Gateway Cities Air Quality Action Plan
Technical Webinar
Air Quality Modeling

Presented by: Edward Carr – ICF International

September 25, 2012
Presentation Outline

• Introduction
• Review of Modeling Approach
• Model to Monitor Comparison
• Emission
• Air Quality
• Next Steps
Presentation Outline

• Introduction
  • Review of Modeling Approach
  • Model to Monitor Comparison
  • Emission
  • Air Quality
• Next Steps
AQAP Participation Framework

Sept – Dec 2012
- Air Quality Analysis
- Health Risk Assessment
- New Measures
- Review Draft Findings & Recommendations

- I-710 Project Team
  - GCCCOG Board
  - Transportation Committee
  - Environmental Committee
  - AQAP Roundtables
  - AQAP Technical Working Groups
  - October 24th
  - October 10th New Measure Workshop
  - Nov 7th

Air Quality Webinar Sept 25th; Health Risk Assessment Webinar Nov 6th
Presentation Outline

• Introduction

• Review of Modeling Approach
  • Model to Monitor Comparison
  • Emissions

• Air Quality Findings

• Next Steps
Overview of the Air Quality Modeling Process

Modeling Protocol

- Emission Inventory Development

- Air Quality Modeling and Evaluation

- Health Risk Assessment

- Additional Measures
Gateway City Study Area

Legend
- Yellow: SCAQMD Area Source Emissions
- Red: Gateway Cities Boundary
- Blue: 5-km Buffer Distance From Gateway Cities Boundary

56 km x 56 km

Rail line, on-road at link level

Watercraft and airports at property boundaries
Scenarios Modeled

- 2009 and 2035 (2008-2010 meteorology)
  - On-road emissions - link and travel analysis zone from SCAG-based TDM
  - Use of EMFAC2011 (incorporates: CARB truck drayage rule + bus and truck regulation, Ports “Clean Truck” Program)
  - Other categories from South Coast AQMD 2030 Emission Inventory
2035 Scenario

• On-road Mobile Emissions
  – I-710 zero emission tailpipe truck freight corridor
  – Add lanes to I-5 between Orange County Line and I-605;
  – SR 47 Improvement Project;
  – Widen Anaheim Street from 4 to 6 lanes;
  – Sepulveda Blvd widen from 2 to 4 lanes;
  – Washington Blvd +1 lane each direction through Commerce
  – Enhanced Goods Movement by Rail;
  – Advanced Traffic Management Information System;
  – Traffic Signal Coordination on Key Arterials
2035 Scenario (continued)

- Other Modifications to AQMD emission inventory since initial development in Dec 2006 includes:
  - OGV’s – diesel aux engine at berth reg, low sulfur regs and IMO Emission Control Area
  - Trains – Statewide Rail yard MOU’s, EPA locomotive engine standards
  - 2012 CA Advanced Clean Cars program
Changes in Modeling Protocol

- **Protocol Changes**
  - Increased met field resolution to 1x1 km
  - Use of EMFAC2011
  - Single year modeled in 2035
    - Interannual variability is small
  - Reduced model to monitored comparison
  - AQ modeling for 2023 “estimated” later in AQAP
  - AQ modeling for 2035 additional measures to be modeled as part of Phase II Transportation Strategic Plan
Presentation Outline

- Introduction
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- Model to Monitor Comparison
- Emission
- Air Quality Next Steps
2009 Baseline Modeling

- Key to Establishing Confidence in Model for use in future year modeling
  - Quantile-Quantile Plots
  - Robust Highest Concentration
  - Mean Concentration
  - Performance Statistics
Comparison with AQMD Monitoring Network

• Compare routine criteria pollutant air quality monitoring data

• 2008-2010 monitoring data
<table>
<thead>
<tr>
<th>Air Quality Station</th>
<th>Pollutants</th>
<th>Model Receptor(s)</th>
<th>Annual Average Pollutant</th>
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<td></td>
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<td>NO2</td>
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<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Pico Rivera</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Long Beach South</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compton</td>
<td>x</td>
<td></td>
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</tr>
<tr>
<td>Lynwood</td>
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### Air Toxic Monitoring (Long Beach)

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<th>Year</th>
<th>Min</th>
<th>Median</th>
<th>Mean</th>
<th>90th %ile</th>
<th>Max</th>
<th>Std Dev</th>
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<td></td>
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<td>0.06</td>
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<td>2008</td>
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<td>*</td>
<td>0.05</td>
<td>*</td>
<td>0.08</td>
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<td>0.06</td>
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<td><strong>Benzene (ppb)</strong></td>
<td>2010</td>
<td>0.18</td>
<td>0.33</td>
<td>0.43</td>
<td>0.77</td>
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<td>2.4</td>
<td>3.5</td>
<td>4.2</td>
<td>0.97</td>
<td>30</td>
<td>0.1</td>
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</table>
Graphical Comparison

