SF Bay Area Seaports Air Emission Inventory

Phase I & II - Data Collection and Draft Work Plan

Prepared for: Bay Planning Coalition

May 30, 2008

Prepared by:

Moffatt & Nichol

Environ

TABLE OF CONTENTS

Page

APPENDICES

TABLES

FIGURES

ACKNOWLEDGMENTS

The authors of this report acknowledge the Bay Area Seaports Air Emissions Inventory Steering Committee who commissioned the preparation of this study:

- Bay Planning Coalition, a 501(c)(4) non profit, public benefit organization
- Bay Area Air Quality Management District, a California public agency
- City of Oakland, a California municipal corporation acting by and through its Board of Port Commissioners
- City of Richmond, a California municipal corporation ("Port of Richmond")
- Port of San Francisco, a California municipal corporation
- Port of Redwood City, a California municipal corporation
- Port of Benicia, a private corporation

1.0 INTRODUCTION

1.1 Background

Early in 2007 the Bay Area Air Quality Management District (BAAQMD or the District) announced as part of its Green Ports Initiative that it would be proposing regulations in 2008 to "reduce air pollution and health risks from marine port activities and require the ports to develop comprehensive action plans to meet those goals." Each port, as part of its action plan, would be required to create an air emissions inventory.

The Bay Planning Coalition (BPC), with its history of being proactive towards issues facing the Bay Area marine industry, organized the five major public ports in an effort to participate in managing forthcoming air quality issues and solutions. All five ports (Benicia, Redwood City, Richmond, Oakland, and San Francisco) are members of the BPC. The BPC engaged the consulting team of Moffatt & Nichol and ENVIRON to assist in the effort to create a regional air emissions inventory for the seaports.

By January 2008, the BPC, the five public seaports, and the BAAQMD had a signed Memorandum of Agreement (MOA) establishing a Steering Committee and general guidelines for the preparation of a maritime emissions inventory. One of the chief aspects of the agreement was that the regional inventory would follow the methodologies established in the Port of Oakland's inventory (Environ, 2008) as much as possible. It was also agreed that District's potential regulations would be based on findings of the regional inventory.

Because the Port of Oakland's 2005 inventory was already complete, no further work would be required for that port. The work would focus on creating a 2005 inventory for the remaining four public ports, in effect "catching them up" to the status of the Oakland inventory. The results for all five ports would be combined to create a regional inventory of maritime related emissions from the Bay Area's public ports.

The consultant team wrote a proposal containing the scope of work for the project. This document is an attachment to the MOA. The cost of preparing an inventory depends heavily on both the availability of data and the level of detail required for agency approval. With this in mind, the team decided a phased approach to the project would be the most cost-effective. As stated in the scope of work, the project is divided into four phases as follows:

> Phase I – collecting data for each port for each source category
> Phase II – developing a workplan based on the data collected
> Phase III – gaining acceptance of the workplan by the Steering Committee
> Phase IV – creating the inventory and writing the report

An important part of Phase I was to identify any significant issues or data gaps. The Phase I findings provided the groundwork to prepare a refined scope of work and cost estimates for Phases III and IV of the project.

In February 2008 the Phase I data collection effort began, with multiple interviews conducted at each port. Additional research, interviews, emails and phone calls with a variety of third party sources including the California Air Resources Board (ARB) and individual port tenants were conducted during the same period. Data collection continued through mid-April at which point a presentation was made to the Steering Committee on the findings of the data collection effort.

A key portion of the work to date has been to explain the different operations at each port and make recommendations as to which operations should be included or excluded from the inventory. The Port of Oakland's recently completed inventory was the primary source of guidance for this project, yet the operations in Oakland are limited to containerized cargo. The types of cargo and operations at the other four ports are far more varied than those found in Oakland. In fact, it should be noted that none of the other ports handles containers. Also unlike the Port of Oakland, the other four ports have tenants conducting non-maritime business.

The presentation to the Steering Committee meeting on April 23, 2008 gave an overview of each port with relevant statistics and a description of their operations and tenants. Aerial photographs were displayed showing the extents of the publicly owned land at each port. Specific recommendations were given on which operations to include in the inventory. For the sake of consistency and to avoid later confusion, the recommendations were made using a decision-making flow chart which is presented in Figure 1-1 of this document. At the same meeting, the data collection effort was reviewed and an outline of the workplan (this document) was handed out for comment. This detailed workplan (Phase II) and data collection report was written based on feedback received from that meeting.

This report culminates Phases I & II and describes how the team proposes to complete the Bay Area Seaports Air Emissions Inventory calculations (Phase IV) once the proposed methods are approved (Phase III).

