet pollution reduction goals.

# Guidance for Schools

STI, EPA, and Arup prepared national guidance to reduce near-road air pollution exposure.

Summary 19

## Mitigation: Consider as a Package

Emissions	Concentrations	Exposure
<b>Transportation Infrastructure</b> <b>1. Corridor Mgt.</b> <ul style="list-style-type: none"> <li>• Improve traffic flow</li> <li>• Reroute trucks</li> <li>• Increase trips by foot, bike, or transit</li> </ul> <b>2. Street Design</b> <ul style="list-style-type: none"> <li>• Lower volumes</li> <li>• Buffer people from roads</li> </ul>	<b>Roadside Features</b> <b>3. Barrier Use</b> <ul style="list-style-type: none"> <li>• Install walls</li> <li>• Add vegetation</li> </ul>	<b>Site Planning</b> <b>4. Design</b> <ul style="list-style-type: none"> <li>• Locate sensitive uses farther from roads</li> <li>• Phase parcels closest to road later in build out</li> </ul>
		<b>Building Design, Ops.</b> <b>5. Design</b> <ul style="list-style-type: none"> <li>• Optimize occupant placement</li> </ul> <b>6. Operations</b> <ul style="list-style-type: none"> <li>• Use/improve HVAC filtration</li> </ul>



*EJ Insight.* Mitigation strategies can package measures to improve long-term effectiveness at reducing emissions, concentrations, and exposure.

# Challenge: Advanced Technology Penetration Can Be Slow in EJ Settings

To what degree and how quickly will EJ communities benefit from future technology advances?

# Data for Los Angeles Area

Group	Households	Without Vehicles
SCAG Region (2009-2013) 16% of households in poverty	5.8 million	8%
EJ Areas (2012) 17% of households in poverty	3.7 million	10%
SB 535 Disadvantaged Communities (2012) 25% of households in poverty	1.8 million	12%
Communities of Concern (2012) 40% of households in poverty	1.1 million	13%



Source: SCAG 2016

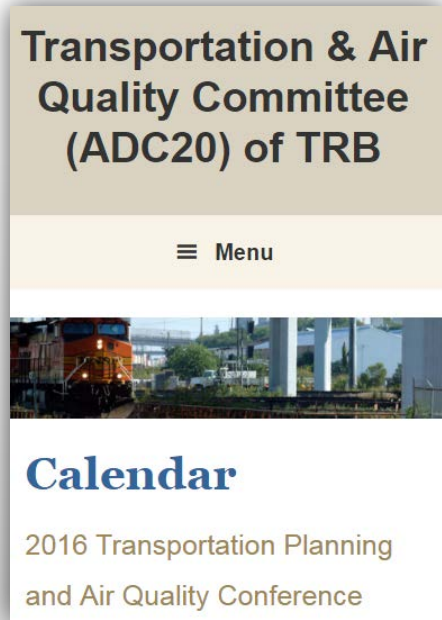
# Issue – How Soon Will Advanced Technology Vehicles Help EJ Communities?



The screenshot shows a news article from Mother Nature Network. The title is "Average EV driver is a well-educated and affluent white male". Below the title is a sub-headline: "New study digs into the demographics of electric vehicle drivers." The author is listed as "MELISSA HINCHA-OWNBY" with a Twitter icon, and the date is "November 20, 2012, 11:38 a.m.". There are social sharing buttons for Facebook (13 shares), Twitter, Pinterest, and Email. At the bottom of the article is a photograph of two electric cars, a blue one and a white one, parked in a lot with palm trees and mountains in the background.

Technology solutions continue to reduce emissions; however, EJ settings may lag behind other areas in experiencing benefits.

STI is addressing advanced technology issues through our leadership role with the U.S. Transportation Research Board (TRB).



The screenshot shows the website for the Transportation & Air Quality Committee (ADC20) of TRB. The header includes the title "Transportation & Air Quality Committee (ADC20) of TRB" and a "Menu" button. Below the header is a banner image showing a train and a modern building. Underneath the banner is a "Calendar" section with the text "2016 Transportation Planning and Air Quality Conference".

# The Air Quality-Related Health Implications Are Profound for EJ Communities

As with all air quality issues, we are most concerned with susceptible population groups, including the elderly, those with pre-existing respiratory conditions, pregnant women, and children.

