Appendix C

Final Report of the

Area Source Work Group

of the NOACA Air Quality Public Advisory Task Force

(Ozone)
NOACA Air Quality Public Advisory Task Force

Area Source Work Group

Final Report – 8-Hour Ozone Options

“Driving Toward Economic and Environmental Sustainability for Northeast Ohio”

March 29, 2006
Contributions to this Report

This Report could not have been compiled without the dedicated assistance of the following, who have all been part of the greater “team.”

Amy Wainright, NOACA
Pamela Davis, NOACA
John Beeker, PhD, NOACA
Mary Wells, NOACA
Bill Davis, NOACA
Ted Esborn, McDonald Hopkins, Chair
Bob Farley, Team NEO
Ed Fasko, Ohio EPA – Northeast District Office
Rick Harkins, Lake Carriers’ Association
David Hearne, City of Cleveland, Division of Air Quality
Stephen Pfeiffer, Cleveland-Cuyahoga County Port Authority
Dana Ryan, Cleveland Hopkins Airport
Linda Sekura, NASA-Glenn
JoAnn Uhlik, Greater Cleveland Partnership
Karen Dzienkowski, Railpower Technologies, Inc.
Ron Buck, Green Energy Technologies, Inc.
Bill Spires, Ohio EPA
Alan Harness, Ohio EPA
Lee Burklea, Ohio EPA
Dr. Jennifer Dunn, USEPA, Region 5
The Ohio Rail Development Commission
USEPA SmartWay
LADCO and Environ
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I. Executive Summary

The Area Source Work Group of the NOACA Air Quality Public Advisory Task Force reports the following significant potential options for achieving attainment of the 8-Hour Ozone NAAQS in Northeast Ohio:

AR-1 Anti-Idling Policy at the Port of Cleveland
AR-2 Ground Support Equipment (GSE) Replacement with Electric, CNG, or Hydrogen
AR-3 Anti-Idling Policy at Cleveland-Hopkins International Airport
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In addition, multiple issues were identified for further study.
II. Introduction

The NOACA Air Quality Public Advisory Task Force established Work Groups for Mobile Sources, Point Sources, Area Sources, Long-Term Planning Options, and a Public Health Forum on air pollution. Together, these Work Groups have assisted the Task Force in creating options for recommendations to the Ohio Environmental Protection Agency (Ohio EPA) for inclusion in the State Implementation Plan (SIP) for the new 8-Hour Ozone National Ambient Air Quality Standards (NAAQS). They will continue by assisting with the SIP for the new NAAQS for fine particulates (PM$_{2.5}$), thus helping Northeast Ohio to come into attainment for these criteria air pollutants.

The Task Force and the Work Groups together will help NOACA to assist the region to protect public health and to comply with federal law.

In addition, they will assist NOACA and Northeast Ohio to plan for future growth, economic viability, and environmental sustainability. The Work Groups have carefully weighed the many advantages and disadvantages of each proposed strategy.

Consequently, this forward-looking document is intended to provide not only creditable SIP measures for Ohio EPA to include, but also “weight of evidence” measures, as described by USEPA’s Phase II Ozone Implementation Rule, to show the good faith of the citizens of Northeast Ohio in moving forward toward clean air and better quality of life.

A. Scope of Work

The Area Source Work Group explored potential emission reduction options for sources of air pollution associated with:

- airplanes, airports, their ground support vehicles and their passenger traffic
- railroads, their traffic, their switchyards and their loading equipment
- commercial marine vessels, their truck traffic and their loading equipment
- recreational boats, jet skis, snowmobiles, and other recreational vehicles
- construction equipment
- industrial equipment such as forklifts and tow motors
- all other nonroad engines, such as lawnmowers and landscaping equipment

Sources of air pollution that belong to small industrial sources, although commonly referred to as “area sources,” were covered by the Point Source Work Group, as was air pollution resulting from residences and consumer activity.

This Draft Final Report represents all options discussed to meet the 8-hour ozone standard. No recommendations are made, and all potential solutions are covered, along with their estimated impacts. It is anticipated that the Task Force will choose from among these options.
Note: Because the Draft Final Report does not discuss PM$_{2.5}$ solutions, some options such as the use of alternative fuels will be re-visited during the Work Group's efforts on PM$_{2.5}$.

B. Area Source Work Group Membership

The Area Source Work Group is made up of the following, supplemented by public participants with knowledge and expertise in the areas under study:

Ted Esborn, McDonald Hopkins, Chair
Bob Farley, Team NEO
Ed Fasko, Ohio EPA – Northeast District Office
Rick Harkins, Lake Carriers’ Association
David Hearne, City of Cleveland, Division of Air Quality
Stephen Pfeiffer, Cleveland-Cuyahoga County Port Authority
Dana Ryan, Cleveland Hopkins Airport
Linda Sekura, NASA-Glenn
JoAnn Uhlik, Greater Cleveland Partnership

C. Meetings

The Area Source Work Group met on:

- September 19, 2005
- October 11, 2005
- November 28, 2005
- January 23, 2006

each time at NOACA's offices. The Work Group also met on February 1, 2006, at the Cuyahoga River for a tour of the marine vessel "FRED R. WHITE," an ore carrier, which was docked there for diesel engine maintenance work.

D. Evaluation Criteria

The Work Group assessed the options using the Evaluation Criteria established by the full Task Force on July 25, 2005. Those Criteria are as follows:

- Quantifiable
- Enforceable
- VOC Reductions in Tons Per Day
- NOx Reductions in Tons Per Day
- Technically Possible
- Successful Implementation Elsewhere
- Require State Legislation/ State Rules/ Local Ordinances
- Costs Per Ton of Pollutant Removed
- Costs in Other Units
- Economic Investment Required
- Economic Benefit or Detriment
- Health Benefit
- Other Benefits or Detriments
- Behavioral Change Required
- 2009 Timing Requirement
- Long-Term Effect
- Additional Comments or Concerns

E. Emissions Inventory

The Work Group reviewed the 2002 Ohio EPA Emissions Inventory for each of the sectors under study.

Marine Vessels
In 2002, according to Ohio EPA, based on USEPA, commercial marine vessels were identified as contributing:

45.3 tpd oxides of nitrogen (NOx)

The data, which represent estimates made by the United States Environmental Protection Agency (USEPA), was questioned as being too high. The estimates were made using Category 3 engines, whereas Lake Erie only has Category 2 engines on lake carriers. Also, fuels that were not as clean-burning as Diesel #2 were used in the calculations, whereas lake carriers burn only Diesel #2.

The Lake Carriers' Association performed a microinventory of the Great Lakes ships for the Port of Cleveland, only. The Association concluded that ships coming to the Port of Cleveland contributed:

0.277 tpd NOx

The number would increase somewhat if the other ports were added to it. However, the Port of Cleveland is the largest in the nonattainment area.

Railroads
According to Ohio EPA, based on USEPA, railroads were identified as contributing:

0.77 tpd VOCs
17.5 tpd NOx

However, work performed by Environ, a subcontractor of the Lake Michigan Air Directors' Consortium (LADCO), determined that railroads in Northeast Ohio contributed:

1.10 tpd VOCs
23.49 tpd NOx
A chart demonstrating the totals for trains appears in the section of the Report on Railroads.

