Oil & Gas-Related Vehicle Traffic and Emissions Inventories

By Lisa Silva and Rose Waldman
Roadway Emission Inventories

- APCD captures O&G traffic on: highways, county roads, other public streets, but does not disaggregate from other traffic.
- Traffic on private land and leased public lands (BLM, USFS) not captured by APCD/EPA – likely a significant omission in inventories.
- Satellite photos show extensive roadway networks in O&G patches.
Studies indicate significant traffic

- Studies indicate significant traffic, but specifics are not directly comparable (apples to oranges)
  - UDOT On-Highway study (2006) *apples*
  - CDOT On-Highway counts (2008) *crabapples*
  - Piceance Basin Pilot (2011) *oranges*

- We will discuss these 3 studies and what they contribute to our knowledge

- We’ll also recommend areas for future study.
Apples, oranges

• UDOT and CDOT study interest: documenting increased O&G traffic and roadway damage, establishing infrastructure needs
  – UDOT looked at HDD traffic on state and federal highways
  – CDOT looked at all types of vehicle traffic on state and federal highways

• Piceance Basin Pilot Project (P3) interest: traffic and air pollutant emissions associated w/ O&G development.
UDOT Study: “Highway Freight Traffic Associated with the Development of Oil and Gas Wells”

Found range of 375 to 1,375 HDD truck trips per well under development.

<table>
<thead>
<tr>
<th>Load</th>
<th>Number of HDD truck trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction equipment</td>
<td>10 to 45</td>
</tr>
<tr>
<td>Drilling rig</td>
<td>30</td>
</tr>
<tr>
<td>Fresh water</td>
<td>100 – 1,000</td>
</tr>
<tr>
<td>Drill mud</td>
<td>10-20</td>
</tr>
<tr>
<td>Frac sand, frac tanks</td>
<td>26</td>
</tr>
<tr>
<td>Cement powder</td>
<td>2-5</td>
</tr>
<tr>
<td>Completion rig water</td>
<td>100</td>
</tr>
<tr>
<td>Completion rig equipment</td>
<td>30-35</td>
</tr>
<tr>
<td>Explosives</td>
<td>1</td>
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</tbody>
</table>
UDOT Study: “Highway Freight Traffic Associated with the Development of Oil and Gas Wells”

- Post-completion HDD truck trips for general maintenance: Between 24 and 40 HDD truck trips every 3 to 5 years.

- Smaller (light duty) trucks that also visit/maintain wells (in-field traffic) were not included in the study.
CDOT Study 2008

• O&G-related trips (all vehicle types) in NE Colorado
  – (I-70, U.S. 40 and State Highways 64, 13, 6, 65, 139, 330, 92, 133, 141)
• Road damage from HDD/oversize, overweight
  – Severe rutting, e.g.
• Safety issues (no shoulders on many roads)
• Greatly increased congestion
• Used average of 900 trips per well.
900 trips x anticipated 20,000 new wells in area = 18 million truck loads in CDOT Region 3

• 18 wheel truck = 5,440 passenger cars

• 18 million trucks x 5,440 = 97 million cars worth of damage between 2008 and 2010

$700 million needed to construct standard shoulders in R3 alone.
Severe Rutting due to heavy loads
Piceance Pilot Project (P3) Study 2011 Overview

• Primary purpose to develop oil and gas mobile source emission inventory for Piceance Basin
• Unit-level emission factors developed that may be applicable to other basins
• Major on-road and non-road mobile source activity associated with well pad construction, drilling, completion, production, and maintenance activities
• Focused on in-field activities
P3 Study – Geographic and Temporal Scope

- Study focuses on Piceance Basin in NW Colorado including Chaffee, Delta, Eagle, Garfield, Gunnison, Lake, Mesa, Moffat, Pitkin, Rio Blanco and Routt Counties
- Basin contains primarily conventional gas and conventional oil production in 2009
- Gas production focused on Garfield County; oil production focused on Rio Blanco County
- P3 study considers activities in calendar year 2009 – latest year for which detailed data was available
P3 Study – Geographic Scope

In-Field vs. Total Trip

- In-field refers to travel on mostly unpaved roadways within oil and gas fields (majority are not public roadways)
- Restriction to in-field in P3 due to difficulty in reconciling mobile source activity and emissions with existing traffic counts and county-level mobile source inventory in CO
P3 Study Progression

• Surveys completed by 3 major oil and gas producers in Piceance Basin
• Field verification
• Survey data aggregated to determine inventory in Piceance
• Emission factors derived using models to apply survey results to other basins
### P3 Study – Results