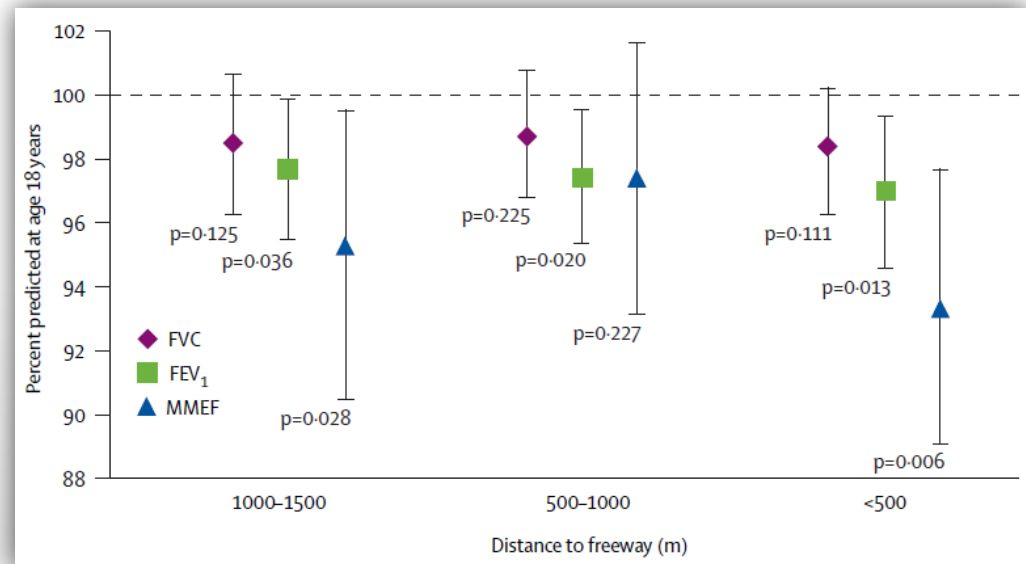
# Children's Lung Development



## Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study

W James Gauderman, Hita Vora, Rob McConnell, Kiros Berhane, Frank Gilliland, Duncan Thomas, Fred Lurmann, Edward Avol, Nino Kunzli, Michael Jerrett, John Peters

STI, USC and others, measured lung function and traffic exposure for 1,445 children for 8 years.



*EJ Insight.* Children who lived <500 m from a freeway had reduced lung function compared to those >1500 m away.

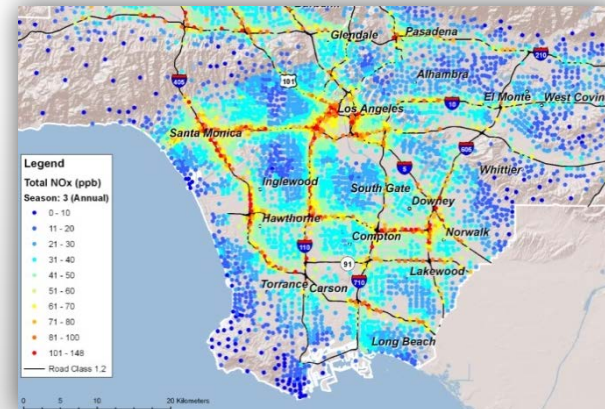
# Near-Roadway Pollution and Childhood Asthma



## Near-Roadway Pollution and Childhood Asthma: Implications for Developing “Win-Win” Compact Urban Development and Clean Vehicle Strategies

Laura Perez, Fred Lurmann, John Wilson, Manuel Pastor,  
Sylvia J. Brandt, Nino Künzli, Rob McConnell

STI worked with USC and others to model concentrations and estimate health impacts.



*EJ Insight:* About 8% of childhood asthma in the Los Angeles area is at least partly due to living within 75 m of a major road.



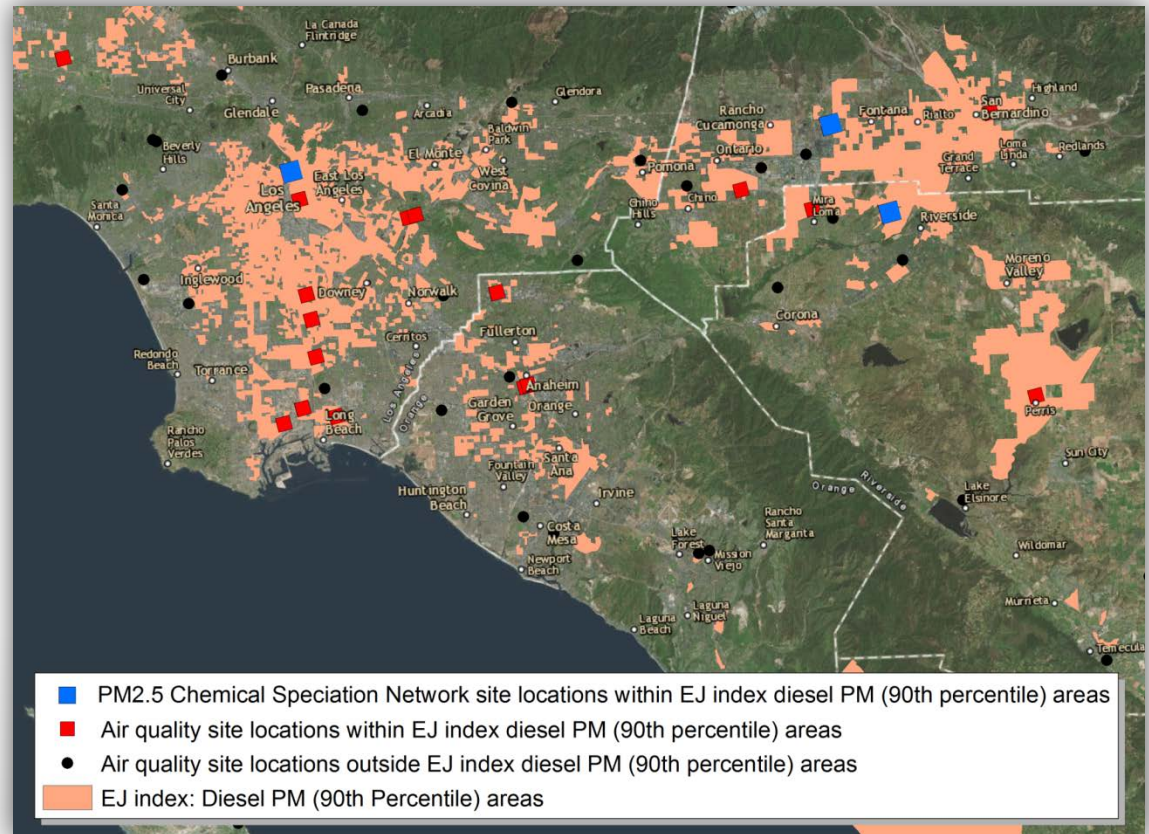
# Opportunity: There Is a Wealth of Existing Data That Can Be Mined to Understand EJ Community Impacts

Complementing the data that are available, new and improved tools enable sophisticated assessments.

