Field Study of $PM_{2.5}$ Emissions From a Road-Widening Project

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Sonoma Technology, Inc.
Air Quality Research and Innovative Solutions

Background (1 of 3)

Project goals

Improve understanding of

- Construction equipment activity and emissions, especially for PM
- Near-road pollutant concentrations resulting from various construction phases
- Opportunities for cost-effective mitigation strategies

Selected construction project

- *Located in a rural part of southern Arizona*
- *Involves widening of State Road 92 from two to five lanes*
- *Spans a 4-mile stretch of SR 92*

Background (2 of 3)

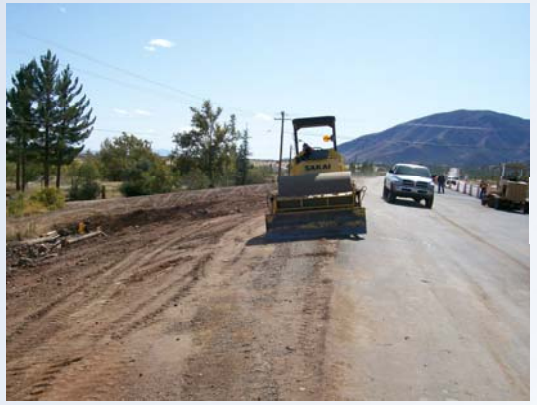
Project overview

- Collect activity data to estimate emissions associated with construction equipment exhaust, fugitive dust, and on-road motor vehicles
- Collect air quality and meteorological data to characterize near-field pollutant concentrations
- Conduct field study from January 2009 to January 2010, the period during which most construction activity occurred

Background (3 of 3)

Project overview

- Emphasis on emissions and air quality impacts by equipment type and phase of construction
  - Land clearing and grubbing
  - Roadway excavation
  - Structural excavation
  - Base and subbase
  - Structural concrete
  - Paving
  - Draining and landscaping



Summary Findings

1. Construction *did* affect PM_{10} concentrations
2. Construction *did not* affect $PM_{2.5}$ concentrations
3. Roadway excavation generated the largest fraction of construction emissions
4. Monitored PM_{10}, $PM_{2.5}$, CO, and NO_2 did not exceed standards (NAAQS)
5. Worst-case measured 24-hr PM_{10} construction impact: 47 $\mu g/m^3$ (might have been worse at unmonitored sites)

Technical Approach (1 of 6)

Activity data collection

GPS units installed on 23 pieces of equipment to track locations, movements, and engine status (off, idle, etc.)

- 5 water trucks
- 3 backhoes
- 3 scrapers
- 3 loaders
- 2 motor graders
- 2 gannon tractors
- 1 compactor
- 1 excavator
- 1 sweeper
- 1 cement truck
- 1 semi-truck

Equipment Photos

Backhoe

Loader

Grader

Gannon Tractor

Roller

Scraper

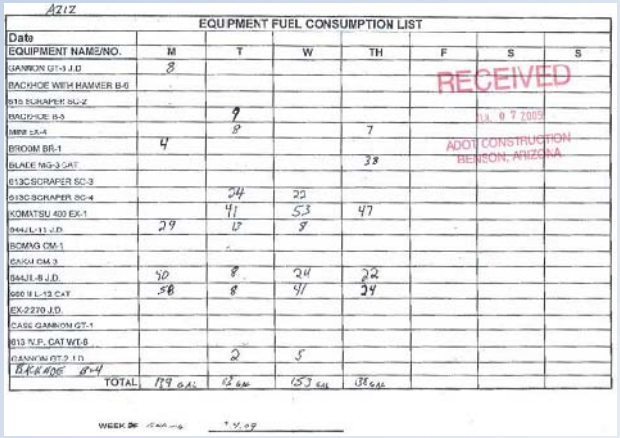
Excavator

Water Truck

Technical Approach (2 of 6)

Activity data collection

- Daily <u>fuel logs</u> provided by construction contractor (fuel consumption by vehicle)
- Daily <u>field diaries</u> provided by ADOT inspectors (summary of work performed, earth moved, equipment used)
- Periodic <u>on-site observations</u> made by STI field technician



