# The Arizona Construction Emissions Field Study

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Sonoma Technology, Inc.
*Air Quality Research and Innovative Solutions*

## INTRODUCTION

Diesel-powered construction equipment is a significant and relatively unregulated source of air pollution. However, although EPA's NONROAD model is available to generate county-level emission estimates from construction equipment, there are no consistent and widely accepted guidelines for estimating emissions from road construction projects for National Environmental Policy Act (NEPA) analysis and State Implementation Plan (SIP) and conformity development.


To better understand emissions and the resulting air impacts from transportation construction projects, the Arizona Department of Transportation (ADOT) has contracted with Sonoma Technology, Inc. (STI) to conduct a field study to quantitatively assess the air quality impacts from a rural road-widening project on State Road 92 (SR92) in southern Arizona. Emission estimates are being prepared based on construction equipment activity collected using GPS units and fuel consumption logs, while near-field pollutant concentrations are being characterized through the collection of air quality and meteorological data at four monitoring stations near the roadway.

## PHASES OF ROADWAY CONSTRUCTION AND ASSOCIATED EQUIPMENT

| Land Clearing and Grubbing | Roadway Excavation | Structural Excavation | Base and Subbase | Structural Concrete | Paving | Drainage and Landscaping |
|---|---|---|---|---|---|---|
| The removal of trees, vegetation, and other material from the construction area. | Excavating, grading, and disposing of soil and other material for the construction of roadway elements such as through lanes and shoulders. | Excavating, grading, and disposing of soil and other material for the construction of structural elements such as retaining walls. | Construction of the road bed foundation with soil and gravel hauled to the construction site from other locations. | Construction of the structural elements of the project (e.g., retaining walls, curbs, gutters, etc.). | The application of asphalt and/or concrete on a prepared road bed foundation. | Drainage work, erosion control, planting, and irrigation. |
| **Equipment:**<br>• Excavators<br>• Crawler tractors/dozers | **Equipment:**<br>• Excavators<br>• Crawler tractors/dozers<br>• Rubber tire loaders<br>• Graders/scrapers<br>• Rollers<br>• Backhoes | **Equipment:**<br>• Excavators<br>• Tractors/loaders<br>• Rubber tire loaders<br>• Backhoes | **Equipment:**<br>• Graders/scrapers<br>• Crawler tractors/dozers<br>• Rollers | **Equipment:**<br>• Rough terrain forklifts<br>• Generator sets<br>• Tractors/loaders<br>• Backhoes<br>• Air compressors | **Equipment:**<br>• Rollers<br>• Pavers<br>• Paving equipment<br>• Tractors/loaders<br>• Backhoes | **Equipment:**<br>• Generator sets<br>• Pumps<br>• Tractors/loaders<br>• Backhoes |

## DATA COLLECTION AND EMISSIONS ESTIMATION

### Activity Data Collection

The SR92 project began in October 2008 and is expected to last for 18 months. However, heavy equipment usage will primarily occur during calendar year 2009, so data collection efforts for the air quality impacts study are being conducted from *January 2009 to December 2009*.

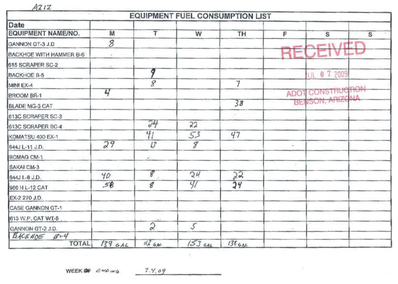
In past studies of construction equipment emissions, various approaches have been used to collect the data needed to estimate emissions, including surveys, time-lapse photography, and on-board monitoring equipment. Since it is unlikely that any one method will provide all the needed information, this field study utilizes a *combination of data collection methods:*

#### GPS Units

STI instrumented 23 pieces of equipment with GPS units that track equipment locations, movements, and engine status (off, idle, etc.). These 23 vehicles represent virtually all of the equipment dedicated to the project and include:

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

**A GPS unit mounted in the cab of a John Deere 615C Scraper owned by Bison Construction Co.**




**Weekly fuel log from the SR92 project (shows daily fuel consumption by vehicle).**

#### Fuel Logs

Construction equipment at the SR92 project is refueled at the end of each workday and records of daily fuel consumption are provided to STI by the construction contractor.

