Exploring Near-Road Data with the Near-Road Dashboard

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Outline

• Near-Road (NR) Network
• NR Dashboard
  – Overview
  – Tabs
• Network-Wide Tabs
  – Pollutant Summary, Increment Calculator, Network Completeness, etc.
• Site-Specific Tabs
  – Site and Method Summary, Pollution Roses, etc.
Near-Road Network

• Higher population living near major roadways and an increase in vehicle miles traveled lead to an increased potential for human exposure to air pollution and subsequent negative health outcomes

• U.S. Environmental Protection Agency (EPA) mandated the Near-Road Network as part of the 2010 review of the National Ambient Air Quality Standard (NAAQS) for NO$_2$

• NR stations were placed to capture the elevated ambient air pollution concentrations expected to be observed from on-road mobile sources

• Designed to represent the most intense exposure in a near-road environment
Near-Road Network

• Site locations are chosen based on several factors that influence pollution exposure (e.g., meteorology, traffic volume)

• 84 active, inactive, or planned NR stations
  – Across 56 core based statistical areas (CBSAs) and 35 states and territories

• NR stations required to measure NO₂ and CO.* Many measure PM₂.₅, NOₓ, NO, volatile organic compounds (VOCs), meteorology, and more

• **Data visualization is key**

  *required in every CBSA with a population of at least 1 million

“Street View,” Google Maps (http://www.googlemaps.com), 2022
Near-Road Dashboard; Overview

• Coded in an R environment; displayed using the Shiny package
• Back-end code compiles all NR data via Air Quality System (AQS) API (2016–present)
• Most recent two years updated weekly; data before that updated every quarter
• Designed to summarize large amounts of information in a quick and concise way
• Features visualizations of particular interest to the NR Network (e.g., increment calculator)
• Users can see a full characterization of a specific NR station
Near-Road Dashboard; Overview

Other features include an associated ReadMe document, tab categorization, and interactive tables:

- Downloadable table
- Sortable columns
- Searchable table
- Navigability within table
Near-Road Dashboard; Tabs

- Network level assessments
  - Network-wide quality indicators
  - Intra-site comparison
- Specific site-level assessments
  - Site-specific quality indicators and analysis tools
  - Site selection necessary for tabs to populate with data (except CBSA)
  - Site metadata, including instrumentation
Network-Wide Tabs; Near-Road Network

- Interactive map
- Shows all active and inactive sites
- Sites designated as “NO₂-only” and “Multiple Pollutants”
- Selection on map interacts with the site-specific tabs
  - Selected site metadata table appears on every site-specific tab
- Metadata table below map
Network-Wide Tabs; Pollutant Summary

- Customizable graphical display of NO₂, CO, and PM₂.₅ annual and sub-annual data
- Selectable year, sample duration, and site(s)
- Turn on/off outliers and NAAQS threshold
- Arrange by concentration or alphabetical order of state
- Sample duration methodology dropdown
- Metadata table below figure
Network-Wide Tabs; Pollutant Summary

No annual completeness requirements for display.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Sample Durations</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₂</td>
<td>1 hour, daily 1 hour max, annual mean of 1 hour</td>
</tr>
<tr>
<td>CO</td>
<td>1 hour, 8-hour average, second highest mean of 8-hour average, second highest mean of 1 hour</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>1 hour, 24-hour, annual mean of 24 hour</td>
</tr>
</tbody>
</table>
Network-Wide Tabs; Increment Calculator

• Customizable graphical display of NO₂, CO, and PM₂.₅ annual and sub-annual increments
• Selectable year, increment duration, and site(s)
• Increment calculation method
• Sorting options
• Matching/non-matching methods
• Increment completeness and duration methodology dropdown
• Metadata table below figure
Network-Wide Tabs; Trends

• Annual trends for NR monitoring pollutants
• Boxplot (top): distribution of slopes across the NR network over the past 5 years
  - Left end: 10th percentile slope
  - Right end: 90th percentile slope
  - Color coded: f-test values of individual trends statistically significant at the 95% confidence level at more than 50% of available trends
• Line plot (bottom): annual percent change in concentration
Network-Wide Tabs; Trends

Range (10th, median, and 90th percentile) of 5 year slope trends at Near Road sites

- UV Carbon PM2.5 at 370 nm; 1 HOUR: 1 Sites
- PM2.5 - Local Conditions; 24 HOUR: 20 Sites
- PM2.5 - Local Conditions; 24-HR BLK AVG: 51 Sites
- PM2.5 - Local Conditions; 1 HOUR: 53 Sites
- Oxides of nitrogen (NOx); 1 HOUR: 68 Sites
- Nitrogen dioxide (NO2); 1 HOUR: 77 Sites
- Nitric oxide (NO); 1 HOUR: 68 Sites
- Carbon monoxide; 8-HR RUN AVG END HOUR: 68 Sites
- Carbon monoxide; 1 HOUR: 66 Sites
- Black carbon PM2.5 STP; 1 HOUR: 16 Sites
- Black Carbon PM2.5 at 880 nm; 1 HOUR: 17 Sites

Mostly Insignificant Trends
Network-Wide Tabs; Network Completeness

• Percent annual completeness of pollutant parameters by site and year
• Only sites with the selected parameter(s) will display
• Rank-ordered based on annual completeness of the selected parameter(s)
  - Rank order is recalculated after a parameter has been added/taken away
• Selectable figure; click, drag, and select to highlight sites to see metadata displayed in a table below
Select a complete year

2017

Select parameter(s)

- Nitrogen dioxide (NO₂)
- Carbon monoxide (CO)
- PM2.5 - Local Conditions

Drag and double-click to display details below plot. Double-click to reset.