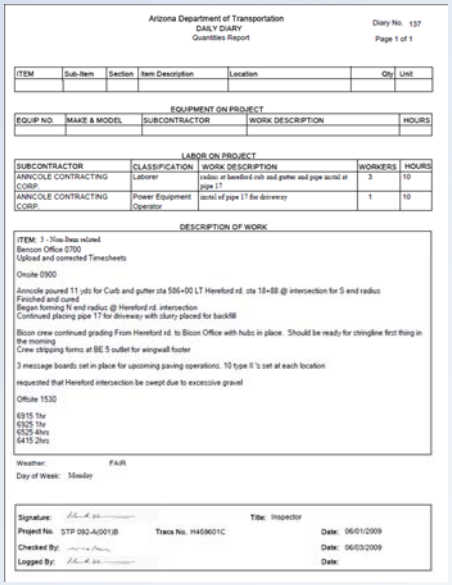
AZIZ

EQUIPMENT FUEL CONSUMPTION LIST

Date	M	T	W	TH	F	S	S
EQUIPMENT NAME/NO.							
CANNON GT-1 J.D	8						
BACKHOE WITH HAMMER B-6							
613 SCRAPER SC-2							
BACKHOE B-5		9					
MINI EX-4		8		7			
BROOM BR-1	4						
BLADE 16G-3 CAT				38			
613C SCRAPER SC-3							
613C SCRAPER SC-4		34	22				
KOMATSU 400 EX-1		41	53	47			
644J/L-11 J.D	29	17	8				
BOMAG CM-1							
CASH CM-3							
644J/L-8 J.D.	30	8	24	22			
966 H L-12 CAT	58	8	41	34			
EX-2270 J.D.							
CASE CANNON GT-1							
613 N.P. CAT WT-8							
CANNON GT-2 J.D.		2	5				
BARRADE B-4							
TOTAL	179 GAL	12 hrs	153 GAL	136 GAL			

RECEIVED
JUL 07 2009
ADOT CONSTRUCTION
BENSON, ARIZONA

WEEK OF



Arizona Department of Transportation
DAILY DIARY
Quantities Report

Diary No. 137
Page 1 of 1

ITEM	Sub-Item	Section	Item Description	Location	Qty	Unit

EQUIPMENT ON PROJECT

EQUIP NO.	MAKE & MODEL	SUBCONTRACTOR	WORK DESCRIPTION	HOURS

LABOR ON PROJECT

SUBCONTRACTOR	CLASSIFICATION	WORK DESCRIPTION	WORKERS	HOURS
ANNCOLE CONTRACTING CORP.	Laborer	radius at beesford curb and gutter and pipe acrtsl at pipe 17	3	10
ANNCOLE CONTRACTING CORP.	Power Equipment Operator	acrtsl of pipe 17 for driveway	1	10

DESCRIPTION OF WORK

ITEM: 3 - Non-Item related
Benson Office 0700
Upload and corrected Timesheets

Onsite 0900

Anncole poured 11 yds for Curb and gutter sta 586+00 LT Hereford rd. sta 18+88 @ intersection for S end radius
Finished and cured
Began forming N end radius @ Hereford rd. intersection
Continued placing pipe 17 for driveway with slurry placed for backfill

Bicon crew continued grading From Hereford rd. to Bicon Office with hubs in place. Should be ready for stringline first thing in the morning
Crew stripping forms at BE 5 outlet for wingwall footer

3 message boards set in place for upcoming paving operations. 10 type II 's set at each location