**Airplanes and Airports**
According to Ohio EPA, based on USEPA, aircraft (at large airports only, including no small county airports) contributed:

- **0.55 tpd VOCs**
- **1.86 tpd NOx**

The ground support equipment and vehicles for airports, ports, and railroads were included in the category of Off-Highway Vehicle, Diesel, contributing together, according to Ohio EPA:

- **4.11 tpd VOCs**
- **34.58 tpd NOx**

Some of the ground support equipment and vehicles were also included in the category of Off-Highway Vehicle, Gasoline 4-stroke, which together contributed:

- **19.37 tpd VOCs**
- **6.33 tpd NOx**

A chart showing all of the nonroad equipment, such as ground support equipment, construction equipment, lawnmowers, and others, appears in Appendix A.
III. Emission Reduction Options Under Consideration

A. Marine Vessels, Shipping, and Ports

The Northeast Ohio nonattainment area has several ports:

Port of Cleveland, operated by the Cleveland-Cuyahoga County Port Authority  
Port of Lorain  
Port of Fairport Harbor  
Port of Ashtabula  
Port of Conneaut

Port of Cleveland  
The vast majority of international shipping activity occurs at the Port of Cleveland. The Lakeside Port facilities include 8 international docks covering 100 acres on the east side of the Cuyahoga River and a 45-acre facility, the Cleveland Bulk Terminal, located on Whiskey Island. Private dock facilities on the Cuyahoga River receive the majority of the interlake bulk cargoes.

The Port of Cleveland averages 12.5 million tons of cargo per year, which includes 700,000 tons of international cargo. The remaining tonnage is interlake bulk cargo.

Shipments at the Port of Cleveland include iron ore, limestone, steel, heavy machinery, cement, sand, and slat in support of local manufacturing and construction. The Port currently handles no container traffic; that cargo moves through the East and West Coast ports of the United States because of vessel size restrictions on the St. Lawrence Seaway.

The interlake vessels that call Cleveland are self-unloading bulk carriers and therefore do not require shore-side equipment for discharge.

International vessels carrying steel and machinery require shore cranes for unloading and lift machines for handling. The Port of Cleveland has 26 diesel fork lift machines and 4 shore cranes for handling cargo. Both the cranes and the lift machines were retrofitted in December 2005 with particulate matter filters.

Truck traffic on the Port facilities on the lakefront appears to generate significant air emissions. The number of truckloads annually is 60,000. At the bulk-handling facilities on the Cuyahoga River, large front-end loaders move the cargo to truck. That volume is approximately 300,000 truckloads based on the totals of stone, cement, and sand moved. Iron ore goes directly into steel production, not to truck. Salt moves from the mine directly onto the vessel.

In 2005, 959 ship-visits (port calls) were made to the Port of Cleveland.
Most of the lake carriers on Lake Erie use diesel locomotive engines (Category 2 - EMD 645) and burn # 2 diesel oil. Bunker "C" oil is not used. The lake carriers can have a lifetime up to 60 years, with consistent diesel engine maintenance.

However, the average age of international ships ("salties") in 2002 was 15 years, but the average age in 2005 was only 8 years. Improvements in the form of new engine designs have been made for international ships. Of the 959 port calls, approximately 100 each year are from international ships.

**Port of Lorain**
A small amount of domestic tonnage is handled at the Port of Lorain. The Port handles only a few international vessels annually. Interlake bulk tonnage include iron ore, limestone, cement, and gypsum.

**Port of Fairport Harbor**
Some shipping is done through the Port of Fairport Harbor, particularly involving sand and gravel, as well as salt. No international cargo goes through the Port.

**Port of Ashtabula / Port of Conneaut**
The Port of Ashtabula handles international bulk cargo movements and some international general cargo. Interlake tonnages of coal, stone, iron ore, etc., make up the majority of the tonnage. The Port has significant shipping traffic but little opportunity for improvements to loading equipment. The loading equipment does not include forklifts, but instead uses equipment that deposits cargo directly into rail cars.

**Marine Vessel Air Pollution Reduction Options**

**Docking Practices**
Docking practices such as port electrification, known as “cold-ironing,” were discussed as valuable in large ports that serve container ships and cruise vessels. However, the Work Group did not study cold-ironing further for Northeast Ohio because of the extremely large costs associated with installing cold-ironing equipment at the ports, and the limited benefit received. Lake carriers, unlike ocean-going vessels or cruise ships, dock for only 4-6 hours at a time.

**Engine Design**
As stated above, the Port of Cleveland handles approximately 900 commercial ship arrivals (port calls) per year with approximately 100 of those ships being international in origin. Ocean-going ships have a shorter life than the domestic Great Lakes vessels, thus their engines are generally newer and have more current air emission technology features. Also, USEPA has issued more stringent air emission requirements for all marine diesel engines, but it is unlikely that Great Lakes vessels will be replaced or re-engined with the newer diesel engines in the near future. In addition, the supporting tugboats are unlikely to be replaced.
Engine retrofit technologies were explored by the Work Group for emission reduction benefits. A tour of an ore carrier was made to view the diesel engines and the hold in which they are housed. Very little room exists in the hold of the ship for additional pollution controls. **Retrofitting would be very expensive in such lake carriers.**

The following chart, taken from "The Need to Reduce Marine Shipping Emissions: A Santa Barbara County Case Study" by the Santa Barbara County, CA, Air Pollution Control District, shows various retrofit control technologies that could be installed on large vessel engines:

<table>
<thead>
<tr>
<th>Control Technology</th>
<th>Nominal NOx Reduction (%)</th>
<th>Nominal Reduction in PM and other Pollutants (%)</th>
<th>Nominal Increased Fuel Use (%)</th>
<th>Net Present Value ($)</th>
<th>Global Cost Effectiveness ($/ton NOx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aftercooler upgrade</td>
<td>10</td>
<td>-1</td>
<td>2</td>
<td>$184,000</td>
<td>$620</td>
</tr>
<tr>
<td>Engine derating</td>
<td>14</td>
<td>-10</td>
<td>4</td>
<td>$386,000</td>
<td>$933</td>
</tr>
<tr>
<td>Fuel pressure increase</td>
<td>14</td>
<td>-21</td>
<td>2</td>
<td>$220,000</td>
<td>$523</td>
</tr>
<tr>
<td>Injector upgrade</td>
<td>16</td>
<td>-21</td>
<td>2</td>
<td>$192,000</td>
<td>$410</td>
</tr>
<tr>
<td>Injection timing Retard</td>
<td>19</td>
<td>-11</td>
<td>4</td>
<td>$363,000</td>
<td>$618</td>
</tr>
<tr>
<td>Water in combustion air</td>
<td>28</td>
<td>1</td>
<td>3</td>
<td>$365,000</td>
<td>$468</td>
</tr>
<tr>
<td>Exhaust gas recirculation</td>
<td>34</td>
<td>-51</td>
<td>0</td>
<td>$16,900,000</td>
<td>$16,377</td>
</tr>
<tr>
<td>Water/fuel emulsion</td>
<td>42</td>
<td>15</td>
<td>2</td>
<td>$325,000</td>
<td>$284</td>
</tr>
<tr>
<td>Selective catalytic reduction</td>
<td>81</td>
<td>0</td>
<td>0</td>
<td>$475,000</td>
<td>$227</td>
</tr>
</tbody>
</table>

The issue of possible particulate matter filters will be re-visited during the PM$_{2.5}$ SIP development work.

**Fuels**

Commercial ships generally use diesel fuel. The use of low-sulfur diesel will result in particulate matter emission reductions. Beginning in 2007, all diesel fuel sold for marine use must meet USEPA low-sulfur requirements. The Work Group will review the subject during the PM$_{2.5}$ SIP development work.

The Work Group explored the possibility of using either an emulsified diesel fuel (PuriNOx by Lubrizol) or using biodiesel.

a. **PuriNOx**

Each lake carrier, when re-filling with fuel, takes on approximately 85,000 gallons. There is no ability to build a PuriNOx blender that would hold the amount of fuel necessary to fill ships.
In fact, no ships re-fuel in Northeast Ohio because all fueling stations must be located at petroleum refineries, due to the large quantity needed. Some re-fuel in Canada and some re-fuel further down the Great Lakes.

b. Biodiesel
The Work Group noted that Minnesota currently requires 2% biodiesel for all diesel users except railroads. Marine vessel shipping associations are lobbying for a repeal of the requirement. Anecdotes relate that biodiesel may clog the engines. More importantly to marine vessel owners, the diesel engine manufacturers have informed them that changes to any alternative fuel will void the engine warranty. A diesel engine overhaul for routine maintenance can cost $600,000 each time it is performed.