#### Field Inspector Diaries

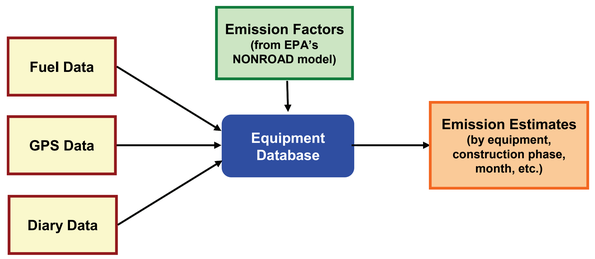
ADOT inspectors maintain daily diaries that document the work performed each day and an estimate of equipment hours; this information is provided to STI weekly.

#### On-Site Observations

An STI field technician makes regular visits to the job site to take pictures and document progress.

### Emissions Estimation

Emission estimates for construction equipment will be based on fuel consumption data; activity data from GPS units and field diaries will be used to identify the location and timing of equipment activities.

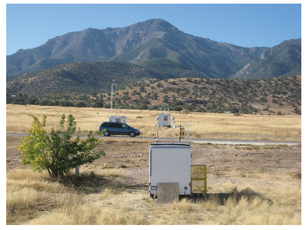


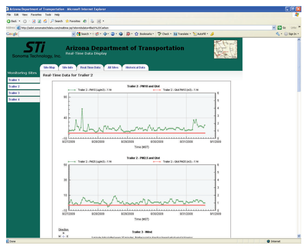

**Note:** Emissions from on-road motor vehicles will also be estimated (based on traffic count data collected by ADOT and emission factors from EPA's MOBILE6 model).

### Ambient Data Collection

STI is collecting ambient air quality and meteorological data at four monitoring sites (two on each side of SR92). The sites are set up perpendicular to SR92 with two sites situated about 100 feet from the road centerline and the remaining two sites situated about 200 feet from the road centerline. This arrangement allows for both upwind and downwind monitoring under all wind conditions, except during periods when the wind is parallel to the roadway. Parameters measured include:

- $PM_{2.5}$
- $PM_{10}$
- Black carbon
- NO, $NO_2$, $NO_x$
- CO
- $CO_2$
- Wind speed
- Wind direction
- Relative humidity
- Temperature
- Solar radiation



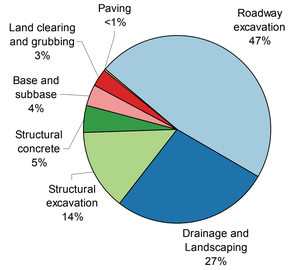



**Images: Photo of monitoring trailers alongside SR92 in southern Arizona (top) and screenshot of monitoring data displayed on a password-protected project web page (bottom).**

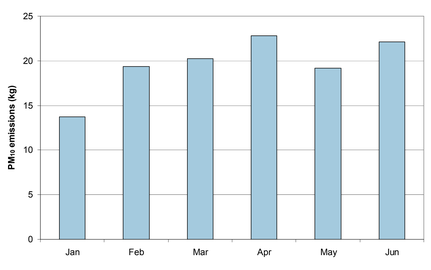
## PRELIMINARY RESULTS

Though data collection is ongoing through December 2009, preliminary estimates of emissions from construction equipment have been prepared using data collected from January to June 2009. (Because all phases of construction are being completed on the east side of the roadway before work on the west side begins, all phases of construction are represented in this data set.)

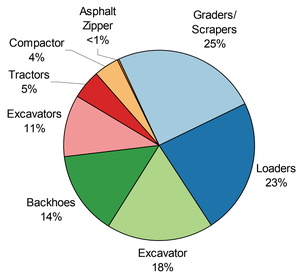
Over the first six months of the project, we estimate that construction equipment at the SR92 project emitted 118 tons of $PM_{10}$, 114 tons of $PM_{2.5}$, and 1,551 tons of $NO_x$ (note: these estimates represent exhaust emissions only; fugitive dust emissions are not included). Almost half the $PM_{10}$ emissions are associated with the roadway excavation phase of construction. However, because the phases of construction overlap in time, monthly emissions are fairly constant over the first half of the project.




**$PM_{10}$ emissions by phase of construction.**




**$PM_{10}$ emissions by month.**




**$PM_{10}$ emissions by equipment type.**

### Ongoing Work

Preliminary results indicate that the data collection methods used are providing a robust data set for evaluating emissions associated with a road construction project. Next steps include:

- Continuing data collection
- Estimating emissions for on-road motor vehicles and water trucks
- Estimating PM emissions from fugitive dust
- Comparing emission estimates with ambient monitoring data
- Assessing emissions by construction phase to help identify useful mitigation strategies

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