1.2 Workplan Overview and Organization

This report outlines the data collection approach and the methods proposed to estimate emissions from seaport activities. The ports under consideration include Benicia, Redwood City, Richmond, and San Francisco. The purpose of this work is to lay the foundation for a regional emissions inventory for marine port activity for the year 2005. The source categories for which activity data were queried and collected include the following:

- Ocean-Going Vessels
- Harbor Craft (assist tugs, excursion vessels, pilot boats, other)
- Cargo Handling and other Off-road Equipment
- Trucks (freight) and Buses (passenger)
- Locomotives

Data for each source category received to date have been compiled and described in more detail in the port-specific Appendices A through D.

The proposed methods to calculate emissions for each of these source categories are described in this workplan report. During the emission estimation phase of this work (Phase IV), these data would be analyzed further to verify a reasonable level of activity for each source to support the known throughputs of the ports. The data collected are assembled in spreadsheets to facilitate emissions calculation in these subsequent phases of work.

The scope of activities for this report is based on the domain where vessel and on-road traffic can be well defined and includes the land based activity on port-owned property only used in the movement of marine freight. Marine-based activity on adjacent privately-owned marine terminals is not included, similar to the Port of Oakland's emissions inventory.

Drawings showing the proposed geographic limit and routing of each source category at each port have been prepared. An assumed routing of vessels, trains and trucks would be developed in Phase IV to allow for spatial allocation of emissions. Where multiple routes exist, an estimated distribution percentage would be developed based on any reliable existing data.

This report is organized as follows:

Section 1 (Introduction) presents a brief history of the project leading up to this workplan report and gives an overview of the workplan along with short descriptions of the four public Bay Area ports included in the study.

Sections 2 through 6 provide the proposed methodologies to be used to calculate the emissions from ocean-going vessels, harbor craft, cargo handling equipment, trucks, and locomotives during Phase IV of the project.

Section 7 (Next Steps) presents a description of Phases III and IV of the inventory work.

Section 8 (References) provides the references cited in this workplan.

Appendices containing port-specific activity data and additional methodological and data collection information are also provided as follows:

Appendix A: Port Of Benicia Activity Data
Appendix B: Port Of Redwood City Activity Data
Appendix C: Port Of Richmond Activity Data
Appendix D: Port Of San Francisco Activity Data
Appendix E: Locomotive Emission and Adjustment Factors
Appendix F: Cargo Handling and Other Off-Road Equipment Survey
Appendix G: Trucking Activity Survey

1.3 Method for Recommending Inclusion or Exclusion

During the development of the MOA for this study, the Steering Committee members agreed that this inventory would follow the methodology of the Port of Oakland's already completed inventory as much as possible. However, since the Port of Oakland handles containerized cargo exclusively and none of the other four ports in this study handles containers, it was not always simple to find an Oakland precedent. Each tenant at each port was evaluated individually using the following decision-making tree to decide whether a specific tenant activity should be included in the data collection phase and subsequent inventory. The flow chart for deciding inclusion or exclusion is shown in Figure 1-1.