Finally, as with PuriNOx, there is no re-fueling in Northeast Ohio. Thus, there is no opportunity to require marine vessels to use biodiesel when visiting Northeast Ohio.

Changes in Shipping Procedures
Changes in local shipping procedures showed marginal reductions in emissions. In 2003, a pellet terminal was relocated from the Lorain Port to the Cleveland Port, which resulted in a change in shipping traffic—now one large ship brings the ore pellets to the Cleveland port and smaller ships move the pellets upstream. Prior to the relocation, smaller ships were required to travel from Cleveland to Lorain and back to pick up the pellets. Representatives from the Cleveland Port Authority and the Lake Carriers Association believe that 8-12 ship running hours were saved for each cargo delivered, using the Cuyahoga River, to the steel mill.

Speed Reduction
No emission reduction benefits were available from a speed limit in the Lake Erie shipping lane because the "Reduced Speed Zone (RSZ)" already extends several miles out into Lake Erie. The ships slow voluntarily as they are approaching port in order to control the vessel.

Loading Equipment
The Cleveland Port utilizes 26 forklifts and 4 cranes to perform loading and unloading operations, each of which uses diesel fuel. The forklifts were retrofitted with particulate matter filters in 2006. However, no alternative fuels such as biodiesel or PuriNOx are in use by the loading equipment.

Any emissions reductions from an alternative fuel would be extremely small due to the very small number of equipment pieces affected.
Anti-Idling Policy at the Port of Cleveland

The Port of Cleveland handles approximately 360,000 truckloads per year, with some trucks idling more than 45 minutes because of long lines for loading. The trucks carry an estimated 10 million tons of cargo per year. Private companies utilizing the port also support large numbers of truckloads per year.

An "anti-idling policy" would reduce NOx emissions associated with the trucks serving the ports. Such a policy would have to be mandatory for all vehicles within the affected area, such as the City of Cleveland, Cuyahoga County, Ashtabula Township, etc. An "anti-idling policy" could even be a statewide law.

Option AR-1
Air Impacts: For purposes of this Report:
Assume 360,000 truckloads annually, or 986 per day.
Assume idling of 30 minutes per truck.
986 trucks x 30 minutes = 29,589 idling minutes per day
0.06 grams/minute VOCs x 29,589 minutes = 1,775 grams = 0.003 tpd VOC
0.59 grams/minute NOx x 41,100 minutes = 16,867 grams = 0.027 tpd NOx
0.002 tpd VOCs reduced
0.019 tpd NOx reduced

(Source of emissions factors for idling: NOACA generated emissions factors in grams/mile for various vehicles at various speeds, based on Mobile 6.2 for the summer of 2009. The emissions factors were then converted from grams/mile to grams/minute, using the slowest speed - 2.7 mph - generated by Mobile 6.2, which has no "idling" speed. For a comparison with 1998 idling emission figures, see USEPA's "Idling Vehicle Emissions" EPA420-F-98-014, April 1998. The USEPA emission factors show even greater reductions because 1998 vehicles were considered, rather than 2009 vehicles.)

Cost: Enforcement and education costs. The measure saves fuel for the truckers.

Finally, the Port Cleveland-Cuyahoga County Authority utilized Congestion Mitigation Air Quality (CMAQ) monies in 2002 to eliminate a truck traffic jam at East 9th Street, from which marginal air pollution reductions also resulted.
B. Aircraft and Airports

The Northeast Ohio nonattainment area has 26 airfields of various sizes. Of those, only 2 were accounted for in the 2002 emissions inventory provided by Ohio EPA (Cleveland-Hopkins International Airport and the Akron-Canton Regional Airport). The remaining 24 small airfields and their aircraft were not included. The Cleveland-Hopkins International Airport represents approximately 75% of the air emissions in the area associated with airports.

The Work Group noted that the Ohio EPA emissions associated with jet aircraft were probably correct in that jet fuel burns more efficiently than other fuels. However, there were no figures for the gasoline-powered small aircraft. Potential options regarding these airfields are discussed below.

The ground support equipment at Cleveland-Hopkins International Airport consists of hundreds of pieces of diesel and gasoline-powered baggage carts, service vehicles, etc. In addition, customer, taxi, and bus idling practices at the Airport were studied for possible reductions.

Controls at Small Local Airfields
There are significant numbers of take-offs and landings at the 24 small local airfields. However, many of the smaller aircraft burn AvGas, which is 100-octane gasoline approved by the Federal Aviation Administration. It was unlikely that such aircraft could burn an alternative summertime fuel, such as low-RVP 7.8 psi gasoline, that might be recommended for cars in the nonattainment area.

The Work Group determined that there might be some benefit to adopting the Florida approach of establishing a fine for dumping gasoline on the ground at an airfield. Because a 2-ounce sample must be taken from the tank before each flight, some pilots may be spilling it onto the ground after examining it for water. Gasoline collection containers would have to be provided.

Air Impact: Approximately 0.00 tpd VOCs reduced

Cost: $2,400 ($100 per dump tank multiplied by 24 airfields)

Cost per ton of VOC reduced: Unknown.
According to USEPA, aircraft ground support equipment (GSE) represents one of three groups of mobile emission sources at airports. Together with aircraft and ground access vehicles, GSE contribute a small but significant share of VOCs, NOx, and particulate matter (PM) emitted in metropolitan statistical nonattainment areas. Total emissions from these three source categories comprise on the order of 2-3% of total manmade emissions in a typical metropolitan area, but this share is expected to increase as air travel continues to grow while emissions from other, non-airport sources are subject to increasingly stringent controls.

According to USEPA, ground access vehicles such as passenger cars and buses just entering and leaving airports often exceed airplanes as the dominant sources of air pollution at airports. Nationally, ground access vehicles emit 56% of VOCs, while aircraft taking off and landing give off only 32.6% (including emissions from Auxiliary power units (APUs)). Ground access vehicles emit 39.3% of NOx, trailing closely behind emissions by aircraft and APUs of 46.3%. Ground service equipment is responsible for 10.9% of airport-generated VOCs and 14.3% of NOx nationally, according to the EPA.

Emission reduction options include:

- The replacement or conversion of gasoline or diesel powered GSE to LPG or CNG
- Fueling
- The replacement or conversion of gasoline, diesel, LPG, or CNG powered GSE to electric power
- The replacement of mobile GSE with electrically powered fixed gate-based equipment
- The retrofit of existing GSE with catalytic converters or particulate traps
- The preferential replacement of existing two-stroke gasoline engines

At Cleveland-Hopkins International Airport, approximately 300 ground support vehicles were reported to be in use. Some operate on gasoline and some on diesel. Approximately 100 are municipally owned and might be candidates for substitution with electric vehicles, CNG vehicles, or hydrogen vehicles, if a funding source such as CMAQ dollars were identified.

Option AR-2
Air Impact:
Assume 100 ground support vehicles replaced with electric
According to Ohio EPA emissions inventory (Appendix A), the VOC and NOx emissions are essentially zero when rounded off to 2 decimal places.
VOCs reduced - Negligible.
NOx reduced - Negligible.
Cost: Not yet estimated because the figure depends on the types of GSE to be replaced.

The federal Voluntary Airport Low Emissions Program (VALE) also contains funding for the incremental cost of a "clean air" technology, over the cost of an ordinary diesel or gasoline-powered vehicle. It also can fund gate electrification and other air quality improvements. The Airport may apply to become a VALE participant in the next round of federal funding.

The Work Group heard a presentation by Green Energy Technologies Inc., which intended to place a demonstration “Smart Energy Tower” at Cleveland-Hopkins International Airport. However, the company did not obtain grant funding for construction.

