PORT-WIDE BASELINE AIR EMISSIONS INVENTORY
EXECUTIVE SUMMARY

July 2005

Prepared for:

PORT OF LOS ANGELES

Prepared by:

Starcrest Consulting Group, LLC
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TABLE OF CONTENTS

EXECUTIVE SUMMARY

LIST OF FIGURES

Figure ES.1: Baseline Inventory In-Port Study Area
Figure ES.2: South Coast Air Basin Boundary
Figure ES.3: OGV and Harbor Vessel Out of Port Geographical Extent
Figure ES.4: Port-Related Emissions by Source Category, tons per day
Figure ES.5: Percentage of Port NOx Emissions by Source Category
Figure ES.6: Percentage of Port TOG Emissions by Source Category
Figure ES.7: Percentage of Port CO Emissions by Source Category
Figure ES.8: Percentage of Port PM10 Emissions by Source Category
Figure ES.9: Percentage of Port PM2.5 Emissions by Source Category
Figure ES.10: Percentage of Port SO2 Emissions by Source Category

LIST OF TABLES

Table ES.1: 2001 Emissions by Source Category, tons per year
Table ES.2: 2001 Emissions by Source Category, tons per day
Table E.S.3 Percentage Breakdown of Port Emissions in Air Basin
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David Redmond, Clean Coastal Waters
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Tommy Taylor, Crescent Warehouse
Bill Sisco, Distribution & Auto Service
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Charles McDaniel, General Petroleum
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Boisen Hwang, Yang Ming Line
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Document Preparation:  Denise Anderson, Consultant for Starcrest
                       Melissa Anderson, Principal, Starcrest
### ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>ARB</td>
<td>(California) Air Resources Board</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>BAH</td>
<td>Booz Allen Hamilton, Inc.</td>
</tr>
<tr>
<td>BNSF</td>
<td>Burlington Northern Santa Fe Railroad</td>
</tr>
<tr>
<td>BSFC</td>
<td>brake specific fuel consumption</td>
</tr>
<tr>
<td>CHE</td>
<td>cargo handling equipment</td>
</tr>
<tr>
<td>CO</td>
<td>carbon monoxide</td>
</tr>
<tr>
<td>DF</td>
<td>deterioration factor</td>
</tr>
<tr>
<td>DMV</td>
<td>Department of Motor Vehicles</td>
</tr>
<tr>
<td>DPM</td>
<td>diesel particulate matter</td>
</tr>
<tr>
<td>DWT</td>
<td>deadweight tons</td>
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<tr>
<td>EEAI</td>
<td>Energy and Environmental Analysis, Inc.</td>
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<tr>
<td>EF</td>
<td>emission factor</td>
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<td>EI</td>
<td>emissions inventory</td>
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<tr>
<td>EMD</td>
<td>(GE) Electromotive Division</td>
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<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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<tr>
<td>FCF</td>
<td>fuel correction factor</td>
</tr>
<tr>
<td>g/day</td>
<td>grams per day</td>
</tr>
<tr>
<td>g/hr</td>
<td>grams per hour</td>
</tr>
<tr>
<td>g/mi</td>
<td>grams per mile</td>
</tr>
<tr>
<td>GVWR</td>
<td>gross vehicle weight rating</td>
</tr>
<tr>
<td>HC</td>
<td>hydrocarbons</td>
</tr>
<tr>
<td>HDV</td>
<td>heavy-duty vehicle</td>
</tr>
<tr>
<td>hp</td>
<td>horsepower</td>
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<tr>
<td>hrs</td>
<td>hours</td>
</tr>
<tr>
<td>ICTF</td>
<td>Intermodal Container Transfer Facility</td>
</tr>
<tr>
<td>IFO</td>
<td>intermediate fuel oil</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>ITB</td>
<td>integrated tug/barge</td>
</tr>
<tr>
<td>kW</td>
<td>kilowatts</td>
</tr>
<tr>
<td>lbs/day</td>
<td>pounds per day</td>
</tr>
<tr>
<td>LF</td>
<td>load factor</td>
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<tr>
<td>LPG</td>
<td>liquefied petroleum gas</td>
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<td>MarEx</td>
<td>Marine Exchange of Southern California</td>
</tr>
<tr>
<td>MCR</td>
<td>maximum continuous rating</td>
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<td>MDO</td>
<td>marine diesel oil</td>
</tr>
<tr>
<td>MMA</td>
<td>Meyer, Mohaddes Associates, Inc.</td>
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<tr>
<td>mph</td>
<td>miles per hour</td>
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<td>MW</td>
<td>megawatts</td>
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ACRONYMS AND ABBREVIATIONS
(Cont’d)

