Assessing the Impact of Transportation Facilities on Ambient Air Toxics

Chad Bailey
EPA OTAQ
NTAQS
Overview

• Measurements of air toxics near transportation facilities
• Modeling tools
• Considerations in model application
Measurements near Roadways
RIOPA – Elizabeth, NJ

- Study of ~100 homes
- Monitoring for a large suite of pollutants
  - Inside each home
  - Outside each home
  - On one resident’s shoulder
- EPA (OTAQ) funded geographic analysis of the study data
Criteria and Hazardous Air Pollutant Trends – RIOPA
(EPA Final Report – Elizabeth, NJ Results)

• Concentrations outside homes were related to the distance from major roads
• Results also found for
  – Interstates, gas stations, truck loading zones
  – PM$_{2.5}$, elemental carbon ("soot"), organic carbon
EPA Near-Roadway Field Study

- EPA ORD field study near I-440 near Raleigh, NC
- Study designed to capture the variability of air pollution and meteorology in space and time
- Extensive monitoring of traffic, air quality, and meteorology
Pictures of the Field Site

Monitoring trailer with tower

JET-REMPI Continuous Air Toxics Monitor

NO-NO$_2$ Monitor

Particulate matter monitors
Near Road AQ
Short term variability

Traffic Volume

CO

BC

Wind Direction
Near Road AQ: Pollutant Mixtures

• Numerous directly-emitted pollutants follow similar trends over time
Vegetation and Barrier Effects

- Mobile monitoring van drove along roads adjoining freeway
  - Open area with no barrier
  - Transect road behind noise barrier
  - Residential area with mature vegetation behind noise barrier

20 nm particle concentrations
Measurements near Freight Facilities
J.R. Davis Rail Yard (UP)

- Upwind and downwind monitoring by DRI for Placer County, CA
  - $\text{PM}_{2.5}$
  - Black carbon
  - Elemental and organic carbon
  - NO, NOx
Roseville Rail Yard Cross-Yard Gradient (DRI)

7-hour (22:05) average BC Concentrations

1.5-1.7 μg/m³

7-hour (22:05) average NO Concentrations

7-hour (22:05) average PM2.5 Concentrations

~7-13 μg/m³

7-hour (22:05) average NOx Concentrations
Rail Yard Influence at East St. Louis Site

(Method of nonparametric wind trajectory regression: color is BC concentration at receptor after wind has passed over location)

Thanks to Ron Henry, USC and Gary Norris, EPA/ORD
Modeling Tools
Project Features

- **Geometric**
  - Layout of Facility
  - Location of signals
  - Approach angles

- **Operational**
  - Traffic volumes
  - Traffic speeds
  - Congestion (LOS)
  - Fleet properties

- **Source-Receptor Distances**
  - Next slide…
How Many People Live Nearby?

Cumulative Population Fraction within X Meters of "Major Roads"
"Major Road" Definitions Shown in Legend

American Housing Survey results pertain to housing units, not population.
Emissions

• Exhaust/Evaporative/Tire & Brake Wear
  – MOBILE6.2: emission factor model (g/mi)
  – HC, CO, NOx, toxics, PM10, PM2.5, EC/OC
  – Requires local information on fleet composition (MPO or on-site collection), fuel properties, I&M, road types, average speeds
  – Can be run for individual road links or for entire modeling domain
  – **NOTE:** PM emission factors not sensitive to speed

• Road dust
  – AP-42, Chapter 13 or alternate local methods
Emissions

• Extended Idling
  – EPA Guidance on Extended Idle Emissions
    • http://www.epa.gov/smartway/swresources.htm#idling

• Nonroad Engines
  – NONROAD Model and Documentation
    • Exhaust Emission Factors for Nonroad Engine Modeling -- Spark-Ignition, NR-010d (EPA420-P-04-010, April 2004)

• Locomotives
  – Emission Factors for Locomotives (EPA420-F-97-051)
Air Quality Modeling

- **Roadway Projects**
  - CALINE3/4
    - Roadways, no intersections
  - CAL3QHCR
    - Accepts 1 year met data
    - Intersections, includes queuing model based on 1985 HCM

- **Non-roadway Projects**
  - AERMOD
    - Flexible source layouts, including parking lots, freight terminals, bus garages, rail lines, toll booths, and point sources
    - Over long term, EPA hopes to add a line source algorithm to account for traffic-induced turbulence
Case Study: Diesel PM

- Intersection of I-40 & Watt Rd., Knoxville, TN
  - Major freight route between Knoxville and Nashville
  - Three truck stops with ~700 overnight parking spots
  - Site of long-term air quality and exposure study by ORNL and U-TN Knoxville

Onsite Data

- U TN-Knoxville collected on-site data for 8 consecutive months, Dec 2003 – Aug 2004
- AQ variables
  - PM2.5
  - NO2/NO
  - CO
  - EC/OC
- Meteorology
  - Wind by 10 m tower
Emissions Preparation

• I-40/Watt Road, Knoxville, TN
  – Volume sources located at major parking zones
  – Data on idling within truck stops by day of week and hour
  – Emissions data for long-term idling, accounting for temperature
Period Average PM2.5 Contours

Best Model Run with Background Excluded

Hartley et al. (2006)
Things to Think About…

• Other models more specific to complex site geometries have been used by researchers and air quality professionals, undergoing further development.

• Model performance is a function of the model, its inputs, and which inputs you measure on a time scale parallel to your comparison data set (vs. default).
Conclusions
Conclusion

• Air quality and exposure studies show that near (and on) roads and other transportation facilities, air concentrations of toxics and other pollutants are elevated above background

• Models can inform decision makers on air quality impacts and associated risks of different transportation options