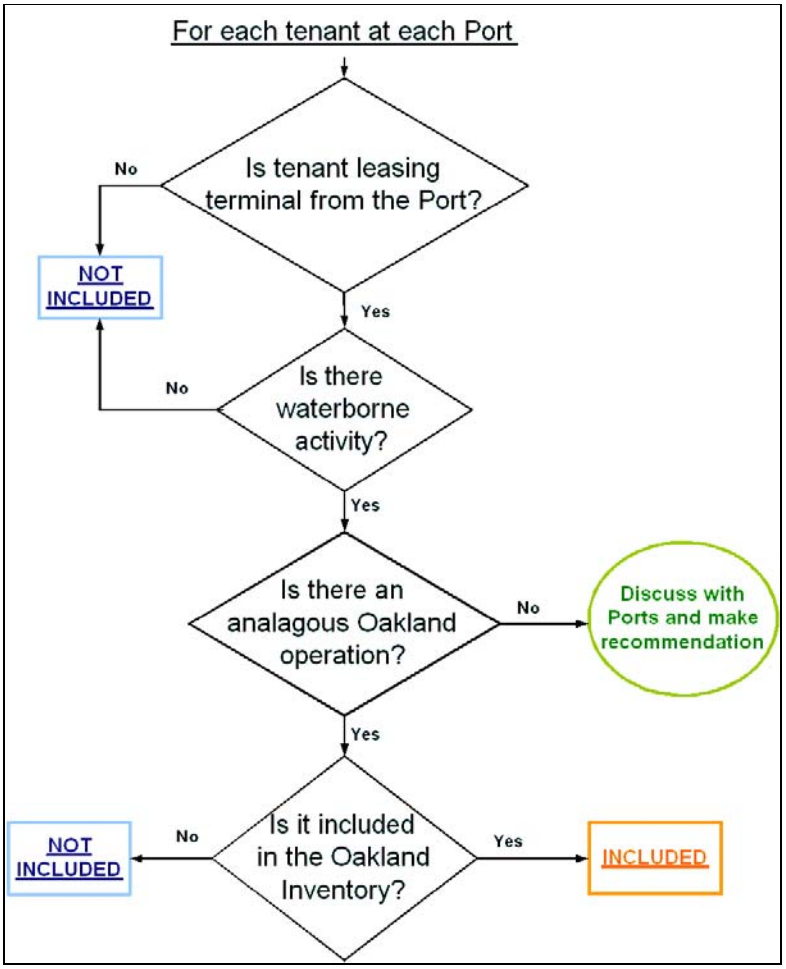

Figure 1-1. Decision-making tree

The Port of Oakland inventory which was completed in 2008 establishes two major precedents for exclusion. The first is that privately owned terminals (such as Schnitzer Steel) are not included. The second is that non-maritime operations (such as the small boat marinas or retail spaces in Jack London Square) on port-owned property are not included. The exclusion of ferry boats leaving from Oakland also led to the decision to exclude San Francisco's ferry boat terminal.

Appendices A through D of this report give tenant lists for each port that use the same color scheme as shown in the decision tree above. Tenants shown in orange are included; tenants listed in blue are not included. Tenants shown in green were given additional consideration resulting in a recommendation for inclusion or exclusion based on conversations with the Steering Committee.

1.4 Ports Overview

This section provides a brief description of the ports in this study. Appendices A through D along with accompanying data files provide a more detailed description of the activities at each port in 2005 as well as the data collected to date on these operations.

1.4.1 Port of Benicia

The primary freight that moves through the Port of Benicia is new automobiles and light-duty trucks. There is also a small petroleum coke operation. The major activity includes the roll off/roll (ro/ro) ships and heavy duty diesel trucks. Automobiles are driven off of the ro/ro ships and then driven to dealers or to a near-dock railroad or loaded onto car carriers and trucked off the terminal. There is also a non-maritime operation in which cars are trucked in, loaded into car containers, and then trucked off-site.

1.4.2 Port of Redwood City

The Port of Redwood City handles mostly dry bulk commodities such as gypsum and aggregate. The Port tenants include some without marine freight activity, and one private-property holder that received marine freight.

1.4.3 Port of Richmond

The public Port of Richmond has three main freight terminals and a few smaller non-freight berths. Two of the main terminals handle roll on/roll off ships and vehicles while the third receives bulk liquid cargo. Tug companies, a marine spill response company, and historic vessels use other berths within the Port.

1.4.4 Port of San Francisco

The Port of San Francisco operates about 7.5 miles of coastline, from the Hyde Street Pier in the north to the industrial areas south of PacBell Park to Islais Creek. The most visible operation is the cruise ship terminal located at Berth 35, but there are a variety of other recreational and industrial maritime activities at the Port including those listed below.

- Bulk Carriers
    - Dry bulk (aggregates, dredge sand)
    - Liquid bulk (tallow)
- Tug and Barge
- Ship repair
- Miscellaneous Harbor Craft
    - Dredging
    - Excursion vessels
    - Pilot vessels
    - Commercial fishing
    - Historic vessels

The land based activity serves these various source categories depending upon the type of freight moved and the operations at each terminal.

2.0 OCEAN-GOING VESSELS (OGV)

This section explains the emission estimation methods that would be used for the base year, 2005, for large deep draft vessels calling at the four ports in this study.

The spatial area contained within this study includes transiting vessels within the Bay Area expanding to activity to the outer buoys past the Sea Buoy to the berths at each port. The westerly extent of the activity is shown in Figure 2-1.