NO\textsubscript{x} oxides of nitrogen
OGV ocean-going vessel
PCEEI Pleasure Craft Exhaust Emissions Inventory
PHL Pacific Harbor Line
PM particulate matter
PM\textsubscript{10} particulate matter less than 10 microns in diameter
PM\textsubscript{2.5} particulate matter less than 2.5 microns in diameter
POLB Port of Long Beach
ppm parts per million
RIA Regulatory Impact Analysis
RO residual oil
Ro-Ro roll-on/roll-off
rpm revolutions per minute
RSD Regulatory Support Document
RTG rubber tired gantry crane
RTL rich text language
SCAQMD South Coast Air Quality Management District
SO\textsubscript{2} sulfur dioxide
SoCAB South Coast Air basin
SSA Stevedoring Services of America
SUV sport-utility vehicle
TEU twenty-foot equivalent unit
TOG total organic gases
tpd tons per day
tpy tons per year
U.S. United States
UP Union Pacific Railroad
USACE U.S. Army Corps of Engineers
VMT vehicle miles of travel
VSR Vessel Speed Reduction
VTS Vessel Traffic Service
EXECUTIVE SUMMARY

The Port of Los Angeles (Port) has prepared a 2001 Baseline Emissions Inventory (EI) in response to concerns from the public about the potential health impacts to surrounding communities from Port operations and to provide the Port with a planning document for development, prioritization and implementation of emission control strategies to reduce these impacts.

To address community concerns about air quality and other impacts, the Board of Harbor Commissioners on October 10, 2001, acting on the request of Mayor James Hahn, adopted a “goal that there will be no net increase in air emissions or traffic impacts from future Port operations.” To initiate action on meeting the goal, the Board directed staff to conduct several environmental baseline studies. The Board approved the Concept Plan for the Port-wide Environmental Studies in December 2001 that combined several of the original air quality initiatives into a single Air Studies Program.

The 2001 Baseline EI is a major milestone for the Port and represents successful completion of the first component of the Air Studies Program. The inventory’s comprehensive activity-based approach provides emission estimates, focusing on emissions of diesel particulate matter, for all significant sources operating in the Port. Development of this EI has been coordinated with the U.S. Environmental Protection Agency - Region 9 (EPA), California Air Resources Board (ARB), and South Coast Air Quality Management District (SCAQMD).

The 2001 EI includes tenant source category emissions that occur on Port-owned land within the Port boundary/district. Figure ES.1 shows the land area of active Port terminals in 2001, designated in yellow, including the area to the northeast. This figure illustrates the in-Port area of study. In addition to in-Port emissions, emissions from locomotives and on-road trucks transporting Port cargo have been estimated for activity that occurs outside the Port, but within the South Coast Air Basin (SoCAB) boundaries. Figure ES.2 shows the SoCAB boundary and the location of the Port. Since both the Port and Port of Long Beach are interconnected with intermodal transportation linkages, every effort was made to only account for freight movements originating from or having a destination at the Port. For marine vessels, the geographical extent of the EI is the same boundary that was used in previous marine vessel inventories for the South Coast Air Quality Management District. Figure ES.3 shows the geographical extent of the out-of-Port study area for marine vessels.

The scope of the study includes five source categories: ocean-going vessels (OGVs), harbor craft (e.g., tugboats, ferries, commercial fishing vessels, dredges, etc.), off-road cargo handling equipment (CHE), railroad locomotives and on-road heavy-duty vehicles (HDV). For each source category, baseline emission estimates were developed for oxides of nitrogen (NOx), total organic gases (TOG), carbon monoxide (CO), particulate matter less than 10 microns (PM10) and 2.5 microns (PM2.5) in diameter, diesel particulate matter (DPM), and sulfur dioxide (SO2). The inventory does not include stationary sources, as these are included in stationary source permitting programs administered by the SCAQMD.
Figure ES.1: Baseline Inventory In-Port Study Area
Figure ES.2: South Coast Air Basin Boundary
Figure ES.3: OGV and Harbor Vessel Out of Port Geographical Extent
Methodology Overview

The basic approach to developing an activity-based or “bottom-up” EI was based on interviews and conversations with tenants who own, operate and maintain equipment and own or charter vessels. Port tenants and shipping lines played an essential role in the success of this EI by providing the most accurate information available. The activity and operational data collected was then used to estimate emissions for each of the various source categories in a manner consistent with the latest estimating methods, as agreed on by the Port and participating regulatory agencies. The information that was gathered, analyzed and presented in this report improves the understanding of the nature and magnitude of Port-wide emission sources and is unprecedented in that it represents the first EI specifically covering Port sources of emissions disaggregated from all other sources contained in regional EIs. Specific data collection and analytical approaches unique to each of the five source categories are summarized below.