# Available Monitoring Data

## Los Angeles area monitors

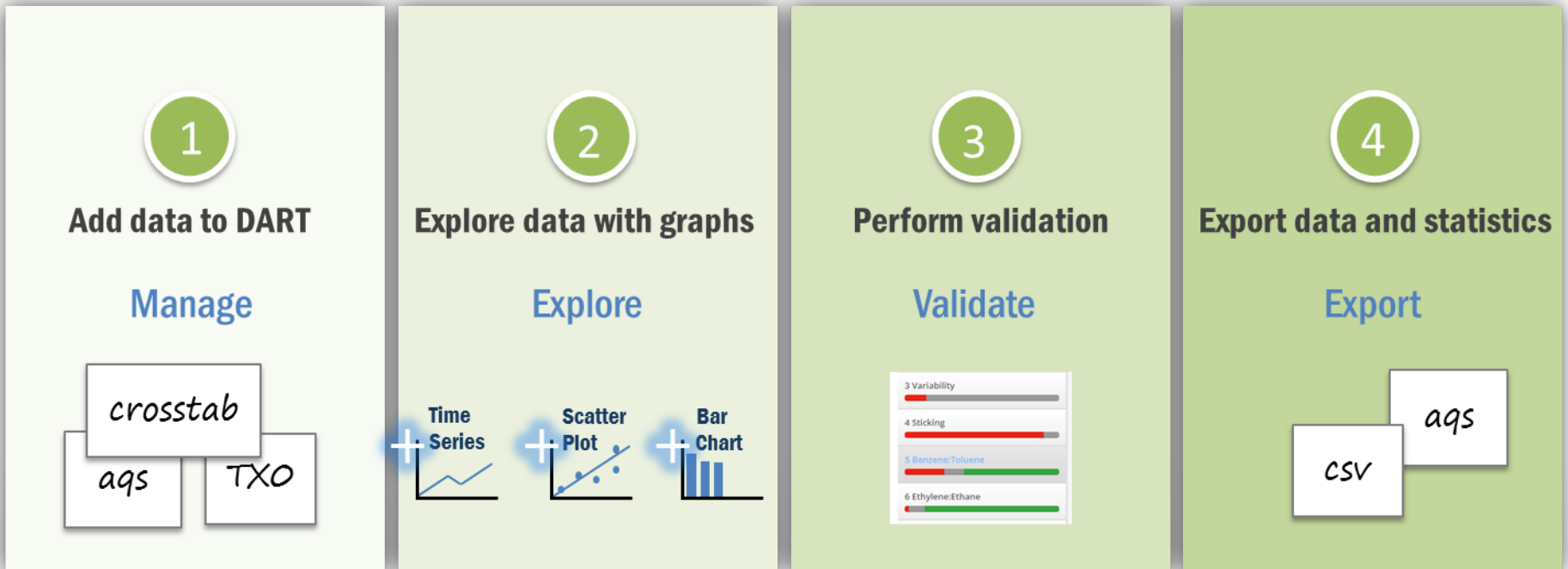
- **Peach:** EJ areas (from EPA EJSCREEN demographics and diesel PM).
- **Blue:** PM<sub>2.5</sub> speciation sites in these EJ areas.
- **Red:** other pollutant sites in these EJ areas.
- **Black:** monitors outside these EJ areas.



*EJ Insight:* Numerous air quality monitors are located in EJ areas, enabling detailed analyses of air quality in EJ versus surrounding areas.

# Data Analysis & Reporting Tool (DART)

[www.airnowtech.org](http://www.airnowtech.org)

