Improving the Spatial Allocation of Construction Equipment Emissions

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Spatial Allocation of Construction Equipment Emissions

- The location of construction projects can have a significant impact on pollutant concentrations at down-wind monitoring sites.

- Default spatial allocation of construction equipment emission is often inaccurate.

- Construction often occurs at the outer edges of urban areas where new housing, commercial development, and roads are being built.

- Large mining sites can also account for a significant portion of construction equipment emissions.
Construction Equipment Sectors

- Heavy Highway
- Municipal
- Residential
- State Transportation Agency
- Landscaping Businesses
- Trenches
- Skid Steer Loaders
- Cranes
- Bore/Drill Rigs
- Agriculture
- Landfills
- Toyota

- Utility
- Commercial Construction
- City/County Roads
- Scrap Recycling Businesses
- Brick and and Stone Businesses
- Concrete Businesses
- Special Trade Businesses
- RT Forklifts
- Manufacturing
- Other Construction Equipment
- Pipeline
- Quarries
Construction Equipment Methodology

1. Conduct surveys and develop surrogate factors to estimate diesel equipment population, usage rates, and equipment characteristics

2. Update the NONROAD 2005 model input files using local data

3. Estimate VOC, NOx, and CO annual emissions from construction equipment using the NONROAD 2005 model

4. Spatial allocate construction equipment emissions

5. Updated spatial allocation of construction emissions in the photochemical model
### VOC and NOx Emissions from Construction Equipment (2005 tons/weekday)

<table>
<thead>
<tr>
<th>Sector</th>
<th>VOC</th>
<th>NOx</th>
<th>% of Total Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Highway</td>
<td>0.06</td>
<td>0.69</td>
<td>8%</td>
</tr>
<tr>
<td>Utility</td>
<td>0.04</td>
<td>0.40</td>
<td>5%</td>
</tr>
<tr>
<td>Commercial Construction</td>
<td>0.05</td>
<td>0.57</td>
<td>6%</td>
</tr>
<tr>
<td>Residential</td>
<td>0.08</td>
<td>0.99</td>
<td>11%</td>
</tr>
<tr>
<td>City/County Roads</td>
<td>0.01</td>
<td>0.12</td>
<td>1%</td>
</tr>
<tr>
<td>TxDOT</td>
<td>0.06</td>
<td>0.48</td>
<td>6%</td>
</tr>
<tr>
<td>Scrap Recycling</td>
<td>0.03</td>
<td>0.18</td>
<td>2%</td>
</tr>
<tr>
<td>Landscaping</td>
<td>0.05</td>
<td>0.23</td>
<td>3%</td>
</tr>
<tr>
<td>Brick and Stone</td>
<td>0.00</td>
<td>0.04</td>
<td>0%</td>
</tr>
<tr>
<td>Concrete</td>
<td>0.01</td>
<td>0.09</td>
<td>1%</td>
</tr>
<tr>
<td>Special Trade</td>
<td>0.10</td>
<td>0.83</td>
<td>10%</td>
</tr>
<tr>
<td>Municipal and County Eq.</td>
<td>0.19</td>
<td>1.24</td>
<td>15%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.00</td>
<td>0.05</td>
<td>1%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.01</td>
<td>0.09</td>
<td>1%</td>
</tr>
<tr>
<td>Toyota</td>
<td>0.00</td>
<td>0.01</td>
<td>0%</td>
</tr>
<tr>
<td>Landfill</td>
<td>0.01</td>
<td>0.17</td>
<td>2%</td>
</tr>
<tr>
<td>Quarry</td>
<td>0.13</td>
<td>1.88</td>
<td>21%</td>
</tr>
<tr>
<td>Other</td>
<td>0.06</td>
<td>0.67</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.88</td>
<td>8.74</td>
<td>100%</td>
</tr>
</tbody>
</table>
Spatial Allocation

• Construction equipment within the San Antonio was spatially allocated for each sector based on type and purpose of equipment used.

• Local department of transportation, utility companies, government agencies, and private companies were contacted to collect data on costs and locations of construction projects.

• Also, residential building permits, commercial building permits, and demolition permits were collected to geo-coded residential and commercial construction emissions.