Ocean-Going Vessels

The basic methodology for estimating emissions from the various types of ocean-going vessels (auto carriers, bulk carriers, containerships, cruise ships, general cargo ships, ocean-going tugboats, refrigerated vessels, roll-on roll-off ships, bulk liquid tankers) that call on the Port utilized local activity-based data, previous marine emissions studies developed in California, elsewhere in the nation, and international studies. In addition to using available data on every OGV visit to the Port in 2001, the Port implemented an unprecedented Vessel Boarding Program that focused on gathering specific vessel characteristics and operational data and gaining an understanding of how the different types of OGVs arrive, depart, and transit the Port, as well as how they operate while at dock (“hotelling”).

Harbor Craft

The Port harbor craft operators and marina managers were interviewed to develop a harbor craft list. ARB’s 2002 Statewide Commercial Harbor Craft Survey and Pleasure Craft Exhaust Emissions Inventory supplemented this information. The harbor craft were separated into the following categories: assist tugboat, towboats and push boats, ferries, excursion vessels, crew boats, work boats, government vessels, dredges and dredging support, commercial fishing vessels, and recreational vessels. Valuable data was provided for assist tugs in the form of histograms on engine operations and loads. This is the first time that hard data of this caliber was used in a marine emissions inventory.

Cargo Handling Equipment

CHE consists of various types of equipment and vehicles that fall within the off-road designation and are used to move cargo within terminals and other off-road areas. The emission estimates for this group were prepared by the ARB using their OFFROAD¹ model, which has been developed to estimate emissions from off-road equipment fleets. Equipment operators and owners were interviewed and equipment lists with detailed specifications were developed that formed the inputs for the OFFROAD model. This ensured that specific information on the fleets that actually operate in the Port was used to estimate emissions.

Railroad Locomotives

Railroad operations are typically described in terms of two different types of operation, line haul and switching. Because of different types of information provided by the railroad companies, emissions were estimated using two basic methods. For most of the switching activities, emission estimates were based on the percentage of time spent in the different throttle notch settings. This information was obtained from on-board observations of switch engine operations during normal shift duties and from on-board dataloggers. For line haul activities (and a limited amount of switching activity), fuel usage was used as a surrogate measure of the level of activity of the locomotives. The EPA has published emissions information for switch and line haul locomotive operations in both throttle notch and fuel consumption modes and this information was used to cross-check between the estimating methods to demonstrate the degree of agreement.

Heavy-Duty Vehicles

There are two components to the estimation of HDV emissions presented in this report: on-road travel and on-terminal operations. For estimating on-road (off-terminal) HDV emissions, on-road activity information was developed by a traffic consultant, Meyer, Mohaddes Associates, Inc. (MMA), using trip generation and travel demand models that were used in previous Port traffic studies. A Port-specific HDV model year distribution was developed by the ARB and the SCAQMD for this study by querying over 7,000 license plate numbers obtained from local terminals against the California Department of Motor Vehicles (DMV) registration database. For estimating on-terminal HDV emissions, terminal operators were interviewed with regards to on-terminal traffic patterns, including time spent waiting at the entry gate, time and distance on terminal while dropping off and/or picking up cargo, and time spent waiting at exit gates. Off-terminal and on-terminal emissions were estimated by multiplying the appropriate emission factor derived from EMFAC 2002 by the time and distance parameters established for the terminals.

Results

2001 emission estimates by source category in terms of tons per year (tpy) and tons per day (tpd) are summarized in Tables ES.1 and ES.2, respectively. These estimates include emissions related to 1) Port operations occurring within the Port boundary/district (In-Port) and 2) the transportation of Port-related cargo within the SoCAB (Regional).