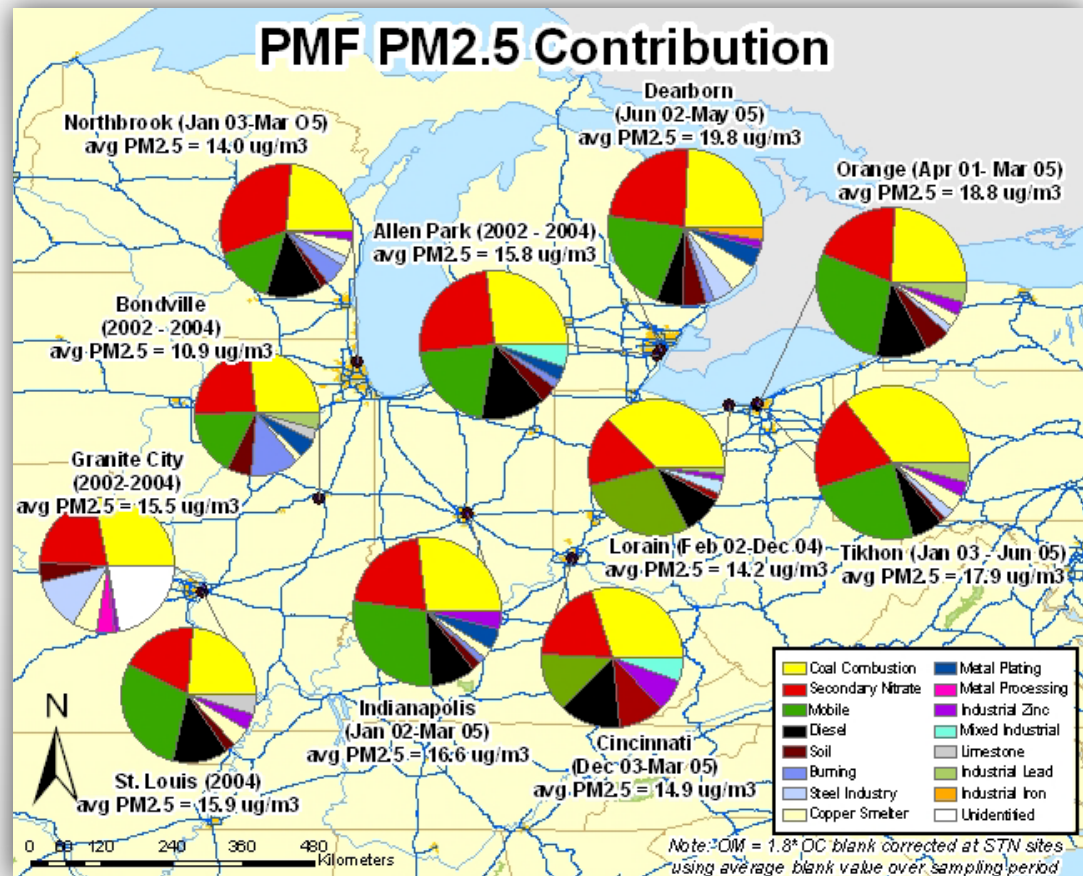


STI created a web-based data analysis tool for EPA. DART allows agencies to manage, explore, validate, and assess data.

*EJ Insight:* DART can be used to access and assess data collected in EJ areas.

# Source Apportionment with PMF

STI identified sources of  $PM_{2.5}$  by applying the Positive Matrix Factorization (PMF) tool to chemically resolved ambient PM data.



*EJ Insight.* The PMF tool, developed by STI and others, can be and has been used to assess pollution sources in EJ areas.

# Opportunity: Technology Developments Are Transforming the Air Quality Field

New technologies are providing lower-cost methods of collecting data and identifying problem areas.

# Low-Cost Sensors – Sacramento EJ Community Wood Smoke Study

STI is helping test innovative toxics and PM sensors. We:

1. Selected EJ study areas.
2. Compared low-cost and traditional monitors.
3. Identified pollution variability across communities.



Collocated monitors (above)  
Residential deployment (right)

*EJ Insight:* The emergence of low-cost sensors creates new opportunities to identify how pollution levels in EJ communities differ from other areas.

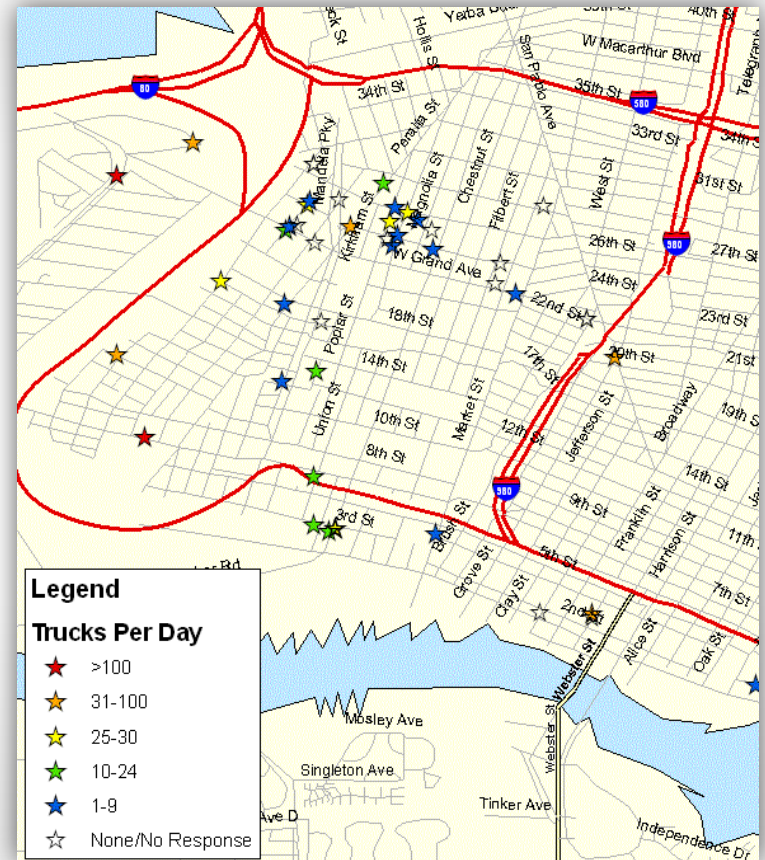
# Opportunity: Controlling a Small Fraction of Sources Can Yield Large Benefits

In many air quality situations, a small fraction of sources emits a large fraction of overall pollution. Identifying these sources can help inform cost-effective control programs.

# West Oakland Port Area Truck Study

STI estimated truck activity and emissions for BAAQMD.

- 2,937 truck trips/day
- 2.2 tons/year of DPM emissions at truck-based businesses
- Ave. 10 minute truck idle time



*EJ Insight:* Over 75% of emissions originated from just 2 of the 52 sites identified.