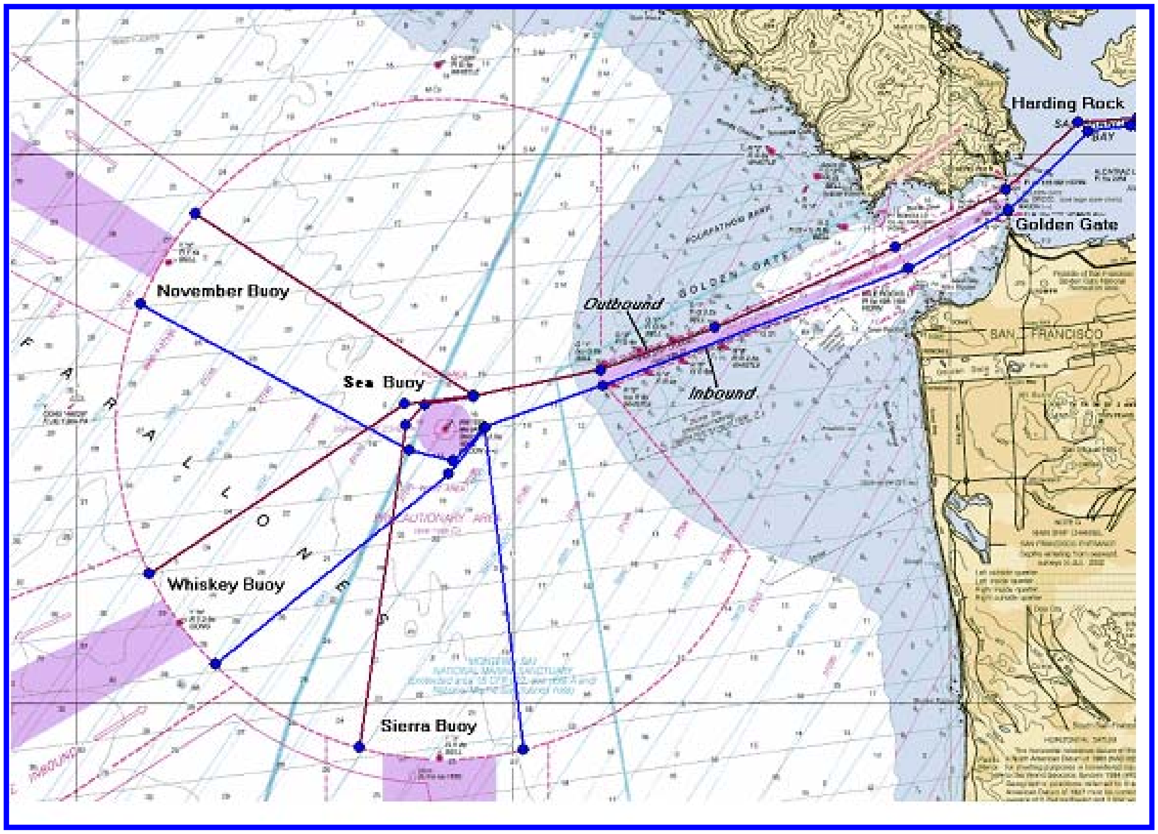

Figure 2-1. Link descriptions outside of the Golden Gate.

The vessel activity for each port would be described in terms of the vessel link from the outer buoys to near each port where the maneuvering model begins. The SF Bar Pilots would be interviewed to provide estimates of the ship route and speed during each approach and the maneuvering time necessary at each port. This per vessel activity would be combined with the port-supplied vessel calls and berthing times for 2005 to estimate the time in mode for all of the vessel activity in the domain.

The vessel calls for each port would be identified in terms of International Maritime Organization (IMO) number (a unique identifier for the vessel), vessel name, berth, berthing date and time stamps, and last and next ports of call. For ships that call on multiple ports (including Oakland) within the Bay Area, the call would be assigned a primary port, so that transiting would not be double counted. The Port of Oakland emission inventory (ENVIRON, 2008) assumed that all calls to Oakland were primary port calls, so those vessels calling at Oakland that also call one of the studied ports would be considered a secondary activity in this study.

2.1 Emission Calculation Methodology

The emission control methodology would follow the ship transit and hotelling modal activity analysis for each vessel call that was collected under this phase of the work. The considerations for determining emissions used the following information to estimate proper input parameters.

- Ship Characteristics
  - Vessel type (e.g. container, bulk, tanker, roll on/roll off)
  - Model year
  - Vessel service speed
  - Propulsion power (engine type either 2-stroke slow speed or 4-stroke medium speed)
  - Auxiliary power (either engine rated power or auxiliary generator capacity)
- Ship call
  - Route in (last call)
    - Cruise
    - Reduced Speed Zone
    - Maneuvering
  - Berthing (time)
  - Anchorage (before or after berthing mode)
  - Route out (next call) with same modes out

The emissions would be calculated by multiplying the rated power of the engines, load factor (speed dependent for propulsion power or surveyed auxiliary), time in mode, and emission factors appropriate to the engine type and average load.

2.2 Engine Load Factors

Propulsion power and vessel speed would be derived from the Lloyds database, which reports design features for each vessel. To obtain estimates of maximum power and speed, the survey data from the Port of Los Angeles emission inventory study (Starcrest, 2005) would be used to adjust the Lloyds estimates as shown in the equations below.

Vessel Propulsion Power = Lloyds Power / (0.968)

Vessel Maximum Speed = Lloyds Vessel Speed / (0.968)

The load factors for the propulsion power over any given link would be determined from the classic Stokes Law cubic relationship for speed and load. The proportional relationship of load to the vessel speed can be expressed as in the following equation where the 100% load factor would correspond to the vessel operating at its maximum speed.

$$\textit{Load Factor} = (\textit{Vessel Speed} / \textit{Vessel Maximum Speed})^3$$

From the Port of Los Angeles study (Starcrest, 2005), the cruise speed of the vessel was estimated to be 0.937 of the maximum speed. This calculation of the load factor at the cruise speed resulted in a load factor of 0.823 during cruise conditions.

The total auxiliary power can be estimated from auxiliary generator capacity available in the Lloyds database and supplemented by other available data and estimates. ARB (2005a) determined load factors from ship surveys conducted in California, shown in Table 2-1.

Table 2-1. Ocean-Going Vessels – Auxiliary engine load factors.