requested that Hereford intersection be swept due to excessive gravel

Offsite 1530

6915 1hr
6925 1hr
6525 4hrs
6415 2hrs

Weather: FAIR
Day of Week: Monday

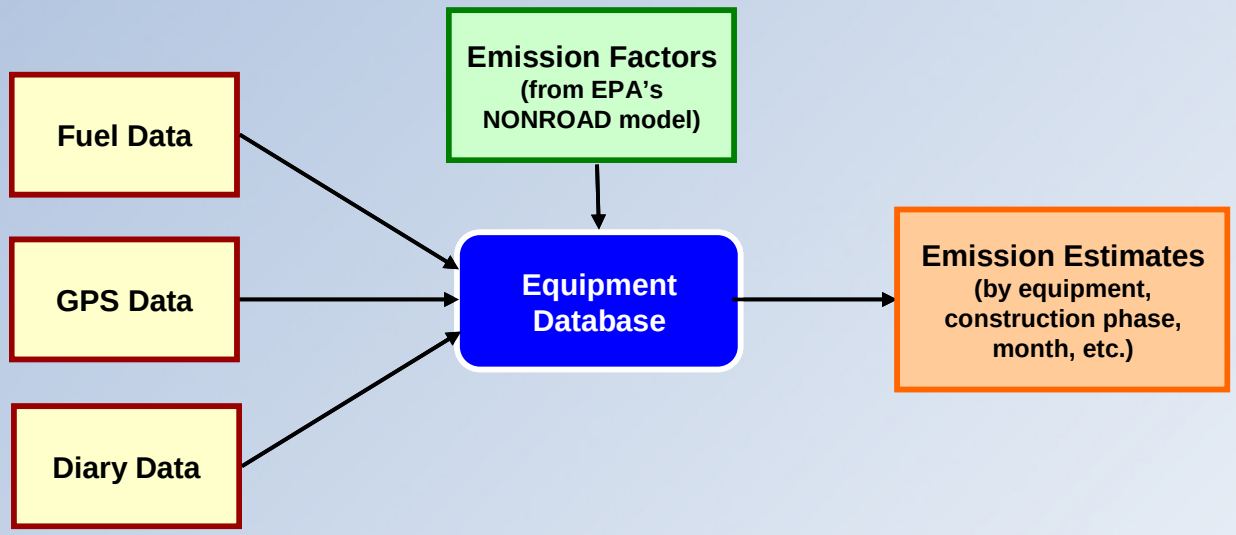
Signature: Title: Inspector
Project No. STP 092-A(001)B Trace No. H459601C Date: 06/01/2009
Checked By: Date: 06/03/2009
Logged By: Date:

Technical Approach (3 of 6)

Activity data collection

- Traffic counts by vehicle type at north and south ends of project

Emissions estimation (fuel-based)

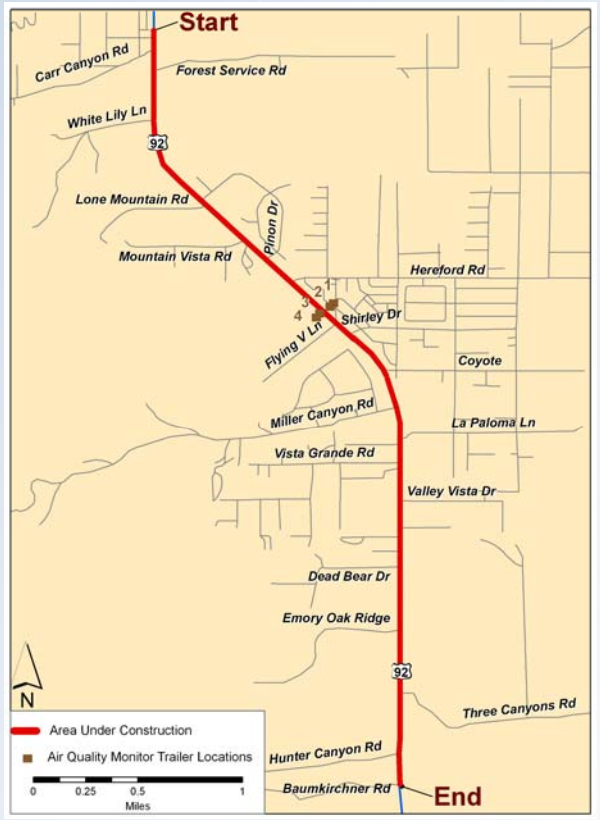


Also estimated emissions from on-road vehicles and fugitive dust based on traffic counts and daily log information

Technical Approach (4 of 6)