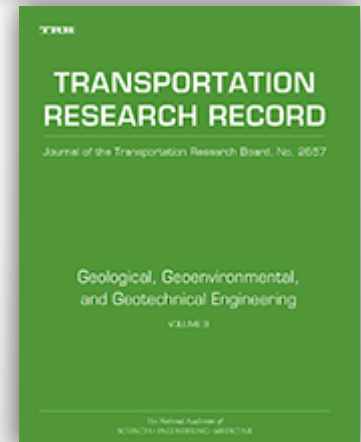
# Truck Rerouting

## U.C. Davis-STI-Caltrans Study (Barrio Logan)

### Mitigating Diesel Truck Impacts in Environmental Justice Communities

Transportation Planning and Air Quality in Barrio Logan, San Diego, California

Alex Karner, Douglas Eisinger, Song Bai, and Deb Niemeier



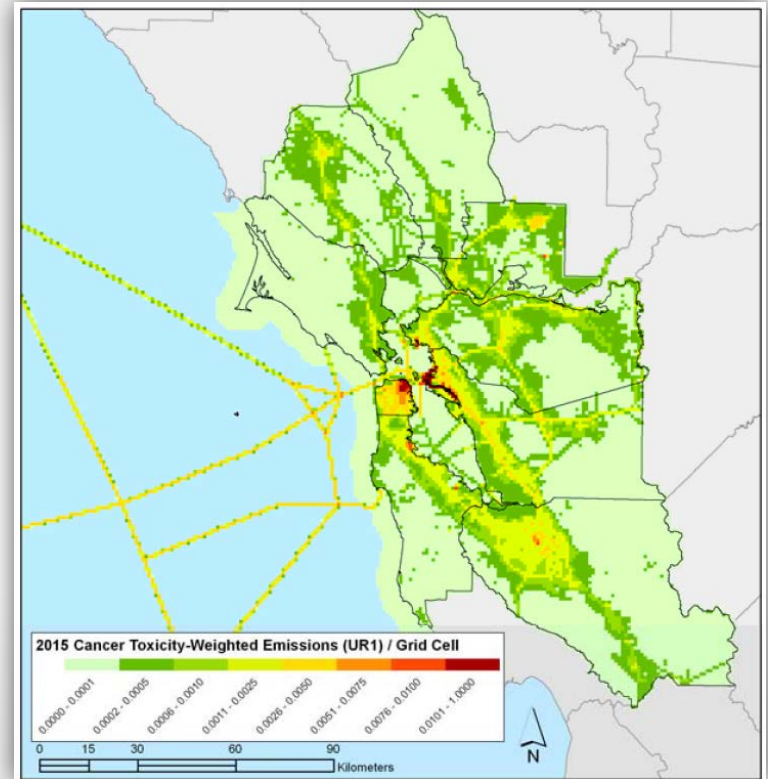
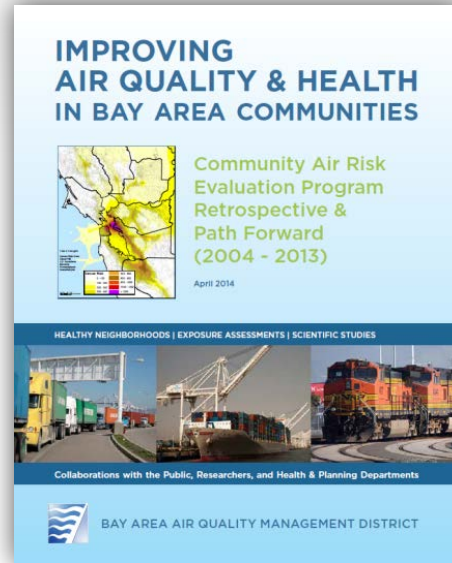
*EJ Insight*: Rerouting port-related trucks substantially reduced diesel PM in a San Diego EJ area (source: Karner et al., 2009).

# Opportunity: Tomorrow's Problems Will Be Different from Those of Today

Due to the many successful control efforts already underway, the air quality problem is changing over time. There is an opportunity to proactively anticipate tomorrow's problems and develop early responses.

# Bay Area Hot-Spots: Forecasts

STI has supported BAAQMD's CARE (*Community Air Risk Evaluation*) program for over 10 years.