• Q-Q plots of CO, PM$_{10}$ PM$_{2.5}$
  – 1- hr and 24-hr concentrations
Quantile-Quantile Plots of Hourly CO
Quantile-Quantile Plots of 24-Hour PM10
Quantile-Quantile Plots of 24-Hour PM2.5

Figure 9. 2009 North Long Beach 24-Hour PM2.5 Concentrations: Monitored vs Modeled

Figure 10. Q-Q Plot 2009 North Long Beach 24-Hour PM2.5 Concentrations: Monitored vs Modeled

Figure 11. 2009 Compton 24-Hour PM2.5 Concentrations: Monitored vs Modeled

Figure 12. Q-Q Plot 2009 Compton 24-Hour PM2.5 Concentrations: Monitored vs Modeled
Statistical Measures: Robust Highest Concentration

- A single number representing how well the model is reproducing the highest concentrations
  - Top 26 values in the distribution with exponential fit
  - RHC, fractional bias, absolute fractional bias
## Robust Highest Concentration Statistics

### 2009 hourly CO and NO\textsubscript{x}

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<th>Carbon Monoxide (CO)</th>
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<td>Locations</td>
<td>RHC\textsubscript{OB} (ppm)</td>
</tr>
<tr>
<td>Units</td>
<td>(ppm)</td>
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<tr>
<td>Compton</td>
<td>5.19</td>
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<tr>
<td>North Long Beach</td>
<td>2.55</td>
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<tr>
<td>Pico Rivera</td>
<td>2.11</td>
</tr>
<tr>
<td>Average</td>
<td>3.28</td>
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</table>

<table>
<thead>
<tr>
<th>NO\textsubscript{x}</th>
<th>Nearest Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locations</td>
<td>RHC\textsubscript{OB} (ppm)</td>
</tr>
<tr>
<td>Units</td>
<td>(ppm)</td>
</tr>
<tr>
<td>Compton</td>
<td>0.49</td>
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<tr>
<td>North Long Beach</td>
<td>0.33</td>
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<tr>
<td>Pico Rivera</td>
<td>0.30</td>
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<tr>
<td>Average</td>
<td>0.37</td>
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### Robust Highest Concentration Statistics

**2009 daily PM$_{10}$ and PM$_{2.5}$**

#### PM$_{10}$

<table>
<thead>
<tr>
<th>Locations</th>
<th>RHC$_{OB}$ (µg/m$^3$)</th>
<th>RHC$_{MO}$ (µg/m$^3$)</th>
<th>Fractional Bias</th>
<th>Absolute Fractional Bias</th>
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</thead>
<tbody>
<tr>
<td>North Long Beach</td>
<td>44.08</td>
<td>101.18</td>
<td>0.79</td>
<td>0.79</td>
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<tr>
<td>South Long Beach</td>
<td>51.91</td>
<td>75.71</td>
<td>0.37</td>
<td>0.37</td>
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<tr>
<td><strong>Average</strong></td>
<td>48.00</td>
<td>88.45</td>
<td>0.58</td>
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#### PM$_{2.5}$

<table>
<thead>
<tr>
<th>Locations</th>
<th>RHC$_{OB}$ (µg/m$^3$)</th>
<th>RHC$_{MO}$ (µg/m$^3$)</th>
<th>Fractional Bias</th>
<th>Absolute Fractional Bias</th>
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<tbody>
<tr>
<td>Compton-700 North Bullis Road</td>
<td>31.38</td>
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<td>35.32</td>
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<tr>
<td>Pico Rivera-4144 San Gabriel</td>
<td>31.02</td>
<td>33.13</td>
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<tr>
<td>South Long Beach</td>
<td>33.09</td>
<td>36.50</td>
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<td>0.10</td>
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<tr>
<td><strong>Average</strong></td>
<td>32.70</td>
<td>36.36</td>
<td>0.10</td>
<td>0.11</td>
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</table>
Statistical Measures: Mean Concentration

• Annual Average Model to Monitored Performance
  – Criteria Pollutants and air pollutants and air toxics
### Annual Average Concentration Statistics