Ambient and meteorological data collection

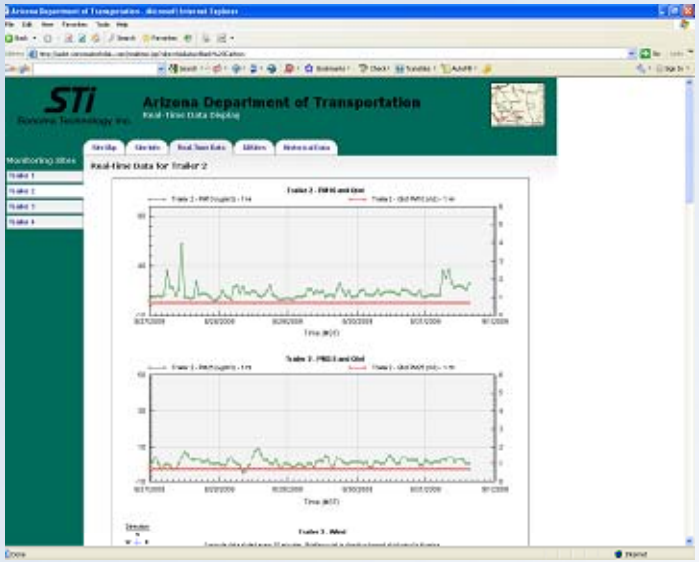
- Four monitoring sites – two on each side of SR 92
- Perpendicular to roadway – two sites 100 feet and two sites 200 feet from road centerline



Technical Approach (5 of 6)

Ambient and meteorological data collection

- Parameters measured
  - $PM_{2.5}$
  - PM_{10}
  - Black carbon
  - NO, NO_2, NO_x
  - CO
  - CO_2
  - Wind speed
  - Wind direction
  - Relative humidity
  - Temperature
  - Solar radiation
- Web-based data retrieval system
- Auto-screening QA procedures



Technical Approach (6 of 6)

Correlation of ambient and activity data

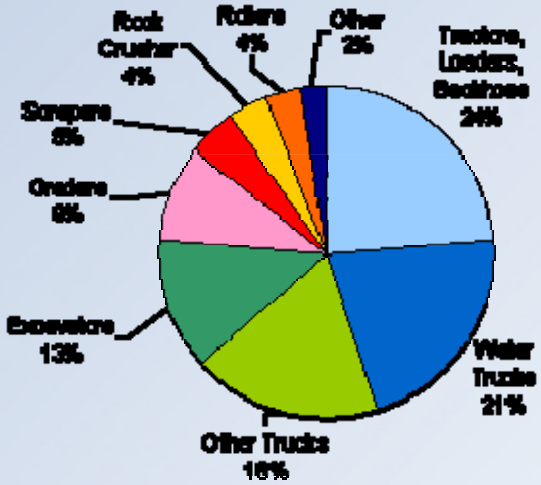
- Activity data summarized by proximity to monitoring sites
- Ambient data analyzed to determine background concentrations and identify episode dates with elevated pollutant concentrations
- Multiple “case study” periods identified and investigated to evaluate impacts from construction activities

Results (1 of 9)

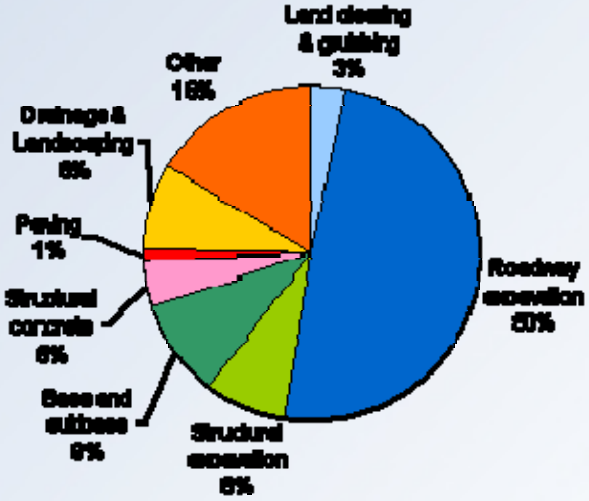
Construction activity summary

- 238 working days in 2009; dust suppression on 192 days (81%)
- Work primarily performed Mon-Thu, 7:00 a.m. to 3:00 p.m.
- 25-30 pieces of equipment on-site
- 76,000 gallons of diesel consumed
- Average day
  - 10 pieces of equipment active
  - 6 hours of operation per vehicle
  - 319 gallons of diesel consumed