Ship-Type	Cruise	Reduced Speed Zone (RSZ)	Maneuver	Hotel
Auto Carrier or RORO	0.15	0.15	0.45	0.26
Bulk Carrier or General Cargo	0.17	0.17	0.45	0.10
Container Ship	0.13	0.13	0.50	0.18
Passenger	0.13	0.13	0.50	0.16
Refrigerated Cargo Vessels	0.15	0.15	0.45	0.32
Tanker	0.24	0.24	0.33	0.26

Source: ARB, 2005

2.3 Emission Factors

ARB (2006a) provided a set of emission factors to be used in this study for consistency with other work performed for the San Pedro Bay ports and elsewhere in California. These emission factors are shown in Table 2-2.

Table 2-2. Ocean Going Vessels – Emission factors.

ARB Provided Emission Factors (g/kW-hr)					
Engine Type	Fuel Type	HC	CO	NOx	PM
Slow Speed	Residual Oil	0.6	1.4	18.1	1.50
Medium Speed Propulsion	Residual Oil	0.5	1.1	14.0	1.50
Medium Speed Auxiliary	Residual Oil	0.4	1.1	14.7	1.50
Medium Speed Auxiliary	Marine Distillate (0.5% sulfur)	0.4	1.1	13.9	0.38
Steam Boiler	Residual Oil	0.1	0.2	2.1	1.50

Sources: ARB, 2006a

ARB (2005a) determined from ship surveys that 71% of container vessels used residual oil and 29% used distillate in their auxiliary engines. Because it would be difficult to determine which vessels use the residual and distillate fuels, a weighted average of the emission factors for all auxiliary engines would be determined. For the Port of Oakland Study, ENVIRON estimated the average emission factor for auxiliary engine emissions by multiplying the medium speed auxiliary emission factors using residual oil by 71%, and the medium speed auxiliary emission factors using marine distillate by 29%, and adding the two together.

Emission factors for OGV would be derived from data at high operational loads. Factors are used to adjust the emission factors which were derived at higher operation loads, for conditions when engines are operating at very low loads where the engine is not as efficient. Table 2-3 shows the adjustment factors to apply to the propulsion engine emission factors for slow speed conditions.

Table 2-3. Ocean Going Vessels – Low load adjustment factors for propulsion engines.

Load %	HC	CO	NOx	PM[1]	SO2
2	31.62	10.00	4.63	5.60	1.00
3	17.21	6.67	2.92	4.03	1.00
4	11.18	5.00	2.21	3.19	1.00
5	8.00	4.00	1.83	2.66	1.00
6	6.09	3.33	1.60	2.29	1.00
7	4.83	2.86	1.45	2.02	1.00
8	3.95	2.50	1.35	1.82	1.00
9	3.31	2.22	1.27	1.65	1.00
10	2.83	2.00	1.22	1.52	1.00
11	2.45	1.82	1.17	1.40	1.00
12	2.15	1.67	1.14	1.31	1.00
13	1.91	1.54	1.11	1.22	1.00
14	1.71	1.43	1.08	1.15	1.00
15	1.54	1.33	1.06	1.09	1.00
16	1.4	1.25	1.05	1.03	1.00
17	1.28	1.18	1.03	1.00	1.00
18	1.17	1.11	1.02	1.00	1.00
19	1.08	1.05	1.01	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00

[1] – Source: ARB (2006a)

A 2% average load would be used to estimate emissions for the maneuvering mode. For reduced speeds, such as the 13.5 knots reduced speed zone mode between the Golden Gate Bridge and the Sea Buoy, the load could be lower than 20%. The reduced speed zone load factor would be derived specifically for each vessel as the cube root of the ratio of actual speed, 13.5 knots, and the maximum speed of the vessel. The low load adjustments in Table 2-3, except for the PM adjustments in Table 2-10, would be applied to the reduced speed zone and the maneuvering modes.

3.0 HARBOR CRAFT

The harbor craft category includes assist tugs, towing tugs, dredging boats, excursion vessels, pilot boats, and fishing boats. A port may serve as the permanent berth, or home berth, for the harbor craft or the port's operations may demand or be available for harbor craft activity. The data collection for this study includes the vessel type, name if available (or a list of vessels likely to be used in service), engine propulsion and auxiliary power, and hours of operation at the port or on port business.

Ferries were specifically excluded from this analysis for several reasons. Ferries are operated by a limited number of companies and should be characterized independently of the ports they serve. The ferries operate between two ports within the study area as well as other ferry terminals not included in the study, so assigning all ferry emissions to one of the study ports misinterprets the activity. Lastly, ferries were excluded from the Port of Oakland's emission inventory, so they would also be excluded from this one.

Assist tug activity is activity directly related to the maneuvering of OGV vessels near and in port. The assist tugs may be based at the port under study or be based elsewhere in the Bay, and could be one or more of a revolving list of vessels based in the San Francisco Bay at any given time. In either case, the tug activity demanded by port traffic would be estimated in terms of the number of hours within the harbor or while in transit to and from the home berth to the channel or berth where the tug would pick up the vessel prior to it maneuvering mode either into or out of the port.