#### 2009 NO\textsubscript{x} and PM\textsubscript{10}

<table>
<thead>
<tr>
<th>NO\textsubscript{x}</th>
<th>Nearest Receptor</th>
<th>Locations</th>
<th>Mean OB</th>
<th>Mean MO</th>
<th>Mean Bias</th>
<th>Mean Error</th>
<th>Normalized Mean Bias</th>
<th>Normalized Mean Error</th>
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<tbody>
<tr>
<td>Units</td>
<td>(ppm)</td>
<td>(ppm)</td>
<td>(ppm)</td>
<td>(ppm)</td>
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<tr>
<td>North Long Beach</td>
<td>0.04</td>
<td>0.11</td>
<td>0.07</td>
<td>0.06</td>
<td>1.50</td>
<td>1.49</td>
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<td></td>
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<tr>
<td>Pico Rivera-4144 San Gabriel</td>
<td>0.06</td>
<td>0.07</td>
<td>0.01</td>
<td>0.01</td>
<td>0.24</td>
<td>0.26</td>
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<tr>
<td>Average</td>
<td>0.05</td>
<td>0.09</td>
<td>0.04</td>
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<td>0.87</td>
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<table>
<thead>
<tr>
<th>PM\textsubscript{10}</th>
<th>Nearest Receptor</th>
<th>Locations</th>
<th>Mean OB</th>
<th>Mean MO</th>
<th>Mean Bias</th>
<th>Mean Error</th>
<th>Normalized Mean Bias</th>
<th>Normalized Mean Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>(µg/m\textsuperscript{3})</td>
<td>(µg/m\textsuperscript{3})</td>
<td>(µg/m\textsuperscript{3})</td>
<td>(µg/m\textsuperscript{3})</td>
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<tr>
<td>North Long Beach</td>
<td>30.40</td>
<td>46.75</td>
<td>16.35</td>
<td>13.73</td>
<td>0.54</td>
<td>0.45</td>
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<td>South Long Beach</td>
<td>32.89</td>
<td>31.09</td>
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<td>4.86</td>
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<td>0.16</td>
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## Annual Average Concentration Statistics

### 2009 annual PM$_{2.5}$

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<th>Locations</th>
<th>Units</th>
<th>Mean OB (µg/m$^3$)</th>
<th>Mean MO (µg/m$^3$)</th>
<th>Mean Bias (µg/m$^3$)</th>
<th>Mean Error (µg/m$^3$)</th>
<th>Normalized Mean Bias</th>
<th>Normalized Mean Error</th>
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<td></td>
<td>12.48</td>
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<tr>
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<td>10.29</td>
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<td>0.40</td>
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<td>3.68</td>
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<td>-0.16</td>
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## Daily Average Air Toxic Distribution

### North Long Beach (2008-2010)

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<th>Modeled</th>
<th>Observed</th>
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<tr>
<td><strong>Air Toxic (units)</strong></td>
<td><strong>Year</strong></td>
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<td></td>
<td>2008</td>
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<td>Cr-6 (ng/m³)</td>
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<td>2009</td>
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<td>Benzene (ppb)</td>
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<td>2008</td>
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<tr>
<td>1,3 Buta (ppb)</td>
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<td>Form (ppb)</td>
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<tr>
<td></td>
<td>2009</td>
</tr>
<tr>
<td></td>
<td>2008</td>
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</tbody>
</table>

*Notes: Modeled values are estimated using computer models, while Observed values are measured in the field.*
Comparison of Model Performance Measures with Similar Studies

• 2007 AQMP
  – Present Q-Q for PM2.5 at N. Long Beach

• 2005 MATES-III
  – Compare with 5 available air toxics
Scatter Plots of $\text{PM}_{2.5}$

**AQMP 2005**

**AQAP 2009**
### Annual Average Air Toxics MATES-III (2005) and AQAP (2009)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Units</th>
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<th>AQAP</th>
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<tbody>
<tr>
<td></td>
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<td>Compton</td>
<td>North Long Beach</td>
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<td>Pico Rivera (&lt; 12 months)</td>
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<td></td>
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<td>Obs</td>
<td>Model</td>
<td>Obs</td>
<td>Model</td>
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<td>0.14</td>
<td>0.08</td>
<td>0.09</td>
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<tr>
<td>arsenic</td>
<td>ng/m³</td>
<td>0.68</td>
<td>3.52</td>
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<td>Hexavalent Chromium</td>
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<td>0.05</td>
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<tr>
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<td>ppb</td>
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<td>3.44</td>
<td>3.5</td>
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<td>North Long Beach</td>
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<td>Pico Rivera (&lt; 12 months)</td>
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<td>Model</td>
<td>Obs</td>
<td>Model</td>
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<tr>
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<td>0.07</td>
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<td>0.10</td>
</tr>
<tr>
<td>arsenic</td>
<td>ng/m³</td>
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<td>1.67</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>benzene</td>
<td>ppb</td>
<td>----</td>
<td>0.23</td>
<td>0.50</td>
<td>0.42</td>
</tr>
<tr>
<td>Hexavalent Chromium</td>
<td>ng/m³</td>
<td>----</td>
<td>0.17</td>
<td>0.06</td>
<td>0.36</td>
</tr>
<tr>
<td>formaldehyde</td>
<td>ppb</td>
<td>----</td>
<td>1.49</td>
<td>~2.4</td>
<td>1.8</td>
</tr>
</tbody>
</table>
Summary of Findings for Model to Monitor Comparison