Fuel consumption by equipment



Fuel consumption by phase

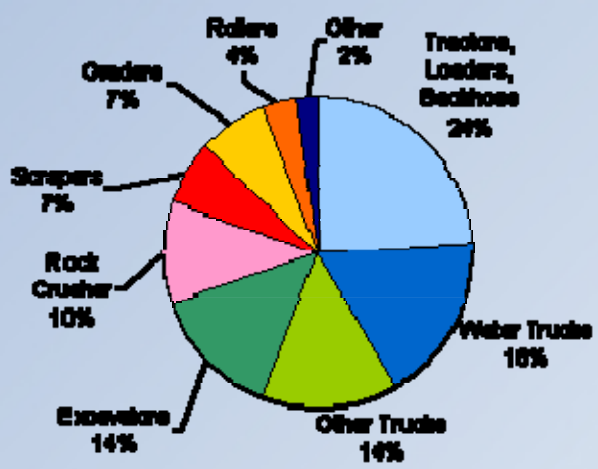


Results (2 of 9)

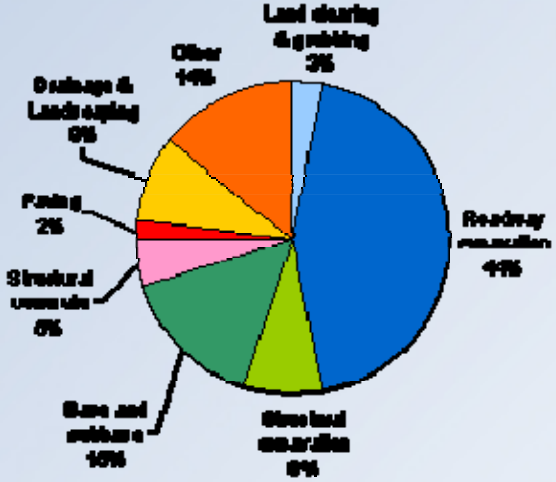
Exhaust emissions summary

- Over half of $PM_{2.5}$ emissions were attributable to tractors/loaders/backhoes and trucks
- Emissions highest during the roadway excavation phase

$PM_{2.5}$ emissions by equipment



$PM_{2.5}$ emissions by phase



Total Emissions

Pollutant	Emissions (kg)
PM_{10}	553
$PM_{2.5}$	537
NO_x	7,102

STI Sonoma Technology, Inc.

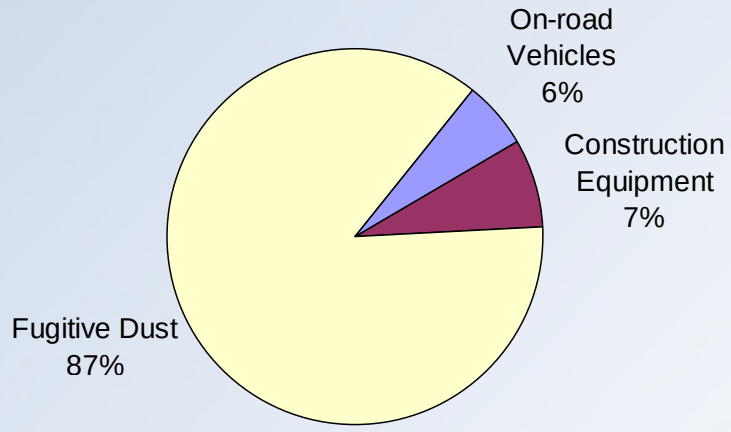
Results (3 of 9)

Fugitive dust emissions summary

- For PM_{10}, construction-related fugitive dust overwhelmed other source categories
- 80% of fugitive dust emissions were associated with the roadway excavation phase
- Emissions estimates for re-entrained road dust did not correlate with real-world air quality data