• GIS software was used to allocate emissions to the 4km grid systems used by photochemical models

• 13 different GIS layers.
### Spatial Surrogates used to Allocate Construction Equipment Emissions

<table>
<thead>
<tr>
<th>Sector</th>
<th>Spatial Allocation Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Highway</td>
<td>TxDOT and MPO Construction Dollar Value</td>
</tr>
<tr>
<td>Utility</td>
<td>CPS, BexarMet, and SAWS Construction Dollar Value</td>
</tr>
<tr>
<td>Commercial Construction</td>
<td>COSA and Bexar Com. Building and Demolition Permits</td>
</tr>
<tr>
<td>Residential</td>
<td>COSA and Bexar Residential Building Permits</td>
</tr>
<tr>
<td>City/County Roads</td>
<td>COSA and Bexar Road Dollar Value</td>
</tr>
<tr>
<td>TxDOT</td>
<td>TxDOT and MPO Construction Dollar Value</td>
</tr>
<tr>
<td>Scrap Recycling</td>
<td>Scrap and waste Materials Employment</td>
</tr>
<tr>
<td>Landscaping</td>
<td>EPA Default</td>
</tr>
<tr>
<td>Brick and Stone</td>
<td>Related construction materials Employment</td>
</tr>
<tr>
<td>Concrete</td>
<td>Block, brick, other, and ready-mix Employment</td>
</tr>
<tr>
<td>Special Trade</td>
<td>COSA and Bexar Commercial Building Permits</td>
</tr>
<tr>
<td>Municipal/County-Op. Eq.</td>
<td>COSA and Bexar Road Dollar Value</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Manufacturing Employees (only companies &gt; 4 employees)</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Crop Location</td>
</tr>
<tr>
<td>Toyota</td>
<td>Location of Toyota</td>
</tr>
<tr>
<td>Landfills</td>
<td>Location of Landfills</td>
</tr>
<tr>
<td>Quarries</td>
<td>Location of Quarries</td>
</tr>
<tr>
<td>Other Sectors</td>
<td>Total Construction Cost</td>
</tr>
</tbody>
</table>

*Source: AACOG (Alamo Area Council of Governments)*
Heavy Highway Construction Eq. Emissions (tons of NOx/day), 2005.

Residential Construction Eq. Emissions (tons of NOx/day), 2005.

Plot Date: Feb. 22, 2007
Map Compilation: Feb. 21, 2007
Source: SA-Bexar MPO, TxDOT, SAWS, CPS, and BexarMET, City of San Antonio, and Bexar County
Difference between Construction Default and Updated Spatial Allocation, (tons of NOx/day), 2005

Plot Date: March 5, 2007
Map Compilation: Feb. 27, 2007
Photochemical Model

• AACOG developed a Comprehensive Air Quality Model with Extensions (CAMx) photochemical model simulating the high-ozone episode that occurred between September 13th and 20th, 1999.

• The model was updated with the latest emission inventory for 2005.

• Two model runs performed for construction equipment:
  1. Default spatial allocation
  2. Updated spatial allocation

• Construction equipment emissions and activity were constant between the two runs.

• When the updated spatial allocated construction equipment emissions were put into the photochemical model, there was a significant impact on ozone formation.
Impact of the Updated Spatial Allocated Construction Equipment on Peak Ozone Formation at Selected CAMS station.

<table>
<thead>
<tr>
<th>CAMS Station</th>
<th>Change in 8-hour ozone average, 2005 (ppb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wednesday Sept. 15</td>
</tr>
<tr>
<td>CAMS 58</td>
<td>0.09</td>
</tr>
<tr>
<td>CAMS 23</td>
<td>0.18</td>
</tr>
<tr>
<td>CAMS 59</td>
<td>0.06</td>
</tr>
<tr>
<td>CAMS 678</td>
<td><strong>0.44</strong></td>
</tr>
</tbody>
</table>
Difference of Layer One Ozone, 8-hour Average, (Construction - Default)

Sept. 15, 2005

Min: -0.50 at (37.71), Max: 0.61 at (38.72)

Sept. 16, 2005

Min: -0.99 at (27.69), Max: 0.48 at (38.72)
Difference of Layer One Ozone, 8-hour Average, (Construction - Default)

Sept. 19, 2005 (Sunday)

Min: -0.15 at (32,70), Max: 0.50 at (31,44)

Sept. 20, 2005

Min: -0.97 at (37,71), Max: 1.16 at (27,84)
Summary

- By separating construction equipment into 25 categories and updating the spatial allocation, the emission inventory was improved.
- The greatest increase in peak hour 8-hour ozone average was 0.44 ppb. and the greatest decrease was -0.16 ppb.
- Updating the spatial allocation of other emission inventory categories could impact the prediction of ozone concentrations in photochemical models.
Difference of Layer One Ozone, 8-hour Average, (Construction – Default)

Sept. 17, 2005

Min = -0.94 at (27.66), Max = 0.44 at (27.65)

Sept. 18, 2005

Min = -0.22 at (27.66), Max = 0.39 at (29.44)
Percent Difference between Construction Default and Updated Spatial Allocation, (tons of NOx/day), 2005

Plot Date: March 5, 2007
Map Compilation: Feb. 27, 2007