Unlike the Port of Oakland study, the ports in this study have barge vessel traffic which needs to be characterized in a similar manner to the OGV activity. The tug and barge transit trips to the port would be treated the same as the OGV vessel calls. The last and next port of call for the tug would be determined to estimate the tug route to and from the port. The transit time in the spatial area of this study (either out to the outer buoys or within Bay) would be estimated for each call.

Dredging activity incorporates both port-contracted dredging within the harbor and Army Corps dredging in the channels leading to the port. The port-contracted dredging includes harbor draft maintenance projects, and can involve unique kinds of equipment on a case-by-case basis. The Army Corps dredging in the channels leading to the port ensures access to the port and is often done with Army Corps contracted dredging vessels. An estimate of the hours of operation along with the dredging vessels' installed power would be used to describe the activity of these vessels.

In addition, some of these ports provide dock space for harbor craft either on a permanent or temporary basis. The characterization of these tug berthings would include the time and operation while berthed as well as transit within the study area. Harbor craft and tugs often cold iron if the stay is extended, so in addition to the berthing times the typical operations in terms of engine operations while berthed need to be well characterized.

Lastly, a variety of harbor craft vessel types are found at these ports including excursion, research, pilot, and fishing vessels. It may be more difficult to determine precise routes for the movements of these vessels, but the vessels have been identified with the home port and estimated activity within the bay indicated.

3.1 Emission Calculation Methodology

Harbor craft emissions would be estimated using the following equation:

Emissions = Rated power x load factor x operating hours x emission factor

The emissions are based on vessel rated power and hours of operation. Load factors for different types of harbor craft would be reviewed with ARB to determine specific loads for different types or harbor craft. ARB would supply the emission factors input parameters for new engine emission and deterioration rates to estimate the in-use emissions factor for each vessel.

The auxiliary engine emissions would be estimated using the same basic equation.

4.0 CARGO HANDLING AND OTHER OFF-ROAD EQUIPMENT

Cargo handling equipment has been loosely defined as any equipment used to move freight to and from ships arriving at ports and more specifically defined by a list of equipment types by ARB (2005b). To date, studies (Starcrest, 2005 and ENVIRON, 2008) have focused on equipment primarily used to move containers. The ports in this study do not move containers, so the equipment used is atypical of cargo handling equipment. Therefore the approach used in this study was to identify all of the off-road equipment regardless of its use at the terminals.

The team has collected information on the equipment population by source type, rated power, hours of operation, and other relevant indicators necessary for estimating emissions.

4.1 Emission Calculation Methodology

Annual CHE emissions would be estimated for each piece of equipment according to engine characteristics (model year, rated power, and equipment type) and equipment activity (hours of operation). Year 2005 equipment population and type, engine characteristics, and operation estimates were derived from surveys of terminal operators. Per ARB (2005b) guidance, the following types of equipment would be used to categorize CHE:

- Cranes (including rubber tire gantry cranes)
- Excavators
- Forklifts
- Container Handling Equipment
- Other General Industrial Equipment
- Sweeper/Scrubbers
- Tractor/Loader/ Backhoe
- Yard Trucks

Cargo handling equipment emissions would be calculated using the following equation:

$$E_p = EF_{p,t} * (1 - CF) * LF * n * hp * hrs$$

where: E_p = annual emissions of pollutant "p"
and
EF = emission factor (g/hp-hr)
CF = control factor (% reduction) by pollutant
LF = load factor (average load expressed as a % of rated power)
n = equipment population
hp = rated power (hp)
hrs = hours of activity per year (hr/year)
p = pollutant species (ROG, CO, NOx, PM10, SO_2)
t = equipment type

Emission factors depend on the fuel type, model year, rated power, cumulative hours/age, and retrofit control factor, if applicable.

Unless terminal operators have equipment specific operation and characteristics available, load factor, useful life, and retrofit control factors would be taken from CHE emissions inventory guidance documentation published by ARB (2005b). Zero hour emission factors, deterioration rates, fuel correction factors would also be taken from ARB (2005b) CHE inventory guidance documentation. For off-road equipment types not defined as CHE, the input data would be derived from the OFFROAD2007 (http://www.arb.ca.gov/msei/offroad/offroad.htm**)** emission inventory model in conjunction with equipment characteristics (model year, rated power, equipment type) and operation (hours of operation) as provided by the terminal operator.

5.0 TRUCKS AND OTHER HEAVY-DUTY VEHICLES

Activity considered in this category would be heavy duty trucks which transport freight to and from port facilities, supply trucks associated with excursion vessels, and passenger buses which transport people to and from the port as part of cruise or excursion vessel operations.

Trucks are the primary method for moving freight to and from some of the terminals included in this study. The number of truck trips depends upon the operations and business at the terminal.