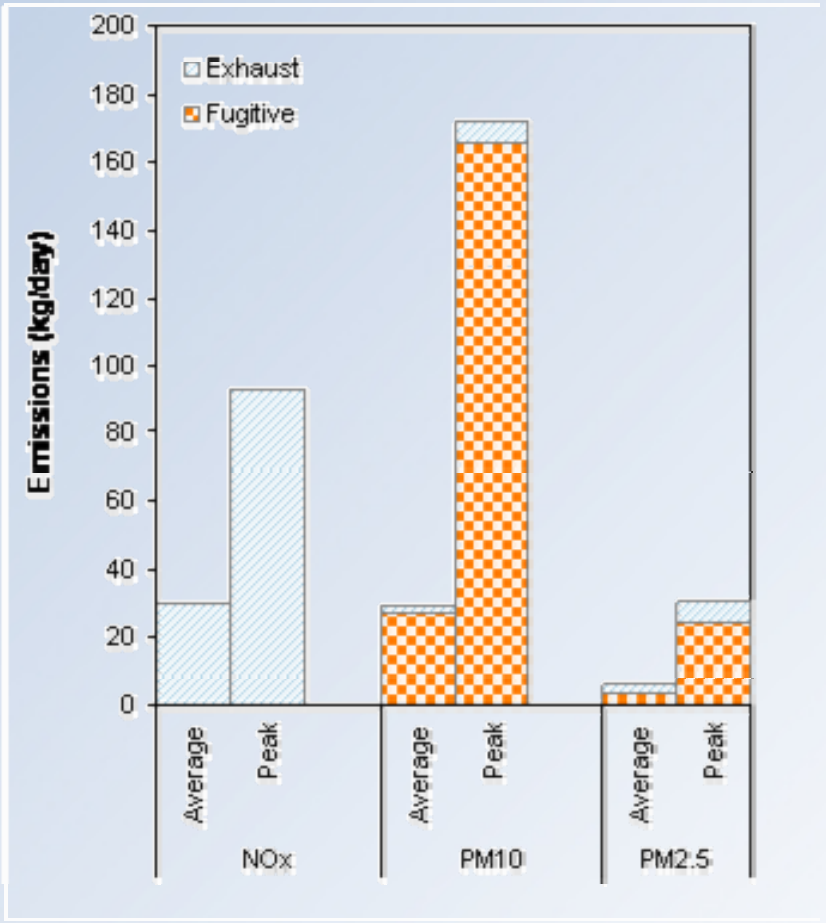
2009 PM_{10} Emissions

7,488 kg (8.3 tons)



Results (4 of 9)

Peak-activity days resulted in substantially higher-than-average daily emissions

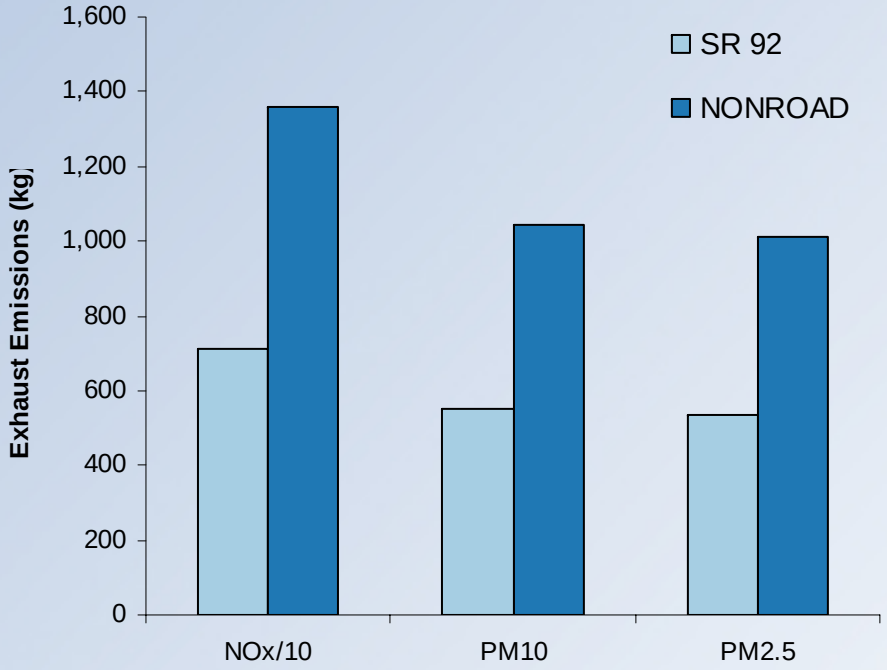


Construction-related daily average and peak (12/9/2009) emissions

Results (5 of 9)