The following USEPA charts show potential VOC reductions associated with airport grounds support equipment:
<table>
<thead>
<tr>
<th>GSE Type</th>
<th>Engine Type</th>
<th>Estimated U.S. Population</th>
<th>Fraction of All GSE</th>
<th>Fraction of Type Specific GSE</th>
<th>Estimated Fraction of All GSE HC</th>
<th>Convert to LPG Fueling</th>
<th>Convert to CNG Fueling</th>
<th>Replace with LPG Equipment</th>
<th>Replace with CNG Equipment</th>
<th>Retrofit with EV Equipment</th>
<th>Retrofit with OXY Catalyst</th>
<th>Retrofit with PM Trap</th>
<th>Replace with Fixed &quot;At Gate&quot; Equipment</th>
<th>Replace with 4-St Gasoline Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft</td>
<td>Diesel</td>
<td>2113</td>
<td>4.3%</td>
<td>76.6%</td>
<td>3.4%</td>
<td>n/a</td>
<td>n/a</td>
<td>up 135</td>
<td>up 55</td>
<td>96</td>
<td>50</td>
<td>20</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Pushback</td>
<td>2-str Gas</td>
<td>0</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>50</td>
<td>65</td>
<td>50</td>
<td>65</td>
<td>99+</td>
<td>90</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Tractor</td>
<td>4-str Gas</td>
<td>489</td>
<td>1.1%</td>
<td>17.7%</td>
<td>2.2%</td>
<td>n/a</td>
<td>35</td>
<td>n/a</td>
<td>n/a</td>
<td>98</td>
<td>70</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>LPG</td>
<td>63</td>
<td>0.1%</td>
<td>2.3%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<td>n/a</td>
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<tr>
<td>Electric</td>
<td>94</td>
<td>0.2%</td>
<td>3.4%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>n/a</td>
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<td>5.8%</td>
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### TABLE 1. POTENTIAL HC REDUCTION STRATEGIES FOR AIRPORT GSE
(Continued)

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<th>GSE Type</th>
<th>Engine Type</th>
<th>Estimated U.S. Population</th>
<th>Fraction of Type Specific GSE</th>
<th>Estimated Fraction of All GSE HC</th>
<th>Convert to LPG Fueling</th>
<th>Convert to CNG Fueling</th>
<th>Replace with LPG Equipment</th>
<th>Replace with CNG Equipment</th>
<th>Replace with EV Equipment</th>
<th>Retrofit with Oxy Catalyst</th>
<th>Retrofit with PM Trap</th>
<th>Replace with Fixed &quot;At Gate&quot; Equipment</th>
<th>Replace with 4-Str Gasoline Equipment</th>
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<td>99+</td>
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1. Unqualified and unqualified values signify emission reductions (in percent). Values preceded by the qualifier "up" signify emission increases (in percent).

2. Emission reductions due to replacement with EV equipment can vary with the emissions performance of local power generating stations. The tabulated values represent "typical" or "average" power generating station emission rates. For HC, the range of emissions variability across U.S. power generating stations is not dramatic and the tabulated emission reduction percentages will be affected by only a few percentage points regardless of local conditions.

3. In addition to the potential for direct replacement of some GSE services, fixed, gate-based systems such as electrical power and conditioned air also potentially reduce aircraft auxiliary power unit (APU) emissions by 70-90 percent and emissions from (non-tabulated) GSE-based air conditioning service equipment by nearly 100 percent. Of the tabulated GSE, ground power unit (GPU) replacement is most feasible, with baggage tug and belt loader replacement quite difficult in retrofit applications.
<table>
<thead>
<tr>
<th>GSE Type</th>
<th>Engine Type</th>
<th>Estimated U.S. Population</th>
<th>Fraction of All GSE</th>
<th>Estimated Fraction of Type Specific GSE</th>
<th>Convert to LPG Fueling</th>
<th>Convert to CNG Fueling</th>
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<th>Replace with CNG Equipment</th>
<th>Replace with EV Equipment</th>
<th>Retrofit with Oxy Catalyst</th>
<th>Retrofit with PM Trap</th>
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### TABLE 3. POTENTIAL NO₂ REDUCTION STRATEGIES FOR AIRPORT GSE (Continued)

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<th>Estimated Fraction of All GSE NO₂</th>
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<th>Convert to CNG Fuelling</th>
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<th>Replace with CNG Equipment</th>
<th>Replace with EV Equipment</th>
<th>Retrofit with Oxy Catalyst</th>
<th>Retrofit with PM Trap</th>
<th>Retrofit with Fixed &quot;At Gate&quot; Equipment</th>
<th>Replace with 4-Str Gasoline Equipment</th>
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1. Unsigned and unqualified values signify emission reductions (in percent). Values preceded by the qualifier “up” signify emission increases (in percent).

2. Emission reductions due to replacement with EV equipment can vary with the emissions performance of local power generating stations. The tabulated values represent “typical” or “average” power generating station emission rates. For NO₂, the range of emissions variability across U.S. power generating stations is dramatic and emission reduction percentages can range, depending on local conditions, from a 182 percent increase through a 91 percent reduction relative to 2-stroke gasoline emissions; a 40-90 percent reduction relative to 4-stroke gasoline emissions; a 20-97 percent reduction relative to LPG emissions; or a 60-99 percent reduction relative to diesel emissions.

3. In addition to the potential for direct replacement of some GSE services, fixed, gate-based systems such as electrical power and conditioned air also potentially reduce aircraft auxiliary power unit (APU) emissions by 70-90 percent and emissions from (non-tabulated) GSE-based air conditioning service equipment by nearly 100 percent. Of the tabulated GSE, ground power unit (GPU) replacement is most feasible, with baggage tug and belt loader replacement quite difficult in retrofit applications.

"-6-"
### TABLE 4. POTENTIAL PM REDUCTION STRATEGIES FOR AIRPORT GSE

<table>
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<tr>
<th>GSE Type</th>
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<th>Fraction of Type Specific GSE</th>
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<th>Replace with CNG Equipment</th>
<th>Replace with EV Equipment</th>
<th>Retrofit with Oxy Catalyst</th>
<th>Retrofit with PM Trap</th>
<th>Replace with Fixed “At Gate” Equipment</th>
<th>Replace with 4-Str Gasoline Equipment</th>
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<td>Replace with Oxy Catalyst</td>
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1. Unqualified and unqualified values signify emission reductions (in percent). Values preceded by the qualifier “up” signify emission increases (in percent).

2. Emission reductions due to replacement with EV equipment can vary with the emissions performance of local power generating stations. The tabulated values represent “typical” or “average” power generating station emission rates. For PM, the range of emissions variability across U.S. power generating stations is dramatic and emission reduction percentages can range, depending on local conditions, from an 80-99+ percent reduction relative to 2-stroke gasoline emissions; a 5000 percent increase through a 98 percent reduction relative to 4-stroke gasoline emissions; a 6000 percent increase through a 98 percent reduction relative to LPG emissions; or a 100 percent increase through a 99+ percent reduction relative to diesel emissions.

3. In addition to the potential for direct replacement of some GSE services, fixed, gate-based systems such as electrical power and conditioned air also potentially reduce aircraft auxiliary power unit (APU) emissions by 70-99 percent and emissions from (non-tabulated) GSE-based air conditioning service equipment by nearly 100 percent. Of the tabulated GSE, ground power unit (GPU) replacement is most feasible, with baggage tug and belt loader replacement quite difficult in retrofit applications.
Anti-Idling Policy at Cleveland-Hopkins International Airport

The topic of idling reductions at the large airports was also studied. Anti-idling practices appeared to have some benefit for ground support vehicles. Further study was needed on whether jets were actually using the "single-engine taxi" that was the recommended practice.

The City of Cleveland is developing an "anti-idling policy" for all city vehicles, which would also apply to city-owned airport vehicles at Cleveland-Hopkins International Airport.