<table>
<thead>
<tr>
<th>County</th>
<th>NOx (tons/yr)</th>
<th>CO (tons/yr)</th>
<th>Total VOC (tons/yr)</th>
<th>SOx (tons/yr)</th>
<th>Total PM10 (tons/yr)</th>
<th>Fugitive Dust PM10 (tons/yr)</th>
<th>Total PM2.5 (tons/yr)</th>
<th>Fugitive Dust PM2.5 (tons/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Garfield</td>
<td>758</td>
<td>325</td>
<td>61</td>
<td>14</td>
<td>6,273</td>
<td>6,226</td>
<td>1,505</td>
<td>1,460</td>
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<td>Gunnison</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>2</td>
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<td>Mesa</td>
<td>67</td>
<td>30</td>
<td>6</td>
<td>1</td>
<td>657</td>
<td>652</td>
<td>158</td>
<td>154</td>
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<tr>
<td>Moffat</td>
<td>42</td>
<td>18</td>
<td>3</td>
<td>1</td>
<td>380</td>
<td>377</td>
<td>91</td>
<td>89</td>
</tr>
<tr>
<td>Rio Blanco</td>
<td>185</td>
<td>81</td>
<td>15</td>
<td>3</td>
<td>1,695</td>
<td>1,684</td>
<td>408</td>
<td>397</td>
</tr>
<tr>
<td>Routt</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>23</td>
<td>23</td>
<td>6</td>
<td>5</td>
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<tr>
<td>Totals</td>
<td>1,055</td>
<td>455</td>
<td>86</td>
<td>19</td>
<td>9,039</td>
<td>8,974</td>
<td>2,171</td>
<td>2,109</td>
</tr>
</tbody>
</table>

- Emissions represent within-field activities – emissions not developed for total trips for on-road vehicles
- Emissions concentrated in Garfield and Rio Blanco counties where most gas and oil production, respectively occur
- PM emissions large in magnitude and dominated by fugitive dust (not tailpipe)
Summary of NOx Emissions Contribution by Source Category

- Other Relocatable Equipment: 54.2%
- Maintenance Operation Equipment: 15.1%
- Refracing Equipment: 6.4%
- Employee Commuter Traffic - Running: 3.2%
- Employee Commuter Traffic - Idling: 0.8%
- Production Traffic - Running: 0.8%
- Production Traffic - Idling: 0.3%
- Production Traffic: 0.2%
- Refracing Equipment: 6.4%
- Employee Commuter Traffic: 8.8%
- Frac ing Equipment: 10.2%
- Others: 8.8%
Summary of Total VOC Emissions Contribution by Source Category

- Other Relocatable Equipment: 51.4%
- Maintenance Operation Equipment: 13.7%
- Fracing Equipment: 6.2%
- Others: 10.4%
- Refracing Equipment: 5.0%
- Production Traffic - Running: 2.0%
- Production Traffic - Idling: 0.6%
- Maintenance Operation Traffic - Running: 0.4%
- Employee Commuter Traffic - Running: 8.3%
- Employee Commuter Traffic - Idling: 1.9%
Summary of Total PM10 Emissions Contribution by Source Category

- Employee Commuter Traffic - Running: 96.5%
- Others: 2.1%
- Maintenance Operation Equipment: 0.4%
- Other Relocatable Equipment: 0.4%
- Production Traffic - Running: 0.5%
P3 Study Limitations

Limited field verification
• Conducted at two sites
• Observed three activities
• Did not attend for full period of activity
• Verified each activity type only once
P3 Study Limitations (continued)

Limited in scope

• Considered only E&P activities, not mid-stream
• Limited number of survey respondents
• One basin; applicability to other basins may be limited
• Did not consider total trip emissions
• Difficult to reconcile with existing state-wide mobile source inventories
P3 Study Conclusions

• For most criteria pollutants, mobile sources are not large portion of emissions from O&G sector compared to point and area sources
  – Mobile PM10 at 91% (driven by fugitive dust)
  – Nox at 6%, CO at 4%, VOC <1%
  – Caveat: compare 2009 mobile inventory to projected 2009 point/area source inventory

• Future studies should improve on limitations from this study
Increasing Knowledge, Remaining Questions - O&G Traffic and Emissions

• On-road studies suggest considerably more trips per well than found in P3 study

• P3 Study suggests mobile source PM$_{10}$ (reintrained road dust) significant component in overall P-Basin air pollutants.

• Unclear whether P3 emission factors can be applied beyond Piceance Basin.
Information gaps

- Mid-stream (e.g., dehydrator servicing), refining operations, truck transport of product not counted
- Need updated Utah highway information
- No in-field Uintah Basin traffic and non-road data (to compare to P3)
- Only 3 companies out of >100 operators and service providers on list participated in P3 survey
- Somewhat cursory field verification-(P3).
Recommendations (p.1)

• Follow up on UDOT highway study (same Uintah area) to discover whether trips per well have are similar to 2006 findings

• Follow up on CDOT highway study focusing on Colorado highways serving Denver/Julesburg and other Colorado Basins

• Gather *in-field* information regarding at least two additional Colorado Basins (see Slide 3 map), including Denver/Julesburg
  » Request participation from additional companies/perhaps with different approach
  » Improve field verification
  » Highlight *water availability* in each case
  » Determine number of trips per well in addition to annual VMT per well, spud, etc.
Recommendations (p.2)

• Attempt to disaggregate on-highway O&G traffic from other

• Reconcile data with actual 2009 point and area source inventory information....

• Other suggestions welcome.