### Network Completeness: 2017

![Network Completeness Graph]

- **MGO goal of >75%**
- **Site Code 371190045**

<table>
<thead>
<tr>
<th>Site Rank</th>
<th>Site Code</th>
<th>Year</th>
<th>Parameter</th>
<th>POC</th>
<th>Method</th>
<th>Duration</th>
<th>% Annual Complete (Parameter)</th>
<th>% Annual Complete (Site)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>371190045</td>
<td>2017</td>
<td>Carbon monoxide (CO)</td>
<td>1</td>
<td>INSTRUMENTAL - Gas Filter Correlation Thermo Electron 48i-TLE</td>
<td>1 HOUR</td>
<td>100.00</td>
<td>95.80</td>
</tr>
<tr>
<td>29</td>
<td>371190045</td>
<td>2017</td>
<td>Nitrogen dioxide (NO₂)</td>
<td>1</td>
<td>Teledyne-API Model 200EUP or T200UP - Photolytic-Chemiluminescence</td>
<td>1 HOUR</td>
<td>90.68</td>
<td>95.80</td>
</tr>
<tr>
<td>29</td>
<td>371190045</td>
<td>2017</td>
<td>PM2.5 - Local Conditions</td>
<td>1</td>
<td>R &amp; P Model 2025 PM-2.5 Sequential Air Sampler w/VSCG - Gravimetric</td>
<td>24 HOUR</td>
<td>96.72</td>
<td>95.80</td>
</tr>
</tbody>
</table>
Site-Specific Tabs; CBSA

- Combines elements of the Pollutant Summary and Increment Calculator tabs
- Selectable year, pollutant, and EPA region
- CBSA and selected site metadata tables
- Standalone map of NR, paired ambient sites, and CBSA boundaries
- Pollutant summary data grouped by CBSA and color-coded by EPA region
- Increment metadata table
Site-Specific Tabs; CBSA

Near Road and Paired Ambient Sites
### Site-Specific Tabs; CBSA

<table>
<thead>
<tr>
<th>CBSA</th>
<th># of NR sites</th>
<th>EPA region</th>
<th>State(s)</th>
<th># of NR sites measuring NO2</th>
<th># of NR sites measuring 1-hour PM2.5</th>
<th># of NR sites measuring 24-hour PM2.5</th>
<th># of NR sites measuring CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rochester, NY</td>
<td>1</td>
<td>2 (NJ, NY, PR)</td>
<td>New York</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Site-Specific Tabs; Site and Method Summary

- Annually selectable set of quality indicators per parameter
- Monitor-specific information (e.g., POC, sample duration, units)
- Color-coded table based on group:
  - Required/optional gases: gas-phase measurements
  - Required/optional PM: particle-phase measurements
  - Required/optional meteorology: meteorological measurements
  - Additional supporting: optional measurements
  - Other meteorology: optional meteorological measurements
### Selected Site:

<table>
<thead>
<tr>
<th>AQS Site Code</th>
<th>Site Name</th>
<th>PQAO</th>
<th>City</th>
<th>State</th>
<th>CBSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>480291069</td>
<td>San Antonio</td>
<td>Texas Commission On Environmental Quality</td>
<td>San Antonio</td>
<td>Texas</td>
<td>San Antonio-New Braunfels, TX</td>
</tr>
</tbody>
</table>