- Good predictive abilities for short-avg periods
  - CO, PM$_{2.5}$ less so for PM$_{10}$
- NO$_x$ performed well but NO$_2$ overpredicted
  - Future year NO$_x$ adjust by obs NO$_2$-to-NO$_x$ ratio
- Although limited good air toxic M-M perform
- Annual PM$_{2.5}$ good but biased high
  - Base year needs adjustment
- Overall reasonably good model performance
Presentation Outline

• Introduction
• Review of Modeling Approach
• Model to Monitor Comparison
• Emissions
• Air Quality
• Next Steps
Emissions Quality Assurance Review and Assessment

• Changes between 2009 and 2035
  - Changes in Emissions within the Gateway Cities
    - Criteria Pollutants
    - Air Toxics
  - Spatial Variations in Emissions
    - Criteria Pollutants (focus on PM$_{2.5}$)
    - Air Toxics (focus on DPM)
Emissions Quality Assurance Review and Assessment

• Changes between 2009 and 2035
  − Changes in Emissions within the Gateway Cities
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    − Criteria Pollutants (focus on PM$_{2.5}$)
    − Air Toxics (focus on DPM)
Daily Average Emissions Gateway Cities 2009 and 2035

- Criteria Pollutants by Source Category
  - Area (e.g., charcoal broiler, coatings)
  - Point (e.g., refinery)
  - On-road (e.g., cars, trucks)
    - Freeway and non-freeway
  - Aircraft and ground support equipment
  - Rail line and railyards
  - Watercraft (ocean going ships, tugs, pleasure craft)
  - Other off-road (e.g., construction, industrial equipment)
2009 and 2035 Daily Average By Source Category – CO Emissions
2009 and 2035 Daily Average By Source Category – NOx Emissions
## 2009 and 2035 Daily Average By Source Category – SOx Emissions

<table>
<thead>
<tr>
<th>Category</th>
<th>2009 - 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>0</td>
</tr>
<tr>
<td>Point</td>
<td>0</td>
</tr>
<tr>
<td>On-road</td>
<td>0</td>
</tr>
<tr>
<td>Aircraft</td>
<td>0</td>
</tr>
<tr>
<td>Airport Ground Support</td>
<td>0</td>
</tr>
<tr>
<td>Railyard</td>
<td>0</td>
</tr>
<tr>
<td>Trains</td>
<td>0</td>
</tr>
<tr>
<td>Ships</td>
<td>0</td>
</tr>
<tr>
<td>Other Off-Road</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
</tr>
</tbody>
</table>

**kg/day**

- **2009**: Red
- **2035**: Blue
- **2009 - 2035**: Green
2009 and 2035 Daily Average By Source Category – TOG Emissions
2009 and 2035 Daily Average By Source Category – PM$_{10}$ Emissions