Emissions comparison

- Ran 2009 NONROAD model for SR 92 equipment using default inputs
- In general, equipment usage rates for 2009 at SR 92 were significantly lower than default annual usage rates in NONROAD, resulting in lower emission estimates



Results (6 of 9)

Air quality data

- Summary statistics for 2009
- Case studies to evaluate conditions contributing to construction impacts
  - Rock crusher use (February 2009)
  - Maximum PM_{10} concentrations (April 2009)
  - Mix of days with and without construction activity (May 2009)
  - Detailed examination of one of the May case-study days
  - Period with no construction activity to illustrate background concentrations (November 2009)

Results (7 of 9)

Air quality data

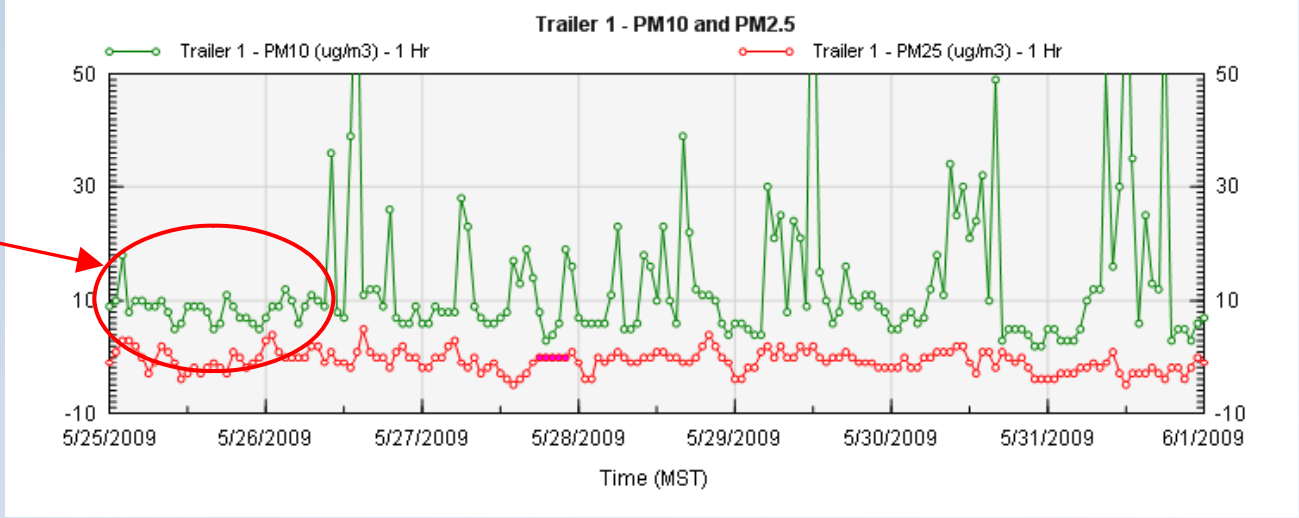
- $PM_{2.5}$ concentrations did not exceed 24-hr or annual NAAQS
- PM_{10} concentrations did not exceed 24-hr NAAQS
- NO_2 concentrations did not exceed the 1-hr NAAQS
- BC concentrations were typically a few tenths of a µg/m³ (1.1 µg/m³ max)

Results (8 of 9)

May 25-31 case study

- Construction resulted in higher 24-hr PM_{10} concentrations (29 µg/m³ max during case study); construction impacts on $PM_{2.5}$ concentrations were far less pronounced
- NO_x-related concentrations increased during daylight hours, but max NO_2 concentrations < 10 ppb