The Airport has already addressed idling from emergency vehicles by providing them with electric "hot start" facilities that allow them to start immediately at any time. In 2006, 23 snow plows will be retired, being replaced with 10 high-speed plows that also have "hot start" technology. Snow plows that currently idle during any snowstorm will no longer be idling.

Taxi and bus idling at Cleveland-Hopkins International Airport also produces air pollution, as well as traffic congestion. A City of Cleveland policy affecting City vehicles would have no impact on such private vehicles. Controlling private vehicle idling would have to be done through a city ordinance affecting all vehicles.

Option AR-3

Air Impact:
To estimate emissions for reducing taxi and bus idling:
Assume 1,500 bus and taxi stops per day at Cleveland-Hopkins International Airport
Assume idling of 10 minutes per vehicle
For 15,000 minutes of idling:
0.005 tpd VOCs reduced
0.001 tpd NOx reduced

Cost: Enforcement and education. Assume hiring 6 additional police officers for $75,000 total salary and benefits per year = $ 450,000.
AR-4 Free Pick-Up/Drop-Off Parking Lot at Cleveland-Hopkins International Airport

At the Akron-Canton Regional Airport, cars performing pick-up and drop-off of passengers are allowed an area of free parking where the cars are not allowed to idle.

A similar lot might be possible at Cleveland-Hopkins International Airport because such cars currently simply circle the airport or park on side roads, idling their engines. For example:

**Option AR-4**

**Air Impact:**
Assume 3,000 private car drop-offs or pick-ups
Assume idling of 30 minutes per vehicle
For 90,000 minutes of idling:
0.028 tpd VOCs reduced
0.007 tpd NOx reduced

**Cost:** Enforcement and education. Assume hiring 6 additional police officers for $75,000 total salary and benefits per year = $ 450,000.
AR-5 Parking Garage - Improved Signage at Cleveland-Hopkins International Airport

Cleveland Hopkins International Airport currently provides 30 minutes of free parking for passenger pick-up/drop-off as an effort to discourage idling practices. Better marketing and signage regarding the free 30 minutes, along with anti-idling enforcement, may result in emission reductions.

Option AR-5
Air Impact: Unknown.
Cost: Cost of signage.
Docking Practices
Gate electrification may be combined with electric GSE at Cleveland-Hopkins International Airport, to the extent it is not already employed. The agreement of the individual airlines would be needed. Continental Airlines owns the largest number of gates at the Cleveland-Hopkins International Airport. The City of Cleveland could own the infrastructure, possibly by purchase with CMAQ dollars.

Providing such infrastructure would enable and encourage the individual airlines to adopt electrification practices.

Engine Design
Airplane companies are gradually transitioning to Stage III jet engines, which have lower emissions, as part of general business practices. As of the date of this Report, substantially all of the aircraft at Cleveland-Hopkins International Airport has changed over to Stage III.
C. Railroads

The Northeast Ohio nonattainment area is served by Norfolk Southern (NS) and CSX for line-haul activities. The area is served by several short-line and industrial railroads that move freight only a few miles. Finally, it is served by Amtrak for passenger travel.

Emission reduction options vary depending on whether the train under discussion is line-haul, short-line, passenger, or a switching locomotive at a switching yard.

Railroad Grade Separation Projects
As reported in the Mobile Source Work Group Draft Final Report, the following emission reductions were seen from the grade separation projects that eliminated the crossing of railroad tracks and roads:

0.000 tpd VOCs reduced
0.003 tpd NOx reduced

Cost: $ 32,390,000

The figures are those reported in the NOACA Transportation Improvement Program.
AR-6  Idling at Railroad Switchyards - Auxiliary Power Units on Switch Yard Locomotives

Anti-idling practices at switching yards may provide significant emission reduction benefits. Several short-line railroads have invested in "hot start" technology to enable switching locomotives to shut off when they are not in use.

There are three significant switching yards in the nonattainment area: Collinwood, Maple Heights, and near Cleveland Hopkins International Airport.

Option AR-6

Air Impact:
USEPA recommends:

- Using mobile auxiliary power units (APUs) (these would provide heat and electricity to the switch yard locomotives (SYLs) during times of rest, rather than continuing to run the engine)

- Install electric-powered heating systems on SYLs (these would connect to the electrical grid and provide energy to operate on-board equipment during times of rest)

Cost: Unknown.

USEPA has promulgated exhaust emission standards for locomotives

- mandates in-use emissions testing
- Only 0.15 percent of a fleet is tested annually
Hybrid Electric Locomotives

Hybrid electric locomotives, some of which are diesel-electric and some of which may be ethanol-diesel (E-Diesel)-electric in the future, are available. Hybrids tend to work best in short-haul situations.

Ordinarily, switch yard locomotives (SYLs) are the oldest locomotives, costing between $20,000 - $50,000 each. They tend to pollute more than newer locomotives.

Option AR-7
Air Impact: Not yet calculated in tons per day.

Cost: Approximately $1,000,000 per hybrid locomotive.

This option will be re-visited during the PM$_{2.5}$ SIP work.
Fuels
Biodiesel fuels may be an alternative fuel option for railroad engines, as may ethanol-diesel (E-Diesel). A local short-line experience with emulsified diesel fuel (PuriNOx) showed that much larger quantities of fuel were needed in comparison to standard diesel.

However, because both biodiesel and E-Diesel do not yet show any benefit for ozone formation, the issue will be re-visited during the PM$_{2.5}$ SIP development work, with a focus on particulate matter emissions.
D. Nonroad Engines

Nonroad sources of VOCs and NOx include many categories, such as:

- Boats
- Jet skis
- Snowmobiles
- Lawnmowers
- Landscaping equipment
- Construction equipment
- Nonroad diesel trucks
- Agricultural tractors
- Logging equipment
- Mining equipment

For a complete list, along with their VOC and NOx emissions, as reported by Ohio EPA for the year 2002, see Appendix A.
AR-8, AR-9, AR-10, AR-11  Diesel Retrofits for Diesel Construction Equipment (Tractors/Loaders/Backhoes)
(Source: "Evaluation of Candidate Mobile Source Control Measures" by Environ for the Lake Michigan Air Directors' Consortium (LADCO) Feb. 28, 2006.)

AR-8  Construction Equipment - Lean-NOx Retrofits
Retrofitting diesel construction equipment such as tractors, loaders, and backhoes, with a lean-NOx catalyst for Tier 0, Tier 1, Tier 2, and Tier 3 show varying levels of NOx reductions, according to LADCO's subcontractor Environ. A Lonestar catalyst was used for Environ's study. An example follows, using the oldest and dirtiest engines, which would be Tier 0:

Option AR-8
Air Impact:
Assume one tractor, loader, or backhoe in Tier 0, 175-300 hp
Assume a useful life of 10 years
NOx reduction in tons/year: 0.28 tpy
NOx reduction in tons/day = 0.0007 tpd
Assume that a fleet of 100 construction equipment vehicles in Tier 0, 175-300 hp in Northeast Ohio were retrofitted:
100 vehicles x 0.0007 tpd = 0.07 tons per day NOx reduced

Cost for 100 vehicles: $2,000,000 (capital cost) plus additional fuel for 10 years

Cost for one vehicle: $20,000 (capital cost) plus additional fuel for 10 years

Cost per ton of NOx removed: $10,542
AR-9        Construction Equipment - Exhaust Gas Recirculation (EGR) plus Diesel Particulate Filters (DPF)
(Source of data: "Evaluation of Candidate Mobile Source Control Measures" by Environ for the Lake Michigan Air Directors’ Consortium (LADCO) Feb. 28, 2006.)

Retrofitting with equipment for exhaust gas recirculation with a diesel particulate filter results in emission reductions. The reductions vary with the model of the equipment and the horsepower that it generates.