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3 California Air Resources Board, EMFAC2002. EMFAC2002 is the emission factor model approved by EPA for use in estimating emissions for on-road vehicles in California.
### Table ES.1: 2001 Emissions by Source Category, tons per year

<table>
<thead>
<tr>
<th>Source Category</th>
<th>NOx In-Port</th>
<th>TOG In-Port</th>
<th>CO In-Port</th>
<th>PM10 In-Port</th>
<th>PM2.5 In-Port</th>
<th>SO2 In-Port</th>
<th>PM10 Regional</th>
<th>PM2.5 Regional</th>
<th>SO2 Regional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocean-Going Vessels</td>
<td>1,967.6</td>
<td>6,922.7</td>
<td>55.6</td>
<td>159.8</td>
<td>553.9</td>
<td>68.8</td>
<td>561.0</td>
<td>55.1</td>
<td>449.9</td>
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<tr>
<td>Harbor Craft</td>
<td>1,968.0</td>
<td>3,530.7</td>
<td>172.2</td>
<td>701.5</td>
<td>1,622.8</td>
<td>99.7</td>
<td>178.0</td>
<td>91.7</td>
<td>163.7</td>
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<tr>
<td>Cargo Handling Equipment</td>
<td>1,862.6</td>
<td>1,862.6</td>
<td>204.5</td>
<td>725.5</td>
<td>725.5</td>
<td>111.6</td>
<td>111.6</td>
<td>102.6</td>
<td>102.6</td>
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<tr>
<td>Railroad Locomotives</td>
<td>445.9</td>
<td>2,465.8</td>
<td>17.0</td>
<td>49.6</td>
<td>249.4</td>
<td>9.9</td>
<td>60.1</td>
<td>9.1</td>
<td>55.2</td>
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<tr>
<td>Heavy-Duty Vehicles</td>
<td>872.5</td>
<td>4,463.5</td>
<td>53.1</td>
<td>246.0</td>
<td>815.3</td>
<td>24.4</td>
<td>87.9</td>
<td>22.4</td>
<td>77.9</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>7,116.6</strong></td>
<td><strong>19,245.3</strong></td>
<td><strong>502.4</strong></td>
<td><strong>1,882.4</strong></td>
<td><strong>3,966.9</strong></td>
<td><strong>314.4</strong></td>
<td><strong>998.6</strong></td>
<td><strong>280.9</strong></td>
<td><strong>849.3</strong></td>
</tr>
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</table>

### Table ES.2: 2001 Emissions by Source Category, tons per day

<table>
<thead>
<tr>
<th>Source Category</th>
<th>NOx In-Port</th>
<th>TOG In-Port</th>
<th>CO In-Port</th>
<th>PM10 In-Port</th>
<th>PM2.5 In-Port</th>
<th>SO2 In-Port</th>
<th>PM10 Regional</th>
<th>PM2.5 Regional</th>
<th>SO2 Regional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocean-Going Vessels</td>
<td>5.39</td>
<td>18.97</td>
<td>0.15</td>
<td>0.44</td>
<td>1.52</td>
<td>0.19</td>
<td>1.54</td>
<td>0.15</td>
<td>1.23</td>
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<tr>
<td>Harbor Craft</td>
<td>5.39</td>
<td>9.67</td>
<td>0.47</td>
<td>1.92</td>
<td>4.45</td>
<td>0.27</td>
<td>0.49</td>
<td>0.25</td>
<td>0.45</td>
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<tr>
<td>Cargo Handling Equipment</td>
<td>5.10</td>
<td>5.10</td>
<td>0.56</td>
<td>1.99</td>
<td>1.99</td>
<td>0.31</td>
<td>0.31</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>Railroad Locomotives</td>
<td>1.22</td>
<td>6.76</td>
<td>0.05</td>
<td>0.14</td>
<td>0.68</td>
<td>0.03</td>
<td>0.16</td>
<td>0.02</td>
<td>0.15</td>
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<tr>
<td>Heavy-Duty Vehicles</td>
<td>2.39</td>
<td>12.23</td>
<td>0.14</td>
<td>0.68</td>
<td>2.24</td>
<td>0.07</td>
<td>0.24</td>
<td>0.06</td>
<td>0.21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19.49</strong></td>
<td><strong>52.73</strong></td>
<td><strong>1.37</strong></td>
<td><strong>5.17</strong></td>
<td><strong>10.88</strong></td>
<td><strong>0.87</strong></td>
<td><strong>2.74</strong></td>
<td><strong>0.77</strong></td>
<td><strong>2.32</strong></td>
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</table>
Figure ES.4 illustrates the comparative contribution of each source category to total Port emissions, by key pollutant.