5.1 Emission Calculation Methodology

Heavy duty vehicle emissions would be estimated by characterizing the trips to and from the marine terminals. Survey data collected for gate counts along with estimates of trip mileage, average speed per road link, idle time within the terminal, and the route to and from the terminal to the point at which it is no longer possible to estimate the route (typically the nearest freeway interchange). The truck emissions would be estimated using the following equation.

$$E_p = n_{Truck\ Trip} * Miles_{Trip} * EF$$

where: E_p = emissions of pollutant "p"
n = number of trips
Miles = trip mileage or hours at idle
EF = emission factor (g/mile, g/hour).
(Requires trips to be defined by speed)

Input activity data would be gathered from several distinct sources. Heavy-duty vehicle trips would be estimated for each terminal and applied to one of various routes within the port area. The necessary input data are as follows:

1) Heavy duty vehicle trips (to and from freeway or off-site storage)
2) Trip mileage (routes)
   a) Outside of the marine terminals
   b) Within the marine terminals
3) Idle time
   a) Outside marine terminals entrance queues
   b) Within marine terminal
4) Emission factors derived from the EMFAC2007 model based on
   a) Gross vehicle weight rating (GVWR)
   b) Age distribution
   c) Average trip speed by road link
   d) Idle emission rate

5.2 Trip Counts

The most basic measure of heavy-duty vehicle activity is the number of trips through each terminal facility, where a trip includes both an entrance and an exit by the heavy-duty vehicle.

For terminals where heavy-duty vehicle trips consist primarily of long haul diesel trucks, which are tracked as the truck enters and leaves the facility, gate counts would be used as a primary measure of activity. To estimate the truck trips at such facilities, a gate count survey was conducted of the terminal operators.

For terminals such as fish processors or excursion vessels where tracking of trucks or buses in and out of the facility is not performed, people familiar with the operations would be queried to provide their best estimate of such activities.

5.3 Truck Routes

Speeds on each route would be taken from terminal operators' survey responses. The emissions would be estimated for the route from each terminal to the nearest main intersection (usually a freeway interchange) from the mileage and average driving time.

5.4 Emission Factors

The EMFAC2007 model would be used for this analysis because this is the approved model for emission factors analysis. The vehicle model year is an important parameter to include in the modeling, so a fleet characterization would need to be determined or estimated. If a port or operator is able to provide data that allows for the estimation of fleet age distribution for trucks at a given facility, the facility-specific age distribution would be used to estimate emission factors. If facility-specific age distribution information is not available, EMFAC2007 default age distribution would be used. Figure 5-1 shows the emission rates at 10 mph by model year of heavy heavy-duty trucks.