Option AR-9
Air Impact:
Assume one tractor, loader, or backhoe in Tier 0, 175-300 hp, retrofitted with EGR + DPF
Assume a useful life of 10 years
NOx reduction in tons/year: 0.21 tpy
NOx reduction in tons/day = 0.0006 tpd
Assume that a fleet of 100 construction equipment vehicles in Tier 0, 175-300 hp in Northeast Ohio were retrofitted:
100 vehicles x 0.0006 tpd = 0.06 tons per day NOx reduced

Cost: $2,300,000 ($23,000 (capital cost) plus additional fuel for 10 years)

Cost per ton of NOx removed: $23,788
AR-10  Construction Equipment - Selective Catalytic Reduction (SCR)
(Source of data: "Evaluation of Candidate Mobile Source Control Measures" by Environ for the Lake Michigan Air Directors' Consortium (LADCO) Feb. 28, 2006.)

Retrofitting with equipment for selective catalytic reduction (SCR) results in emission reductions. The reductions vary with the model of the equipment and the horsepower that it generates.

Option AR-10
Air Impact:
Assume one tractor, loader, or backhoe in Tier 0, 175-300 hp, retrofitted with SCR
Assume a useful life of 10 years
NOx reduction in tons/year: 0.52 tpy
NOx reduction in tons/day = 0.0014 tpd
Assume that a fleet of 100 construction equipment vehicles in Tier 0, 175-300 hp in Northeast Ohio were retrofitted:
100 vehicles x 0.0014 tpd = 0.14 tons per day NOx reduced

Cost: $2,750,000 ($27,500 (capital cost) plus additional fuel for 10 years)

Cost per ton of NOx removed: $7,788
Replacing older engines, such as Tier 0 engines with uncontrolled emissions, with newer engines such as Tier 2 or Tier 3, results in emission reductions.

Option AR-11
Air Impact:

First example - For purposes of this Report:
Assume replacing 100 loaders or backhoes (100-175 hp) Tier 0 with Tier 2 engines
Useful life of 10 years
NOx reduction of 0.21 tons per year x 100 engines = 21 tons per year
NOx reduction of 0.06 tons per day

Cost: $1,375,000 ($13,750 per new engine)

Cost per ton of NOx removed: $7,675
Elimination of Two-Stroke Engines
The Work Group noted that 2-stroke engines tend to pollute more than 4-stroke engines. Eliminating 2-stroke engines from the marketplace would eventually tend to reduce ozone formation, as well as particulate matter.

The Work Group did not pursue the strategy because data from "Evaluation of Candidate Mobile Source Control Measures" by Environ for the Lake Michigan Air Directors' Consortium (LADCO) Feb. 28, 2006) shows no NOx benefit, and the VOC benefit is unknown. The strategy will continue to be studied during the PM2.5 SIP development work because the data shows definite PM benefits.

Low-RVP Gasoline
Northeast Ohio, as of 2004, had the following registered watercraft:

- 18,971 boats
- 3,188 personal watercraft (jet skis)

The Work Group noted that a low-RVP gasoline such as 7.0 psi or 7.8 psi, or federal reformulated gasoline (RFG), would produce VOC benefits from gasoline-powered boats and jet skis across the nonattainment area in the summer months when the gasoline was sold.

Air Impact: The emissions benefits are included in the overall sales of gasoline figures discussed in the "Fuels" Section of the Final Mobile Source Report.

Costs: The costs are as they appear in the Final Mobile Source Report. An increase in the cost of a gallon of gasoline may occur between 1 cent and 6 cents, although even higher prices are possible, depending on supply and demand in any given summer.

Accelerated Turnover of Gasoline-Powered Lawn and Garden Equipment
Accelerating the purchase of new gasoline-powered lawn, garden, and landscaping equipment would provide VOC benefits, and even some NOx benefits. Newer equipment provides more complete combustion.

The Work Group noted that USEPA is going to promulgate new standards for small engines for this entire sector. However, the new equipment will not be available for purchase in time to affect the 2010 attainment date for Northeast Ohio.
Clean Marina / Clean Boater Programs

Northeast Ohio, as of 2004, had the following registered watercraft:

18,971 boats
3,188 personal watercraft (jet skis)

The Ohio Department of Natural Resources’ (ODNR) Clean Marinas Program is a proactive partnership designed to encourage marinas and boaters to use simple, innovative solution to keep Ohio’s coastal and inland waterway resources clean.

The basic goal of the Program is environmental stewardship by making marinas and boaters more aware of environmental laws, rules and jurisdictions, and to get as many marinas as possible to follow best management practices and to be designated as “Clean Marinas.”

Marinas take a pledge to commit to improving water quality protection through basically the adoption of boating best management practices. Each marina is required to assess their facility using Ohio’s Clean Marinas Program Checklist and the Program Guidebook to determine if the marina meets the Clean Marina standards. Once designated, marinas are encouraged to annually assess and confirm in writing to ODNR their continued Clean Marina status.

The Ohio Clean Boater Program is part of the Ohio Clean Marina Program that encourages boat owners to follow Best Boater Practices (BBPs) to keep oil, sewage, toxic boat cleaning and maintenance products, plastics, cigarette butts and other trash, fishing gear and invasive species out the local environment. Many of the BBPs are water-related, but some have air emission reduction benefits, as well, including:

a. Fuel & Engine Maintenance
Maintaining inboard engines can cause special problems because of materials such as oil, gasoline, and antifreeze. The discharge of all of these materials is prohibited under federal and state law and detrimental to the environment. The hydrocarbons and heavy metals that are present in petroleum products are toxic even in very small amounts. Some petroleum products are even suspected of causing cancer.

Stage II Vapor Recovery: Unfortunately, the Work Group learned that Stage II vapor recovery nozzles cannot be employed on marina gas pumps because the design of boat gas tanks allows vapors to escape.

Regular inspection of fuel lines will help reduce air pollution. Replacing deteriorated lines with a U.S. Coast Guard Type A alcohol-resistant fuel line hose also helps. The alcohol content of unleaded fuels can deteriorate fuel lines in several months resulting in leak or evaporation of fuels.

In addition, USEPA encourages boaters to:
• limit engine operation at full throttle
• eliminate unnecessary idling
• avoid spilling gasoline
• use a gasoline container that can be held securely
• pour gasoline slowly
• use a funnel or spout with an automatic stop device to prevent overfilling the gas tank
• close the vent on portable gas tanks when the engine is not in use or when the tank is stored
• transport and store gasoline out of the direct sunlight
• use caution when pumping gasoline into a container at the gas station
• carefully measure the proper amounts of gasoline and oil when refueling
• follow the manufacturer's recommended maintenance schedule
• prepare engines properly for winter storage
• buy new, cleaner marine engines

b. Boat Cleaning & Painting

To reduce air pollution, boaters are encouraged by ODNR to:
• use environmentally friendly products
• use legal bottom paints
• avoid toxic paints
• use water-based paints
• avoid the use of wood preserver, paint thinners, etc.

Option AR-12

Air Impact: Unknown because it depends on the number of marinas joining the program and the number of boaters using good practices.

Cost: Unknown.
Portable Fuel Containers

According to the Lake Michigan Air Directors' Consortium (LADCO), portable fuel containers (PFCs) are designed for transporting and storing fuel from a retail distribution point to a point of use and eventually dispensing fuel into equipment. Commonly referred to as “gas cans,” these products come in a variety of shapes and sizes with nominal capacities ranging in size from less than one gallon to over six gallons. Available in metal or plastic, these products are widely used to refuel residential and commercial equipment and vehicles when the situation or circumstances prohibits direct refueling at a service station. PFCs are used to refuel a broad range of small off-road engines and other equipment (e.g., lawnmowers, chainsaws, personal watercraft, motorcycles, etc.).

VOC emissions from PFCs are classified by different processes:

* PFC refueling vapor displacement and spillage emissions result when fuel vapor is displaced from the gas can and from gasoline spillage/over-filling during refueling at a service station. These emissions may already be accounted for under the Stage II refueling source category.