<table>
<thead>
<tr>
<th>Category</th>
<th>2009</th>
<th>2035</th>
<th>2009 - 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airport Ground Support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Railyard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ships</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Off-Road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Dust (links)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Dust (TAZ)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

```
<table>
<thead>
<tr>
<th>Category</th>
<th>2009</th>
<th>2035</th>
<th>2009 - 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airport Ground Support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Railyard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ships</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Off-Road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Dust (links)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Dust (TAZ)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```
2009 and 2035 Daily Average By Source Category – PM$_{2.5}$ Emissions
2009 and 2035 Daily Average Emissions
Onroad Sources
2009 and 2035 Daily Average Emissions
Area Sources

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>2009</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>23,000</td>
<td>21,000</td>
</tr>
<tr>
<td>NOX</td>
<td>15,000</td>
<td>14,000</td>
</tr>
<tr>
<td>SOX</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>TOG</td>
<td>180,000</td>
<td>180,000</td>
</tr>
<tr>
<td>PM10</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>PM2.5</td>
<td>10,000</td>
<td>10,000</td>
</tr>
</tbody>
</table>
2009 and 2035 Daily Average Emissions Point Sources
2009 and 2035 Daily Average Emissions
All Offroad Mobile Sources
## Summary of Change in PM$_{10}$ and PM$_{2.5}$ Emission By Source Category 2009-2035 (kg/day)

<table>
<thead>
<tr>
<th>Source Category</th>
<th>PM10</th>
<th>PM2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>4,247(14%)</td>
<td>1,563(11%)</td>
</tr>
<tr>
<td>Point</td>
<td>198(12%)</td>
<td>181(12%)</td>
</tr>
<tr>
<td>On-Road</td>
<td>-2,162(-23%)</td>
<td>-2,344(-42%)</td>
</tr>
<tr>
<td>Aircraft</td>
<td>62(21%)</td>
<td>61(21%)</td>
</tr>
<tr>
<td>Airport GSE</td>
<td>-26(-61%)</td>
<td>-25(-64%)</td>
</tr>
<tr>
<td>Railyard</td>
<td>-31(-71%)</td>
<td>-28(-71%)</td>
</tr>
<tr>
<td>Trains</td>
<td>-182(-45%)</td>
<td>-166(-45%)</td>
</tr>
<tr>
<td>Watercraft</td>
<td>89(4%)</td>
<td>-162(-8%)</td>
</tr>
<tr>
<td>Other Off-Road</td>
<td>-2,249(-66%)</td>
<td>-2,075(-69%)</td>
</tr>
<tr>
<td>Total</td>
<td>-53(-0.07%)</td>
<td>-2,996(-11%)</td>
</tr>
</tbody>
</table>
Emissions Quality Assurance Review and Assessment

• Changes between 2009 and 2035

  − Changes in Emissions within the Gateway Cities
    − Criteria Pollutants
    − Air Toxics
  − Spatial Variations in Emissions
    − Criteria Pollutants (focus on PM$_{2.5}$)
    − Air Toxics (focus on DPM)
Area Source PM2.5 Emissions

2009

2035

Legend
- Study Area
- Gateway Cities Boundary
- Highways
- City Limits

Emissions of PM2.5 (2009) (kg/day)
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300

Emissions of PM2.5 (2035) (kg/day)
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300

Spatial Grid = 4km by 4km
Source: USGS Streammap USA 2010
ESRI Imagery Layers
Point Source PM2.5 Emissions in 2009 and 2035
Marine Vessel & Port PM2.5 Emissions in 2009 and 2035
Other Off-Road PM2.5 Emissions in 2009 and 2035
Other Airport PM2.5 Emissions in 2009 and 2035
On-Road Emission Allocations

- Emissions allocations for on-road, airport, ships and rail represent a more detailed approach than used in AQMP or MATES
  - 5 x 5 km grids (DTIM4) – criteria pollutants
  - 2 x 2 km grids (MATES-III) - toxics
Gateway City On-Road Freeway PM$_{2.5}$ Emissions in 2009 and 2035
Non-Freeway* PM2.5 Emissions in 2009 and 2035

*Primary and Secondary Arterials and Local Roadways
Key Findings across the Gateway Cities: Changes between 2009 and 2035

- Roadways no longer dominate all emission source types in the Gateway Cities

- Only on-road sources show emission reductions for all criteria air pollutants

- Area source emissions show growth for most types of emissions and are the dominate category for TOG and PM