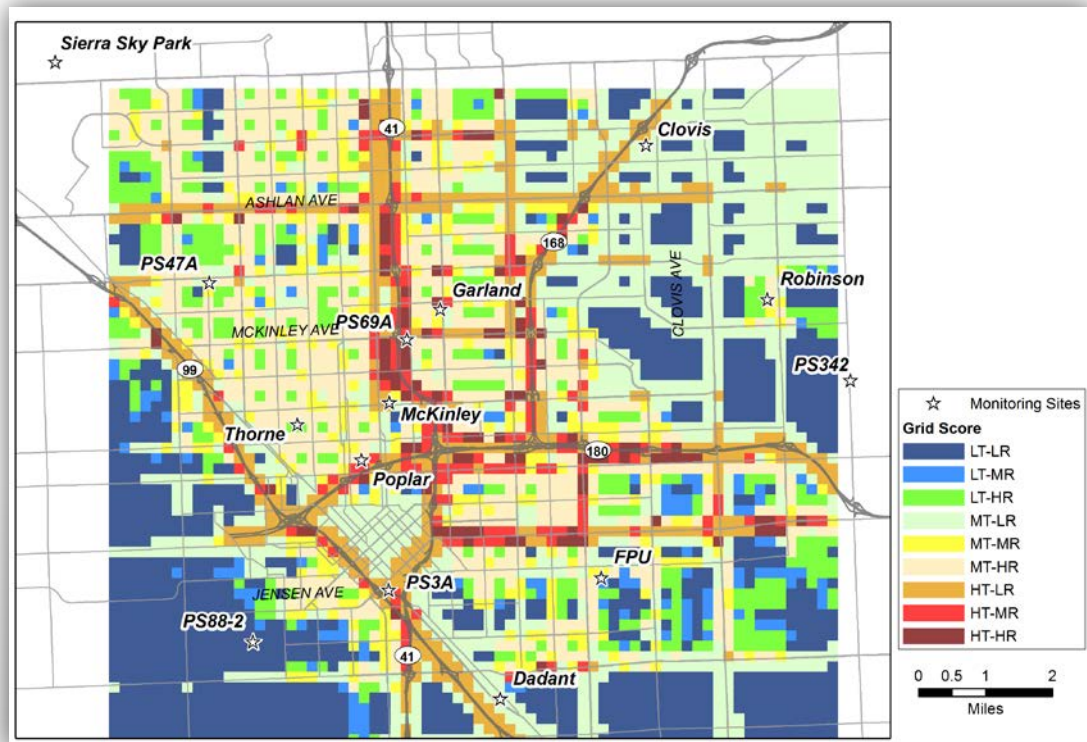


*EJ Insight.* Our emissions analyses identified at-risk communities. On-road sources, construction activities, and marine vessels contributed over 70% of the cancer toxicity-weighted emissions for both 2015 and 2020.

# Fresno Air Quality: Trends

## Children's Health & Air Pollution Study (CHAPS)

Higher PAH concentrations occur along highway corridors and in regions with high traffic/high industry.



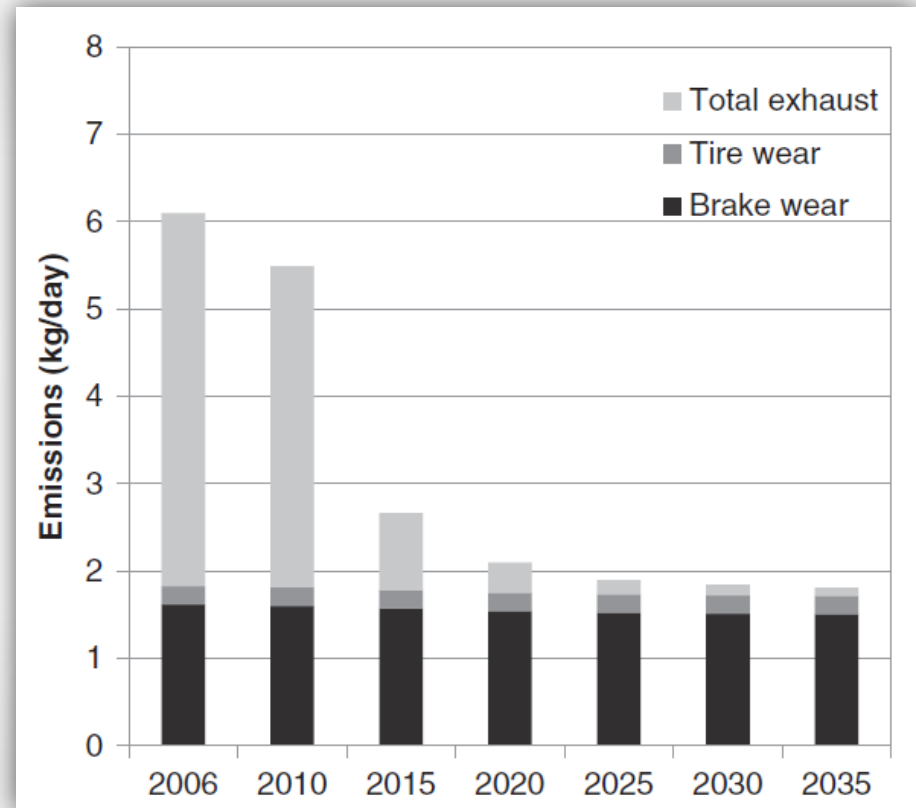
*EJ Insight.* Long-term STI measurements and analyses show PAH concentrations have trended down (cut about 2/3) from 2000 to 2015.

# PM Emissions from Vehicles Are Changing

## Emissions Modeling with MOVES and EMFAC to Assess the Potential for a Transportation Project to Create Particulate Matter Hot Spots

Stephen Reid, Song Bai, Yuan Du, Kenneth Craig, Garnet Erdakos, Lynn Baringer, Douglas Eisinger, Michael McCarthy, and Karin Landsberg

- STI did Calif. & U.S. analyses.
- We used an STI-created emissions modeling tool and identified trends.



*EJ Insight.* PM<sub>2.5</sub> vehicle emissions are changing in composition away from tailpipe (exhaust) emissions towards brake and tire wear. EJ community benefits will depend on penetration rate of newer vehicles.

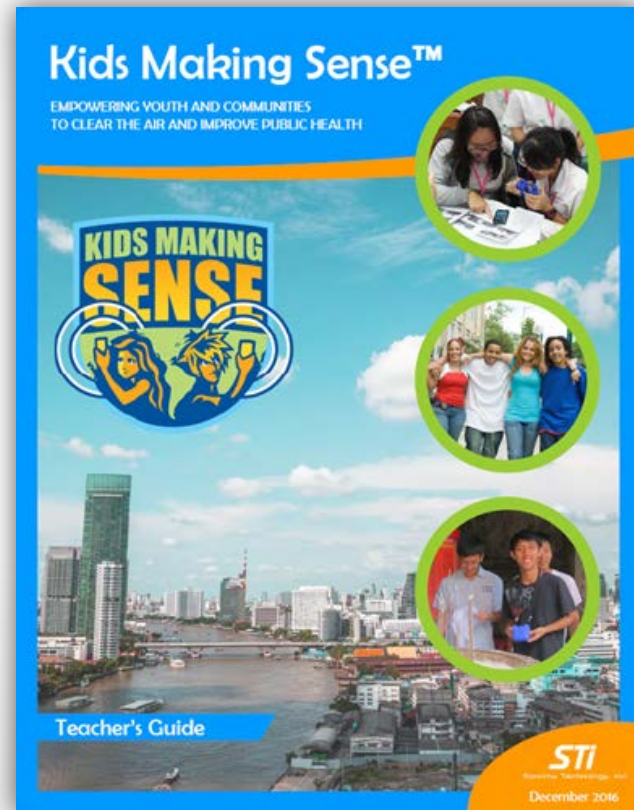
# Closing Thoughts...