* Transport-spillage emissions from PFCs occur when fuel escapes from gas cans that are in transit.

* Diurnal emissions result when stored fuel vapors escape to the air through any possible openings while the container is subjected to the daily cycle of increasing and decreasing ambient temperatures. Diurnal emissions depend on the closed- or open- storage condition of the PFC.

* Permeation emissions are produced after fuel has been stored long enough in a container for fuel molecules to infiltrate and saturate the container material, allowing vapors to escape through the walls of containers made from plastic. Transport-spillage emissions from PFCs occur when fuel escapes from gas cans that are in transit.

Diurnal emissions are the largest category, accounting for roughly two-thirds of the total emissions from these five processes. Transport-spillage, diurnal, and permeation emissions associated with PFCs were estimated to account for about 1.2% of the total anthropogenic VOC emissions in the MRPO region in 2002.
The LADCO Potential Control Measures, as presented by LADCO’s subcontractor MACTEC, are as follows:

**AR-13 Candidate Measure ID SOLV3A:**
- Adopt Ozone Transport Commission (OTC) Model Rule PFCs (18% reduction in 2009 and 54% reduction in 2015, assuming a 10% turnover in PFCs per year starting in 2007.)

**SOLV3A Capital Control Cost Estimate**
LADCO: $250 - 480/ ton VOC reduced

<table>
<thead>
<tr>
<th>SOLV3A</th>
<th>5 State LADCO Region</th>
<th>NE Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 Base VOC Emissions</td>
<td>51,000 tpy</td>
<td>140 tpd</td>
</tr>
<tr>
<td></td>
<td>10,800 tpy</td>
<td>29 tpd</td>
</tr>
<tr>
<td>2009 VOC Reduction</td>
<td>- 9,200 tpy</td>
<td>- 25 tpd</td>
</tr>
<tr>
<td></td>
<td>- 1,500 tpy</td>
<td>- 4 tpd</td>
</tr>
<tr>
<td>2009 Base VOC Emissions</td>
<td>41,800 tpy</td>
<td>115 tpd</td>
</tr>
<tr>
<td></td>
<td>9,300 tpy</td>
<td>25 tpd</td>
</tr>
<tr>
<td>2015 VOC Reduction</td>
<td>- 18,300 tpy</td>
<td>- 50 tpd</td>
</tr>
<tr>
<td></td>
<td>- 3,500 tpy</td>
<td>- 10 tpd</td>
</tr>
<tr>
<td>2015 VOC Emissions</td>
<td>23,500 tpy</td>
<td>65 tpd</td>
</tr>
<tr>
<td></td>
<td>5,800 tpy</td>
<td>15 tpd</td>
</tr>
<tr>
<td>Estimated Capital Costs</td>
<td>$7 - 13 M</td>
<td>$2 - 3 M</td>
</tr>
</tbody>
</table>
AR-14  Candidate Measure ID SOLV3B:
- Adopt incentive programs in nonattainment areas to accelerate phase in of compliance
  PFCs. (Give out a new PFC when an old one is traded in at no additional cost.)

**SOLV3B Capital Control Cost Estimate**
LADCO: $4,600/ton VOC reduced

<table>
<thead>
<tr>
<th>SOLV3B</th>
<th>5 State LADCO Region</th>
<th>NE Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 Base VOC Emissions</td>
<td>51,000 tpy</td>
<td>140 tpd</td>
</tr>
<tr>
<td>2009 VOC Reduction</td>
<td>- 12,300 tpy</td>
<td>- 34 tpd</td>
</tr>
<tr>
<td>2009 Base VOC Emissions</td>
<td>38,700 tpy</td>
<td>114 tpd</td>
</tr>
<tr>
<td>2015 VOC Reduction</td>
<td>- 15,200 tpy</td>
<td>- 42 tpd</td>
</tr>
<tr>
<td>2015 Emissions</td>
<td>23,500 tpy</td>
<td>72 tpd</td>
</tr>
<tr>
<td>Estimated Capital Costs</td>
<td>$38 M</td>
<td>$10 M</td>
</tr>
</tbody>
</table>

Ohio EPA has indicated that it will promulgate a rule for Portable Fuel Containers that would be statewide.
F.  Agriculture

Mega farms
The Work Group reviewed "mega farms" and Certified Animal Feeding Operations (CAFOs) to see whether there were any manure lagoons in the Northeast Ohio nonattainment area that might emit VOCs affecting ozone formation. Such manure lagoons might be susceptible to containment with methane digesters.

However, none appeared within the 8 counties, although several large chicken farms and swine farms are just outside the nonattainment area.

The area's 2 horse-racing tracks constituted the largest concentrated animal operation, but their combined manure output was not a substantial contributor to air pollution in the nonattainment area.
Retrofitting diesel farm tractors with a lean-NOx catalyst showed various NOx reductions for Tier 0, Tier 1, Tier 2, and Tier 3, according to LADCO's subcontractor Environ. A Lonestar catalyst was used for Environ's study. One example follows, using the oldest and dirtiest engines, which would be Tier 0:

**Option AR-15**

**Air Impact:**
Assume one farm tractor, Tier 0, 100-175 hp
Assume a useful life of 10 years
NOx reduction in tons/year: 0.16 tpy
NOx reduction in tons/day = 0.0004 tpd

Cost for one tractor: $13,579 (capital cost) plus additional fuel for 10 years

**Cost per ton of NOx removed:** $10,498

For purposes of this Report, assume that a fleet of 10 tractors in Northeast Ohio were retrofitted:

10 tractors x 0.0004 tpd = 0.004 tons per day NOx reduced

Cost for 10 tractors: $104,980 (capital cost) plus additional fuel for 10 years
AR-16  Diesel Agricultural Tractors - Replacing Older Engines with Newer Engines
(Source of data: "Evaluation of Candidate Mobile Source Control Measures" by Environ for the Lake Michigan Air Directors' Consortium (LADCO) Feb. 28, 2006.)

Replacing older engines, such as Tier 0 engines with uncontrolled emissions, with newer engines such as Tier 2 or Tier 3 results in emission reductions of varying sizes.

According to LADCO's subcontractor, Environ, the following ranges might result, depending on the tractor size and assuming a useful life of 10 years.

<table>
<thead>
<tr>
<th>Agricultural tractors</th>
<th>Replace Tier 0 With Tier 2</th>
<th>Tier 1 with 3</th>
<th>Tier 2 with 3</th>
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</thead>
<tbody>
<tr>
<td>NOx reduced - tons per year</td>
<td>0.02 - 1.07</td>
<td>0.04 - 0.84</td>
<td>0.02 - 0.36</td>
</tr>
<tr>
<td>NOx reduced - tons per day</td>
<td>0 - 0.003</td>
<td>0 - 0.002</td>
<td>0 - 0.001</td>
</tr>
</tbody>
</table>

**Cost per ton of NOx removed:** $7,000-26,000  $11k-36k  $22k-84k

**Option AR-16**

**Air Impact:**
Assume one farm tractor, Tier 0, 100-175 hp, replaced with a Tier 2 engine
Assume a useful life of 10 years
NOx reduction in tons/year: 0.21 tpy
NOx reduction in tons/day = 0.0006 tpd

Cost for one engine: $13,750

**Cost per ton of NOx removed:** $7,833

For purposes of this Report, assume that a fleet of 10 tractors in Northeast Ohio received engine replacements:

**10 tractors x 0.0006 tpd = 0.006 tons per day NOx reduced**

Cost for 10 tractors: $134,500
IV. Qualitative Options

Trees and Shrubs

Some trees and shrubs are biogenic background sources of VOCs, which contribute to ozone formation. However, some trees and shrubs do not emit VOCs. And most trees and shrubs help to remove pollutants, such as particulate matter and carbon dioxide, from the air.