#### Select a Year

- 2016

#### Select Group(s)

- Required Gasses, Required PM, Other

---

**Site: 480291069**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter Code</th>
<th>Code</th>
<th>POC</th>
<th>Method Code</th>
<th>Method Code</th>
<th>Method</th>
<th>Method Type</th>
<th>Units</th>
<th>Count</th>
<th>Count &gt; MDL</th>
<th>Avg. MDL</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide</td>
<td>42101</td>
<td>1</td>
<td>093</td>
<td>INSTRUMENTAL - GAS FILTER CORRELATION CO Analyzer</td>
<td></td>
<td>FRM</td>
<td></td>
<td>Parts per million</td>
<td>230</td>
<td>22</td>
<td>0.5</td>
<td>Required Gasses</td>
</tr>
<tr>
<td>Nitrogen dioxide (NO2)</td>
<td>42602</td>
<td>1</td>
<td>099</td>
<td>INSTRUMENTAL - GAS PHASE CHEMILUMINESCENCE</td>
<td></td>
<td>FRM</td>
<td></td>
<td>Parts per billion</td>
<td>7964</td>
<td>4886</td>
<td>2.7</td>
<td>Required Gasses</td>
</tr>
<tr>
<td>Nitric oxide (NO)</td>
<td>42601</td>
<td>1</td>
<td>099</td>
<td>INSTRUMENTAL - GAS PHASE CHEMILUMINESCENCE</td>
<td></td>
<td>FRM</td>
<td></td>
<td>Parts per billion</td>
<td>8066</td>
<td>2755</td>
<td>5</td>
<td>Required Gasses</td>
</tr>
<tr>
<td>Oxides of nitrogen (NOx)</td>
<td>42603</td>
<td>1</td>
<td>099</td>
<td>INSTRUMENTAL - GAS PHASE CHEMILUMINESCENCE</td>
<td></td>
<td>FRM</td>
<td></td>
<td>Parts per billion</td>
<td>8008</td>
<td>4273</td>
<td>5</td>
<td>Required Gasses</td>
</tr>
<tr>
<td>PM2.5 - Local Conditions</td>
<td>88101</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Required PM</td>
</tr>
<tr>
<td>Wind Direction - Resultant</td>
<td>61104</td>
<td>1</td>
<td>020</td>
<td>INSTRUMENTAL - VECTOR SUMMATION</td>
<td></td>
<td>Degrees Compass</td>
<td></td>
<td></td>
<td>8447</td>
<td>8434</td>
<td>0.1</td>
<td>Meteorology</td>
</tr>
<tr>
<td>Wind Speed - Resultant</td>
<td>61103</td>
<td>1</td>
<td>020</td>
<td>INSTRUMENTAL - VECTOR SUMMATION</td>
<td></td>
<td>Knots</td>
<td></td>
<td></td>
<td>8447</td>
<td>8438</td>
<td>0.1</td>
<td>Meteorology</td>
</tr>
<tr>
<td>Outdoor Temperature</td>
<td>62101</td>
<td>1</td>
<td>040</td>
<td>INSTRUMENTAL - ELECTRONIC OR MACHINE AVG.</td>
<td></td>
<td>Degrees Fahrenheit</td>
<td></td>
<td></td>
<td>8760</td>
<td>8786</td>
<td>-60</td>
<td>Other Meteorology</td>
</tr>
<tr>
<td>Wind Speed - Scalar</td>
<td>61101</td>
<td>1</td>
<td>050</td>
<td>INSTRUMENTAL - ELECTRONIC OR MACHINE AVG.</td>
<td></td>
<td>Knots</td>
<td></td>
<td></td>
<td>8447</td>
<td>8406</td>
<td>0.6</td>
<td>Other Meteorology</td>
</tr>
</tbody>
</table>

Showing 1 to 9 of 9 entries
Site-Specific Tabs; Summary Statistics

• Similar layout to Site and Method Summary tab
• Provides summary values (i.e., minimum, mean, median, maximum) for each parameter
• Additional indicators: count of valid reported samples, count of samples above the method detection limit (MDL), and percentage of samples above the MDL
Site-Specific Tabs; Time Series Investigation

• Compare two parameters, one hourly and the other hourly or daily, in a time series graph (top), pollution rose (middle), and scatter plot (bottom)

• A standalone map below the scatter plot displays the urban scale NR site

• Interactive time series graph, pollution rose, and scatter plot
  - User can zoom in to a pollutant spike, and the pollution rose and scatter plot will update accordingly

• Pollution rose will only display if there is wind speed/direction at the NR site
Site-Specific Tabs; Time Series Investigation

Select an hourly parameter
Nitric oxide (NO)

Select a second parameter
- Show 1-Hr Parameters
- Show 24-Hr Parameters
- None

Nitrogen dioxide (NO2)

Drag across plot area and double-click to zoom. Double-click again to reset.
Site-Specific Tabs; Time Series Investigation
Site-Specific Tabs; Time Series Investigation

Nitrogen dioxide (NO₂) in ppb vs. Nitric oxide (NO) in ppb

Toggle Reference Lines:
- One-to-one line may be outside plot limits.
- One-to-one
- Linear Regression
Site-Specific Tabs; Time Series Investigation
Site-Specific Tabs; Pollution Rose

- Pollution roses for NO$_2$ and PM$_{2.5}$
- A standalone map below the scatter plot displays the urban scale NR site
- Selectable year and season:
  - Spring: March, April, and May
  - Summer: June, July, and August
  - Fall: September, October, and November
  - Winter: December, January, February
Near-Road Dashboard Summary

The Near-Road Dashboard:
• Compiles a large quantity of data from all Near-Road sites
• Displays data through various forms of visualization
• Allows for site-to-site comparison
• Is highly interactive and easily accessible
Sonoma Technology

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From EPA: Tim Hanley, and Nealson Watkins; Legacy Team: Mike McCarthy
Questions?

Explore the Near Road Dashboard live at the Sonoma Technology booth!

Also check out the suite of dashboards available:

- PAMS Dashboard
- NCore Dashboard
- FRM-FEM Comparability Dashboard
- Ozone, CO, NO, NO$_2$, NO$_y$, SO$_2$, and FRM Dashboards

Presenter contact: cscarborough@sonomatech.com