Implications for Air Quality and Emission Reduction Targets from Inventory Review

- $\text{PM}_{2.5}$ will be most difficult pollutant to achieve and maintain NAAQS/CAAQS
  - Most effective reductions should target area source emissions

- $\text{NO}_x$ reductions primarily needed to further improve air quality for ozone and secondary PM
  - Continue to focus equally on on-road, ships and other off-road (construction equipment) sources
Emissions Quality Assurance Review and Assessment

• Changes between 2009 and 2035
  – Changes in Emissions within the Gateway Cities
    – Criteria Pollutants
    – Air Toxics
  – Spatial Variations in Emissions
    – Criteria Pollutants (focus on PM$_{2.5}$)
    – Air Toxics (focus on DPM)
Air Toxic Species

- Benzene (gasoline and evap, industry)
- 1,3 butadiene (combustion, refining)
- Formaldehyde
- Arsenic (point – glass mfg furnace)
- Diesel PM (diesel fueled)
- Hexavalent chromium (brake and tire, electroplating)
2009 and 2035 Daily Average By Source Category – Benzene Emissions
2009 and 2035 Daily Average By Source Category – 1,3-Butadiene Emissions
2009 and 2035 Daily Average By Source Category – Formaldehyde Emissions
2009 and 2035 Daily Average By Source Category – Arsenic Emissions
2009 and 2035 Daily Average By Source Category – Chromium Emissions
2009 and 2035 Daily Average By Source Category – DPM Emissions
2009 and 2035 Daily Average Emissions Mobile Sources

Air Toxic

Kg/day

Benzene  Butadiene  Formaldehyde  Arsenic  DPM  Cr6

2009  2035
2009 and 2035 Daily Average Emissions
Area Sources

Air Toxic

- Benzene
- Butadiene
- Formaldehyde
- Arsenic
- DPM

Kg/day

2009
2035
2009 and 2035 Daily Average Emissions Point Sources
2009 and 2035 Daily Average Emissions Off-Road Sources (ships, rail, aircraft, const.)

Air Toxic

- Benzene
- Butadiene
- Formaldehyde
- Arsenic
- DPM

Kg/day
## Summary of Air Toxic Emission Changes Only
By Source Category 2009-2035 (kg/day)

<table>
<thead>
<tr>
<th>Category</th>
<th>Benzene</th>
<th>Butadiene</th>
<th>Formaldehyde</th>
<th>Arsenic</th>
<th>DPM</th>
<th>Cr-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>0.2(0%)</td>
<td>-1(25%)</td>
<td>-6(-2%)</td>
<td>0.0(14%)</td>
<td>-55(-53%)</td>
<td>0.0 (0%)</td>
</tr>
<tr>
<td>Point</td>
<td>13(8%)</td>
<td>18(24%)</td>
<td>-9(-3%)</td>
<td>1.4(17%)</td>
<td>7(5%)</td>
<td>0.05(28%)</td>
</tr>
<tr>
<td>Freeway and Non-Freeway</td>
<td>-286(-67%)</td>
<td>-53(-72%)</td>
<td>-172(-75%)</td>
<td>0.01(0%)</td>
<td>-476(-46%)</td>
<td>0.14(28%)</td>
</tr>
<tr>
<td>Aircraft</td>
<td>17(18%)</td>
<td>13(17%)</td>
<td>104(17%)</td>
<td>0.1(10%)</td>
<td>0(0%)</td>
<td>0.0 (0%)</td>
</tr>
<tr>
<td>GSE</td>
<td>-6(-55%)</td>
<td>-2(-57%)</td>
<td>-6(-56%)</td>
<td>0.0(0%)</td>
<td>-30(-88%)</td>
<td>0.0 (0%)</td>
</tr>
<tr>
<td>Rail yard</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0(0%)</td>
<td>-31(-71%)</td>
<td>0.0 (0%)</td>
</tr>
<tr>
<td>Rail-line</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0(0%)</td>
<td>-182(-45%)</td>
<td>0.0 (0%)</td>
</tr>
<tr>
<td>Watercraft</td>
<td>-15(-7)</td>
<td>-11(-23%)</td>
<td>-37(-16%)</td>
<td>&lt;-0.01(-87%)</td>
<td>-198(-49%)</td>
<td>0.0 (0%)</td>
</tr>
<tr>
<td>Other Off-Road</td>
<td>-89(-15%)</td>
<td>-14(-11%)</td>
<td>-62(-13%)</td>
<td>&lt;-0.01(-75%)</td>
<td>-2,288(-90%)</td>
<td>0.0 (0%)</td>
</tr>
<tr>
<td>Total</td>
<td>-366(-22%)</td>
<td>-51(-9%)</td>
<td>-188(-9%)</td>
<td>1.5(16%)</td>
<td>-3,252(-69%)</td>
<td>0.19(54%)</td>
</tr>
</tbody>
</table>
Emissions Quality Assurance Review and Assessment

• Changes between 2009 and 2035
  − Changes in Emissions within the Gateway Cities
    − Criteria Pollutants
    − Air Toxics
  − Spatial Variations in Emissions
    − Criteria Pollutants (focus on PM$_{2.5}$)
    − Air Toxics (focus on DPM)
Diesel PM Area Emissions in 2009 and 2035
Diesel PM Point Source Emissions in 2009 and 2035

The Gateway Cities
Air Quality Action Plan

2009

2035
Shipping DPM Emissions in 2009 and 2035
Other Off-Road DPM Emissions in 2009 and 2035
Freeway DPM Emissions in 2009 and 2035

Legend
- Gateway Cities Boundary
- Highways
- City Limits

Emissions of DPM (2009) (kg/day)
- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- > 2

2009

2035

Source: ESRI Streetmap USA (2012); ESRi Imagery Layer
Non-Freeway* DPM Emissions in 2009 and 2035