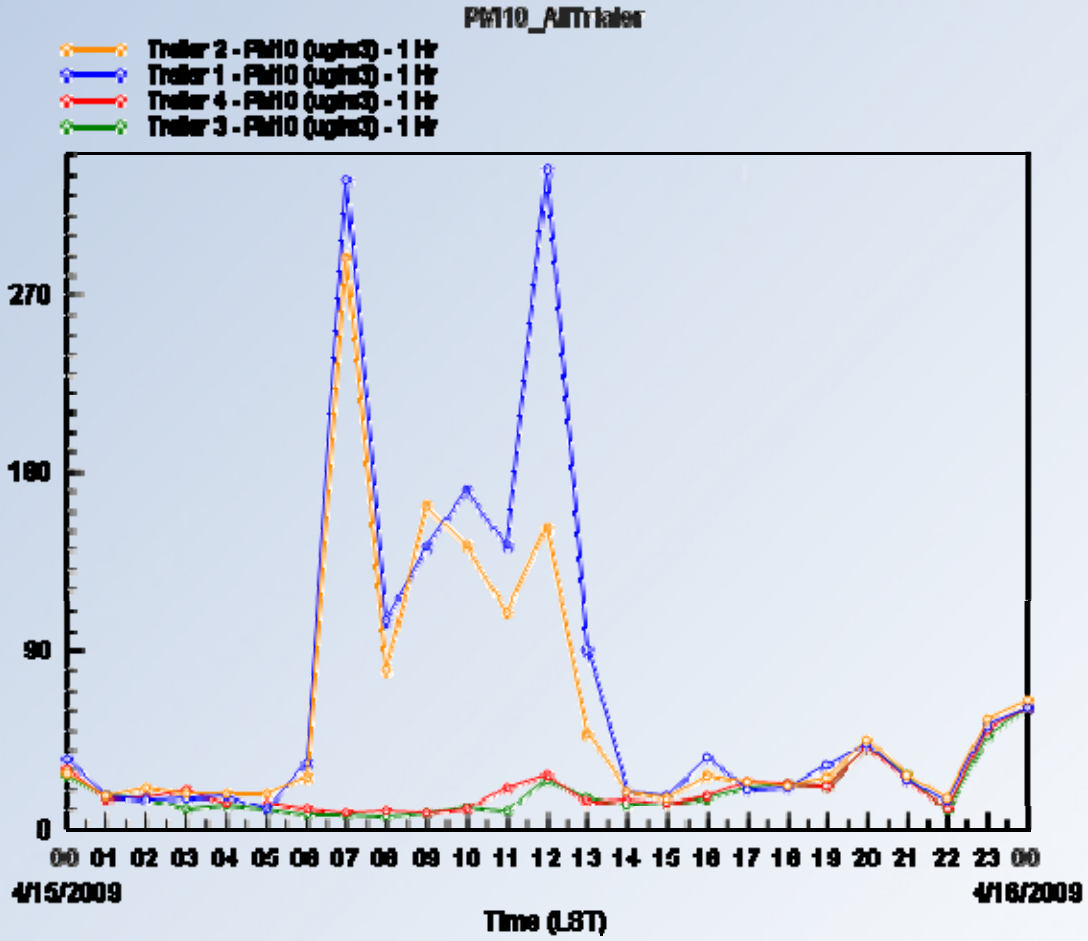
No PM_{10} impacts on Labor Day, when construction was halted (but on-road traffic only 23% lower than an average weekday).



Results (9 of 9)

April 15, 2009, case study

- Highest recorded 24-hr PM_{10} concentration (72 µg/m^3)
- Incremental differences between upwind trailers (3 and 4) and downwind trailers (1 and 2) of 54 to 300 µg/m^3 of PM_{10} (1-hr averages)
- $PM_{2.5}$ concentrations remained relatively consistent with values observed at other times



Key Findings (1 of 2)

- Equipment activity and emissions were highest during roadway excavation
- Water trucks, “other” trucks, and tractors/loaders/backhoes represented ~70% of case study activity, emissions
- Real-world equipment use was lower than the defaults in EPA’s NONROAD model
- Real-world PM_{10} data did not correspond with on-road dust emissions calculations

Key Findings (2 of 2)

- Findings indicate limited potential for $PM_{2.5}$ hot-spot contributions
- PM_{10} hot-spot impacts depend on project characteristics and background PM_{10}
- Further PM_{10} mitigation efforts could focus on fugitive dust controls

Thank you!

Questions?