**Figure ES.4: Port-Related Emissions by Source Category, tons per day**

Table ES.3 illustrates the percentage breakdown of average annual emissions by source category for each pollutant and is an extension of the bar chart above.

**Table ES.3: Percentage Breakdown of Port Emissions in Air Basin**

<table>
<thead>
<tr>
<th></th>
<th>NOX</th>
<th>TOG</th>
<th>CO</th>
<th>PM$_{10}$</th>
<th>PM$_{2.5}$</th>
<th>SO$_{2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocean-Going Vessels</td>
<td>36%</td>
<td>21%</td>
<td>14%</td>
<td>56%</td>
<td>53%</td>
<td>86%</td>
</tr>
<tr>
<td>Harbor Craft</td>
<td>18%</td>
<td>34%</td>
<td>41%</td>
<td>18%</td>
<td>19%</td>
<td>11%</td>
</tr>
<tr>
<td>Cargo Handling Equipment</td>
<td>10%</td>
<td>19%</td>
<td>18%</td>
<td>11%</td>
<td>12%</td>
<td>1%</td>
</tr>
<tr>
<td>Railroad Locomotives</td>
<td>13%</td>
<td>9%</td>
<td>6%</td>
<td>6%</td>
<td>7%</td>
<td>2%</td>
</tr>
<tr>
<td>Heavy-Duty Vehicles</td>
<td>23%</td>
<td>17%</td>
<td>21%</td>
<td>9%</td>
<td>9%</td>
<td>1%</td>
</tr>
</tbody>
</table>
The following five figures illustrate the percentage breakdown of average annual emissions by source category for each pollutant and graphically display the data contained in Table ES.3. In summary, the ocean-going vessels account for the largest percentage of emission for every pollutant, except for CO emissions in which the recreational vessels, included in the harbor vessel category, have a large percentage of the estimated CO emissions.

The NO\textsubscript{X} emissions from ocean-going vessels represent 36% of Port-related emissions; heavy duty vehicles represent 23%; harbor craft represent 18%; locomotives represent 13%; and cargo handling equipment represent 10% of total Port NO\textsubscript{X} emissions.

**Figure ES.5: Percentage of Port NO\textsubscript{X} Emissions by Source Category**

The TOG emissions from harbor craft represent 34% of Port-related emissions; ocean-going vessels represent 21%; cargo handling equipment represent 19%; heavy duty vehicles represent 17%; and locomotives represent 9% of total Port TOG emissions.

**Figure ES.6: Percentage of Port TOG Emissions by Source Category**
The CO emissions from harbor craft represent 41% of Port-related emissions; heavy duty vehicles represent 21%; cargo handling equipment represents 18%; ocean-going vessels represent 14%; and locomotives represent 6% of total Port CO emissions.

**Figure ES.7: Percentage of Port CO Emissions by Source Category**

![Pie chart showing CO emissions by source category]

The PM10 emissions from ocean-going vessels represent 55% of Port-related emissions; harbor craft represent 18%; cargo handling equipment represents 12%; heavy duty vehicles represent 9%; and locomotives represent 6% of total Port PM10 emissions.

**Figure ES.8: Percentage of Port PM_{10} Emissions by Source Category**

![Pie chart showing PM_{10} emissions by source category]
PM$_{2.5}$ emissions from ocean-going vessels represent 52% of Port-related emissions; harbor craft represent 20%; cargo handling equipment represents 12%; heavy duty vehicles represent 9%; and locomotives represent 7% of total Port PM$_{2.5}$ emissions.

**Figure ES.9: Percentage of Port PM$_{2.5}$ Emissions by Source Category**

The SO2 emissions from ocean-going vessels represent 86% of Port-related emissions; harbor craft represent 11%; locomotives represent less than 2%; and cargo handling equipment and heavy duty vehicles each represent less than 1% of the total Port SO2 emissions.

**Figure ES.10: Percentage of Port SO$_2$ Emissions by Source Category**
Next Steps
The successful completion of the Port-wide Baseline Emissions Inventory will enable the Port to initiate work on the remaining components of the Air Studies Program. Specifically, it provides the requisite data for preparation of a Port-wide health risk assessment and development of air emission control strategies necessary to achieve the Board’s goal of “no net increase” in Port emissions. It also provides the foundation for future updates to the EI and preparation of project environmental analyses.