*Primary and Secondary Arterials and Local Roadways
Key Findings:
Changes in Toxic Emissions from 2009 and 2035

• DPM decreases overall by 70% despite 12% growth in VMT
• On- and off-road mobile emissions are the major sources responsible for emissions decreases
• Benzene – decreasing because of reductions from both on-road and off-road mobile sources
Presentation Outline

• Introduction
• Review of Modeling Approach
• Model to Monitor Comparison
• Emissions
• Air Quality
• Next Steps
Air Quality

Changes between 2009 and 2035

- Criteria Pollutants (focus on PM2.5)
- Air Toxics (focus on DPM)
2009 and 2035 PM$_{2.5}$ Concentrations

- Total Annual Average PM$_{2.5}$ (all sources)
- Major Sub Categories (same scale)
  - Secondary (PM formed in the atmosphere)
  - Freeways
  - Non-Freeways*
  - Area Sources
  - Watercraft

* Primary and Secondary Arterials and Local Roadways
Relative Response Factors (RRF) and Future Year Attainment for PM2.5

- RRF is used to bridge the gap between air quality model output evaluation and applicability to the health based air quality standards, EPA guidance (EPA, 2006) – also used by AQMD
  - $RRF = \frac{\text{Future-Year Model Prediction}}{\text{Base-Year Model Prediction}}$
  - $RRF \times \text{“Design Value”} \leq \text{Air Quality Standard (meet standard)}$
  - Where the “design value” is the observed PM$_{2.5}$ concentration in 2009
Example of Using RRF for Compton

- Compton 2009 PM\textsubscript{2.5} Design Value (14.7 µg/m\textsuperscript{3})

\begin{equation}
RRF_{\text{Compton}} = \frac{20.3 \text{ µg/m}^3}{28.6 \text{ µg/m}^3} = 0.71
\end{equation}

- 0.71 x 14.7 µg/m\textsuperscript{3} = 10.4 µg/m\textsuperscript{3} (projected 2035 PM\textsubscript{2.5} value)

- Note: EPA on June 29\textsuperscript{th}, 2012 FR Notice to revised the annual PM\textsubscript{2.5} standard in the range between 12-13 µg/m\textsuperscript{3}
2009 and 2035 PM$_{2.5}$ Gateway Cities Area Wide (3,136 km$^2$) Source Contributions
Total Annual Average PM$_{2.5}$ Concentrations
2009 and 2035

Legend
- Gateway Cities Boundary
- Highways
- City Limits
- Annual Concentration of PM$_{2.5}$ (2009/2035)
  - < 10 ug/m$^3$
  - 10 - 12 ug/m$^3$
  - 12 - 15 ug/m$^3$
  - 15 - 20 ug/m$^3$
  - > 20 ug/m$^3$

2009

2035

Source: ERI; Streetscape USA (2010); ERI Imagery Layer
Annual Average PM$_{2.5}$ Concentration across the Gateway Cities 2009 and 2035
Annual Average Secondary PM$_{2.5}$ Concentration
2009 and 2035
The Gateway Cities
Air Quality Action Plan

Annual Average Freeway PM$_{2.5}$ Concentration
2009 and 2035

Legend
- Gateway Cities Boundary
- Highways
- City Limits
- Annual Concentration of PM$_{2.5}$ (2009) ug/m$^3$
  - < 2
  - 2 - 4
  - 4 - 5
  - 6 - 8
  - > 8

2009

2035

Legend
- Gateway Cities Boundary
- Highways
- City Limits
- Annual Concentration of PM$_{2.5}$ (2035) ug/m$^3$
  - < 2
  - 2 - 4
  - 4 - 5
  - 6 - 8
  - > 8

Source: EIR, Metropolitan LA 2010, EIR Project Layer

Aircraft 4%
Secondary PM 55%
Non-Freeway Dust 7%
Other Off-Road 4%
Freeway Dust 3%
Non-Freeway 4%
Watershed 3%
Railroad 1%

Aircraft 4%
Secondary PM 40%
Non-Freeway Dust 9%
Other Off-Road 2%
Watershed 2%
Freeway Dust 2%
Non-Freeway 7%
Railroad 5%
Watershed 12%
Annual Average Non-Freeway* PM$_{2.5}$ Concentration 2009 and 2035

*Primary and Secondary Arterials and Local Roadways
Annual Average Area Source PM$_{2.5}$ Concentration 2009 and 2035
Annual Average Watercraft PM$_{2.5}$ Concentration
2009 and 2035
Change in PM$_{2.5}$ Source Contribution GC wide 2009 and 2035

- Secondary PM$_{2.5}$ dominates
  - decreases from 51% to 46%
- Area sources increase from 18% to 24% - widespread over GC
- Combined all on-road activity constant ~ 24%
  - Much higher near warehouse and freeways
- All other sources total 5-10%
- Pleasure craft important in nearby Port areas
2035 Annual Average PM$_{2.5}$

- Two locations above 15 µg/m$^3$ standard
  - San Pedro

- If standard is lowered to 12 µg/m$^3$
  - ~24% of the receptors would be above the standard
Air Quality

Changes between 2009 and 2035

- Criteria Pollutants (focus on PM2.5))
- Air Toxics (focus on DPM)
2009 and 2035 DPM Concentrations

• Total annual average DPM
• Major sub-categories annual average DPM
  – Freeways
  – Non-freeways*
  – Rail-line
  – Watercraft
  – Other off-road