# Kids Making Sense™

STI is working with the

- Coalition for Clean Air
- Comité Cívico del Valle, and others

to educate school-aged children in a southern California EJ community (Eastern Coachella Valley).



*EJ Insight.* Empowering youth builds a sustainable, long-term knowledge base to help EJ communities understand and address air pollution issues.

# EJ Insights: Key Messages

## Challenges

1. We have made enormous progress improving air quality, but **areas close to roads, ports, and industry** are still at risk; these are often EJ areas.
2. Controls are sometimes less effective than originally forecast; we need **sustained evaluation** to assess progress and identify needed additional actions.
3. **Technology advances** continue to drive down emissions; however, EJ communities may lag behind in experiencing benefits.

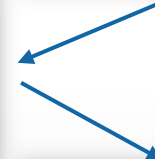
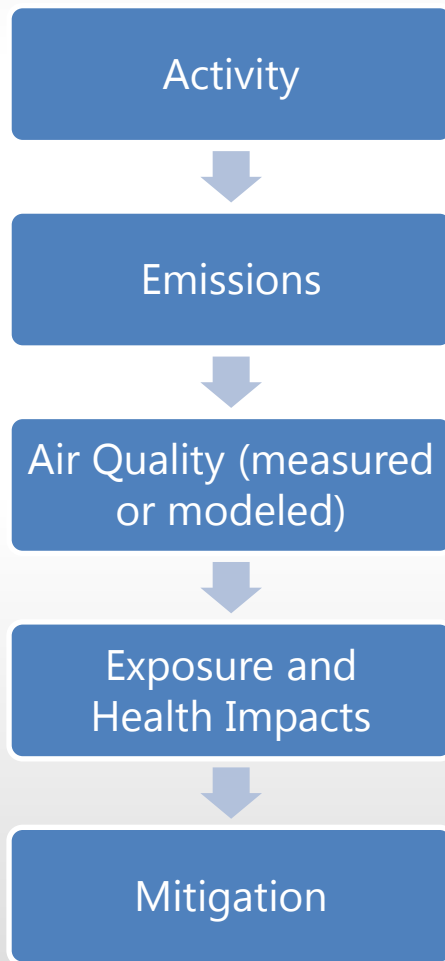


# EJ Insights: Key Messages

## Opportunities

1. A wealth of **existing data** can be mined, using improved tools, to understand EJ community impacts.
2. There are new, **lower-cost methods** of identifying problem areas.
3. A large fraction of the problem originates from **a small fraction of the sources**. Identifying those sources can cost-effectively target controls.
4. **Tomorrow's problems will be different from those of today**. We have an opportunity to proactively anticipate those problems and respond early.

# Effective EJ Support Addresses All Aspects of Air Quality Management



# Contact Us



**Steve Brown**  
Division Manager,  
Environmental  
Analysis



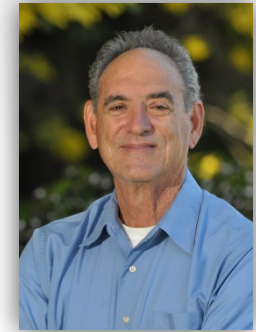
**Doug Eisinger**  
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# Supplemental Material

# Health: Traffic-Related Air Pollution

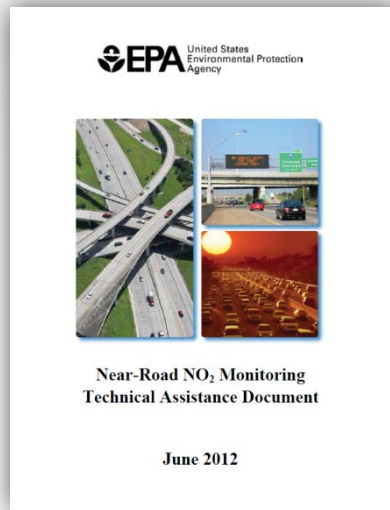
STI helped HEI peer-review its landmark study. HEI found suggestive evidence of a causal relationship between traffic pollutants and:

- Onset of childhood asthma
- Other respiratory problems
- Impaired lung function
- Total mortality
- Cardiovascular mortality
- Cardiovascular morbidity