According to USEPA, heat islands are of growing concern millions of Americans living in and around cities. This phenomenon describes urban and suburban temperatures that are 2 to 10°F (1 to 6°C) hotter than nearby rural areas. Elevated temperatures can impact communities by increasing peak energy demand, air conditioning costs, air pollution levels, and heat-related illness and mortality.

Urban vegetation can directly and indirectly affect local and regional air quality by altering the urban atmospheric environment. The four main ways that urban trees affect air quality area:

- Temperature reduction and other microclimatic effects
- Removal of air pollutants
- Emission of volatile organic compounds and tree maintenance emissions
- Energy effects on buildings

According to USEPA, trees remove gaseous air pollution primarily by uptake via leaf stomata, though some gases are removed by the plant surface. The amount of gaseous pollutants and particulates removed by trees depends on tree size and architecture, and local meteorology and pollutant concentrations. Uptake rates are high when pollutant concentrations and leaf surface areas are high. Trees remove pollution by intercepting airborne particles. Some particles can be absorbed into the tree, although most particles that are intercepted are retained on the plant surface. The intercepted particle often is resuspended to the atmosphere, washed off by rain, or dropped to the ground with leaf and twig fall. Consequently, vegetation is only a temporary retention site for many atmospheric particles.

By shading cars and lowering parking lot temperatures, trees can reduce evaporative emissions of hydrocarbons (VOCs) that leak from fuel tanks and hoses. Parked cars contribute 15 to 20 percent of total motor vehicle VOC emissions. Parking lot tree planting is one practical strategy communities can use to meet and sustain mandated air quality standards.

The Work Group studied a list of low-ozone-emitting trees and shrubs and then shortened the list to native species that would do well in Northeast Ohio. The list follows:
TREES:
Black cherry
Black walnut
Box elder
Red mulberry
Choke cherry
Green ash (caution: emerald ash borer problems)
Redbud
Sassafras
Silver maple

SHRUBS:
Smooth sumac
<table>
<thead>
<tr>
<th>Emissions (Tons Per Day)</th>
<th>ScC</th>
<th>ScCname</th>
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<tbody>
<tr>
<td>2260</td>
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<td>Emissions (Tons Per Day)</td>
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<tr>
<td>-------------------------</td>
<td>-------</td>
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<tr>
<td>4.76</td>
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**26.08**

**2265**

<p>| 0.07 | 2265001010 | Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, Motorcycles: Off-road, , ,                           |
| 0.56 | 2265001030 | Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, All Terrain Vehicles, , ,                         |</p>
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| 0.02                    | 2260004026 | Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Trimmers/Edgers/Brush Cutters (Commercial),  
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| 0.00                    | 2260004035 | Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Lawn and Garden Equipment, Snowblowers (Residential), Horsepower-Hours, Work, Output |
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| 0.00                    | 2260006005 | Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Commercial Equipment, Generator Sets, Horsepower-Hours, Work, Output |
| 0.00                    | 2260006010 | Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Commercial Equipment, Pumps, Horsepower-Hours, Work, Output |
| 0.00                    | 2260006015 | Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Commercial Equipment, Air Compressors, Horsepower-Hours, Work, Output |
| 0.00                    | 2260007005 | Mobile Sources, Off-highway Vehicle Gasoline, 2-Stroke, Logging Equipment, Chain Saws > 6 HP, Horsepower-Hours, Work, Output |
| **0.16**                | **2265** |                                                                          |
| 0.01                    | 2265001010 | Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, Motorcycles: Off-road,  
|                         |        |                                                                          |
| 0.09                    | 2265001030 | Mobile Sources, Off-highway Vehicle Gasoline, 4-Stroke, Recreational Equipment, All Terrain Vehicles,  
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### Number of "Total Annual Operations"

2004

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<td>Gates (7D8)</td>
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<td>Concord Airpark (2G1)</td>
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Appendix B
## Low Ozone-Forming Potential Trees

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<td>Apple [Malus sp.]</td>
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<tr>
<td>Aristocrat Flowering Pear [Pyrus calleryana 'Aristocrat']</td>
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<tr>
<td>Arizona Ash [Fraxinus velutina]</td>
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<tr>
<td>Atlas Cedar [Cedrus atlantica]</td>
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<tr>
<td>Australian Willow [Geijera parvifolia]</td>
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<tr>
<td>Avocado [Persea americana]</td>
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<tr>
<td>Bigleaf Maple [Acer macrophyllum]</td>
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<tr>
<td>Bing Cherry [Prunus avium]</td>
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<tr>
<td>Black Cherry [Prunus serotina]</td>
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<td>Black Locust [Robinia pseudoacacia]</td>
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<tr>
<td>Black Walnut [Juglans nigra]</td>
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<td>Blenheim Apricot [Prunus armeniaca]</td>
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<td>Box Elder [Acer negundo]</td>
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<td>Bradford Pear [Pyrus calleryana 'Bradford']</td>
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<td>Bronze Loquat [Eriobotrya deflexa]</td>
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<td>California Black Walnut [Juglans hindsii]</td>
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<td>California Walnut [Juglans californica]</td>
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<tr>
<td>Camphor [Cinnamomum camphora]</td>
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<td>Camphor [Cinnamomum pedunculatum]</td>
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<td>Canary Island Pine [Pinus canariensis]</td>
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<td>Cape Chestnut [Calodendrum capense]</td>
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<tr>
<td>Carolina Laurel Cherry [Prunus caroliniana]</td>
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<td>Catalina Cherry [Prunus lyonii]</td>
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<tr>
<td>Italian Stone Pine [Pinus pinea]</td>
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<tr>
<td>Jacaranda [Jacaranda mimosifolia]</td>
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<tr>
<td>Japanese Maple [Acer palmatum]</td>
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<tr>
<td>Leylandi Cypress [Cupressocyparis leylandii]</td>
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<tr>
<td>Loquat [Eriobotrya japonica]</td>
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<tr>
<td>Meyer Lemon [Citrus limon 'Meyer']</td>
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<tr>
<td>Meyer Lemon [Citrus limonia burm.]</td>
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<tr>
<td>Modesto Ash [Fraxinus velutina 'Modesto']</td>
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<tr>
<td>Montebello Ash [Fraxinus velutina coriacea]</td>
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<tr>
<td>Monterey Pine [Pinus radiata]</td>
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<tr>
<td>Mountain Serviceberry [Amelanchier alnifolia]</td>
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<tr>
<td>Nonpareil Almond [Prunus dulcis]</td>
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<tr>
<td>Nootka Cypress [Chamaecyparis nootkatensis]</td>
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<td>Orange [Citrus orangona]</td>
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<td>Oregon Ash [Fraxinus latifolia]</td>
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<tr>
<td>Pear [Pyrus communis]</td>
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<td>Port Orford Cedar [Chamaecyparis lawsoniana]</td>
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<tr>
<td>Queensland Pittosporum [Pittosporum rhombifolium]</td>
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<td>Red Bay [Persea borbonia]</td>
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<tr>
<td>Red Hickory [Carya sp.]</td>
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<tr>
<td>Red Maple [Acer rubrum]</td>
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<td>Red Mulberry [Morus rubra]</td>
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<td>Red Pine [Prunus densiflora]</td>
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<td>Low Ozone-Forming Potential Trees</td>
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<td>Catalina Ironwood [Lyonothamnus floribundus aspleni folius]</td>
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<td>Chinese Hackberry [Celtis sinensis]</td>
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<td>Choke Cherry [Prunus virginiana]</td>
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<td>Crape Myrtle [Lagerstroemia indica]</td>
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<td>English Walnut [Juglans regia]</td>
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## Appendix D

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<th>Commuter</th>
<th>Switch Yards</th>
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<th>Switch Yards</th>
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*Data is shown in tons/yr unless otherwise labeled.

**TONS PER DAY**

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**CLASS I - LINE HAUL**

**CLASS II - SHORT HAUL**

---

**Environ Dec. 04**

*(Switch yards are estimates only.)*