* Primary and Secondary Arterials and Local Roadways
The Gateway Cities
Air Quality Action Plan

2009 and 2035 DPM Gateway Cities Area Wide
(3,136 km²) Source Contributions

<table>
<thead>
<tr>
<th>Source Type</th>
<th>2009</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>Mean = 3.80 µg/m³</td>
<td>Mean = 0.79 µg/m³</td>
</tr>
<tr>
<td>Non-Freeway</td>
<td>18%</td>
<td>14%</td>
</tr>
<tr>
<td>Other Off-Road</td>
<td>29%</td>
<td>15%</td>
</tr>
<tr>
<td>Rail-line</td>
<td>6%</td>
<td>1%</td>
</tr>
<tr>
<td>Watercraft</td>
<td>3%</td>
<td>7%</td>
</tr>
<tr>
<td>Railyard</td>
<td>1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Point</td>
<td>1%</td>
<td>3%</td>
</tr>
<tr>
<td>Area</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>Aircraft</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Area 2009

Area 2035

2009

2035
Total Annual Average DPM Concentration
2009 and 2035

Legend
- Gateway Cities Boundary
- Highways
- City Limits
- Annual Concentration of DPM (2035)

2009

2035

Legend
- Gateway Cities Boundary
- Highways
- City Limits
- Annual Concentration of DPM (2035)
Annual Average DPM Concentration across the Gateway Cities 2009 and 2035
Annual Average Freeway DPM Concentration 2009 and 2035
Annual Average Non-Freeway* DPM Concentration
2009 and 2035

*Primary and Secondary Arterials and Local Roadways
Annual Average Watercraft DPM Concentration 2009 and 2035

Legend
- Gateway Cities Boundary
- Watercraft
- Freeway
- Rail-line

Annual Concentration of DPM (2009)
- 0 - 0.99
- 1 - 2
- 2 - 5
- > 5

2009

Legend
- Gateway Cities Boundary
- Highways
- City Limits

Annual Concentration of DPM (2035)
- 0 - 0.99
- 1 - 2
- > 2

2035
Annual Average Other Off-Road DPM Concentration 2009 and 2035
2035 DPM Source Contribution Summary

- Combined on-road mean ~ 54%
  - Higher near warehouse and freeways
- Rail-line ~ 15% - clustered in corridors
- Other-off road contribute ~15%
- All other sources in total 0.1-29% depending upon location
- Recreational watercraft emissions are largest contributor in nearby Port areas
Other Pollutants in 2035

• 1-hour NO$_2$ concentrations
  – All receptors in GC are below the NAAQS except 5 in South Gate

• Annual NO$_2$
  – No exceedances < half of the NAAQS

• 24-hour PM$_{2.5}$ exceedance
  – All receptors in GC are below the NAAQS except 17 receptors clustered in San Pedro

• CO and SO$_2$ – all well below NAAQS
Estimated Air Quality in 2023

- 2023 will be more like 2035 than 2009 due to:
  - near complete phase-in of all post-2006 ULSD emission reduction technology (filters and traps)
- Possible AQ hot-spot may occur in construction zones for receptors close to activity
  - short-term averages (PM, NO₂) only and where existing background is high
  - green equipment and dust control measures will help minimize impact
Impacts to New Measures

• One strategy will not work equally everywhere – strong spatial variations

• May need to look at measures targeting secondary PM$_{2.5}$ precursors (would require photochemical modeling to evaluate)
Which changes in air quality did not match our expectations?

• Importance in vicinity of Port of 2035 recreational watercraft to PM$_{2.5}$
• Secondary PM$_{2.5}$ remains high fraction in 2035
• Very large reductions in DPM from other off-road source category
Which pollutants will be most problematic

- PM$_{2.5}$ – especially if annual standard is lowered to 12 µg/m$^3$
- Reductions to secondary PM$_{2.5}$
- Further reductions in DPM necessary?
  - Advanced Collaborative Emission Study (ACES)
    - multi-party effort to characterize health effects post-2006 diesel engines and 2010 advances
    - Completion of 30-mth long-term exposure Dec 2012, final report late 2013
Presentation Outline

• Introduction
• Review of Modeling Approach
• Model to Monitor Comparison
• Emission and Air Quality Findings
• Next Steps
Next Steps

• Health Risk Assessment
  – Analysis Underway
  – HRA Technical Webinar (early Nov)
  – AQ/HRA Report (Nov/Dec)

• New Measures
  – Roundtable Workshop to Review New Measures (Oct 10)
  – Webinar on New Measures (Nov)
  – AQAP Report (Feb 2013)
Next Gateway City COG Meetings

• Nov/Dec Environmental Committee (tentative)
  – AQ Results (Summary)
  – HRA Results (preliminary)
  – New Measures

• March Environmental Committee
  – Draft AQAP