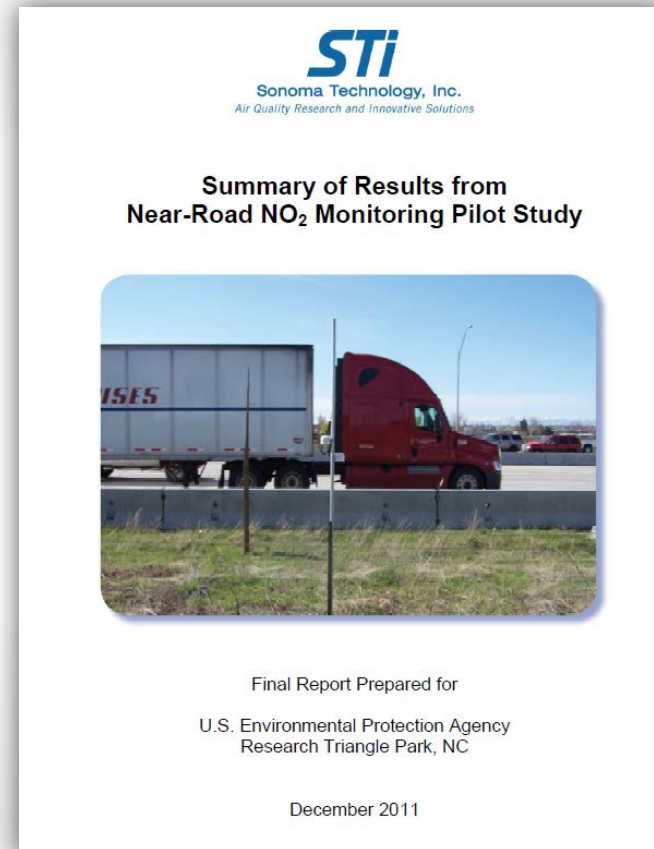


*EJ Insight.* Exposure to traffic-related air pollution exacerbates asthma.

# National Guidance Support for EPA

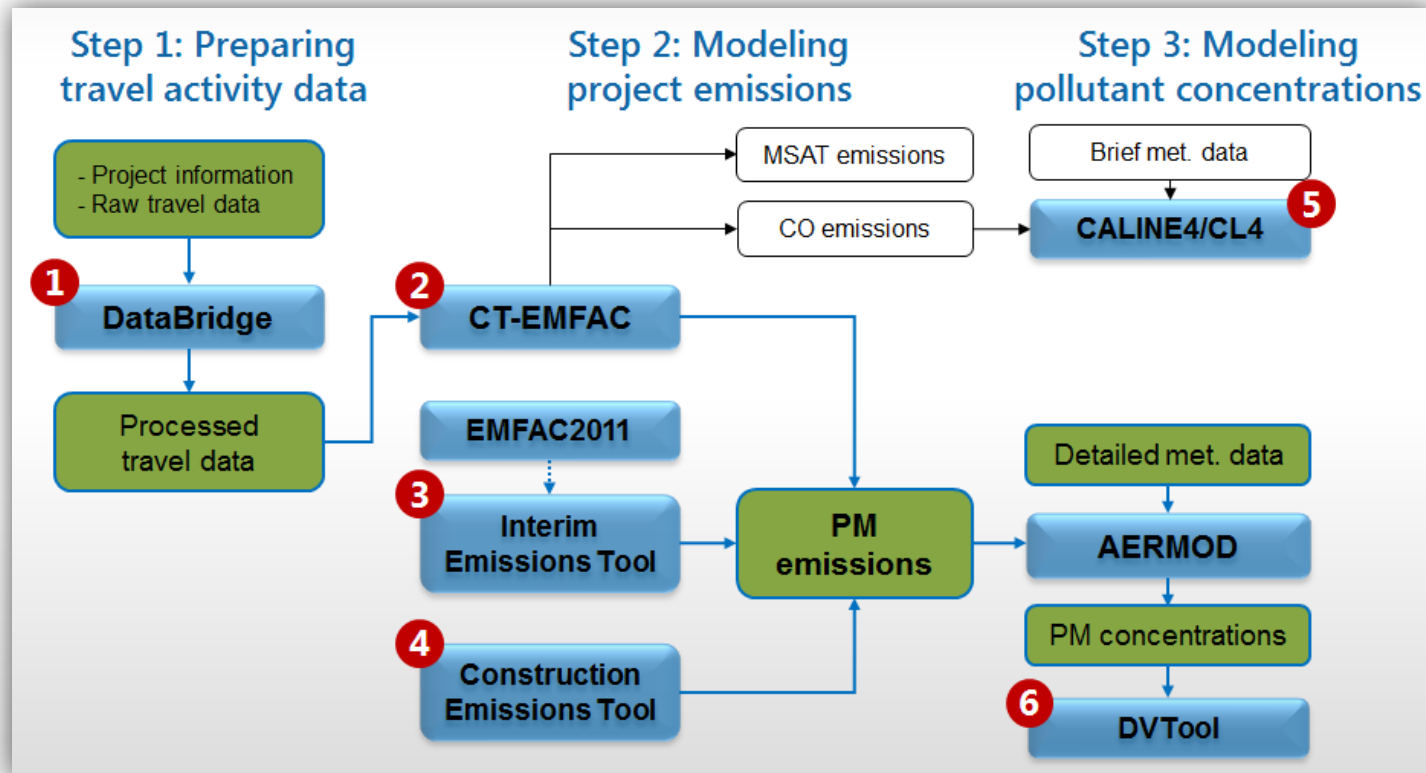


STI completed a five-city pilot study and helped EPA prepare national near-road measurement guidance.



*EJ Insight:* Deploying infrastructure for near-road NO<sub>2</sub> monitoring created an opportunity to measure multi-pollutant impacts.

# Support for Near-Road Analyses: Examples of Tools Developed by STI



*EJ Insight.* Analyses sequentially estimate activity, emissions, and concentrations. Complex modeling can be simplified by linking tools.

# Near-Road Pollution Illustration

STI helped a city and an affordable housing developer resolve differences over potential air pollutant exposure and health risk.

View from freeway toward site; note brick building for reference.



View from street toward site; note same brick building.



Freeway to housing: 150 m

*EJ Insight.* Numerous assumptions are embedded in the analysis chain; these can lead to unrealistic outcomes if not properly quality-checked.