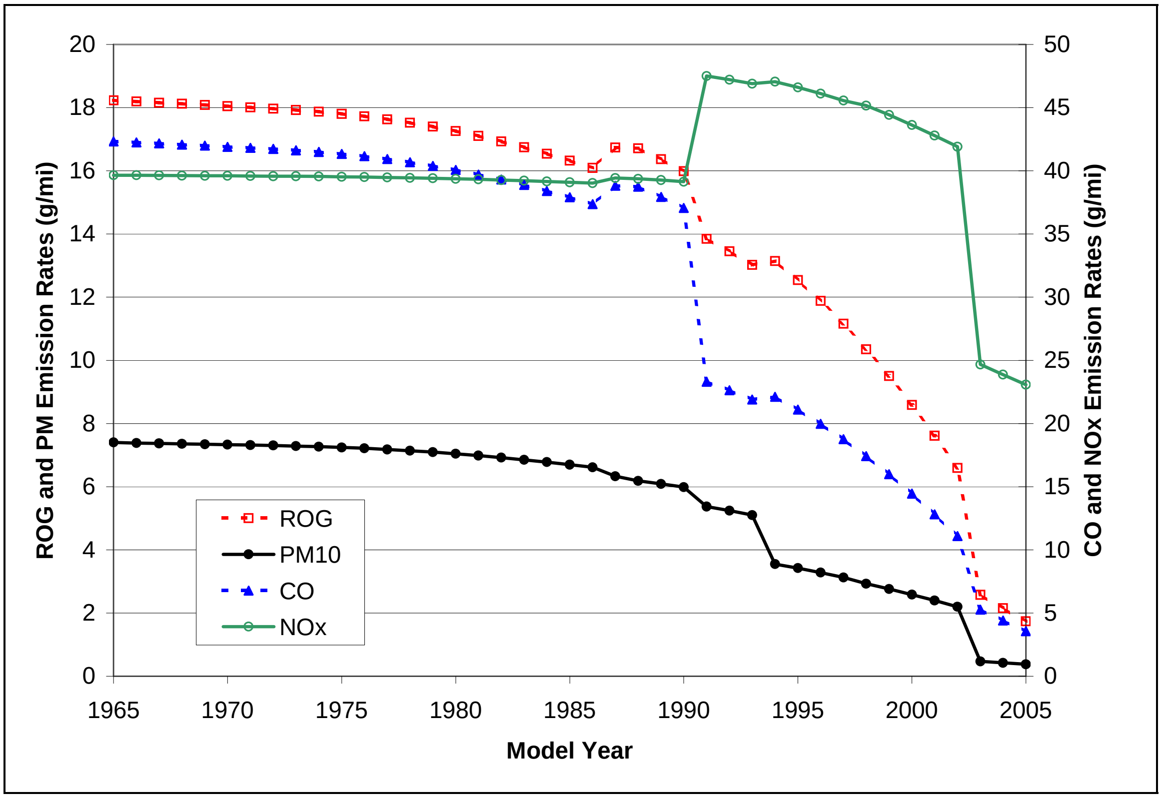

Figure 5-1. Truck emission factors at 10 mph in 2005 as modeled by EMFAC2007.

6.0 LOCOMOTIVES

Locomotive activity is present only at the Ports of Redwood City and San Francisco. Union Pacific serves the Port of Redwood City, and the San Francisco Bay Railroad serves the Port of San Francisco moving cars off port to the Union Pacific main lines. Equipment operation at these two ports has been surveyed to gather information from these two railroad operations.

6.1 Activity Data Collection

The activity data that railroads typically record is fuel consumption, but Union Pacific may also be able to provide hours of engine operation and duty cycle information. With the fuel consumption rate for the locomotives and duty cycle estimates, the hours of operation could be estimated or vice versa.

ARB (2006b) has laid out a methodology for preparing inventories at rail yards that requires time in notch activity information. Notch settings are power settings that run from 1 to 8 with two additional settings for idle and dynamic braking. To determine the relative time in notch, specially designed software is available for certain models but not all locomotives. Data of time in notch are not universally available for the older models usually used in local or switching operation at ports. EPA (1998) has proposed a typical time in notch duty cycle for switching engines that may be used to simulate activity while in operation at the port.

In addition, it may be difficult to precisely distinguish on-port and off-port activity for the locomotives. A best estimate of the relative activity on and off port grounds would be made. Ultimately, a time in notch while on port grounds would be estimated to provide a basis for estimating emissions.

6.2 Fleet Characterization

The type of locomotive model used is important to its emission rates. The larger and higher rated power the engine, generally the higher emission rates. However with the advent of emission regulations of locomotives starting in 2000 with Tier 0 new engine and retrofit standards and Tier 1 and Tier 2 standards for new engines starting in 2002 and 2005, the make and model of engine become important input data. The emission factors depend upon the make and model of the engine as described in detail in the next section.

The SF Bay Railroad uses a special type of locomotive built originally in 1946. ARB is undertaking emission studies of this type of locomotive, which would be used to estimate emissions from these locomotives.

6.3 Summary of Locomotive Emission Factors by Engine Model

Emission factors to be used in this study would be based primarily on the emission factors used in the risk assessment study for the Union Pacific Roseville facility (ARB, 2004), and the Southwest Research Institute (SwRI, 2000) study sponsored by ARB, entitled “Diesel Fuel Effects on Locomotive Exhaust Emissions”. Since publication of the Roseville report, ARB has provided additional emission factors for criteria pollutants, and made some adjustments to the original Roseville data (ARB, 2006c). Emission factor data from the Exhaust Plume Study performed by SwRI (2005) would also be utilized.

The PM emission factors relevant to locomotives are summarized in Table E.1 for several different locomotive model groups and certification tiers. Specific locomotives and engines in each locomotive model group can be inferred from the fleet characterization described for a facility. Based on conversations with the principal researcher on all the locomotive studies (SwRI, 2006), a fuel sulfur content of 0.3% was used on all emissions test results and certification data produced with locomotives to date. The emission rates using this 0.3% sulfur fuel are reflected in Appendix E (Table E.1). The factors affecting the emission rates include the engine's rated power and the certification standard to which the engine was defined including precontrolled (before emission standards), Tier 0, Tier 1, or Tier 2 levels.

The fuel sulfur correction methodology described by ARB (2005c) would be used to adjust PM emission rates from an average fuel sulfur level of 0.3% to 0.105% using the fuel sulfur – PM relationship equation, A + B * (fuel sulfur, ppm). The emission reductions calculated for 2-stroke and 4-stroke engines shown in Appendix E (Table E.2) would be applied to the base emission rates to calculate the emission rates at the in-use fuel sulfur levels. Fuel consumption estimates are shown in Appendix E (Table E.6).

Emissions for other criteria pollutants would be calculated in a similar manner, by engine model and by notch setting. Emission factors for these other pollutants are shown in Appendix E (Tables E.3, E.4, and E.5). No correction to the NOx emission rates to account for the partial use of California diesel would be made because the fuel used in specific engines at specific facilities is not known and the impact of low sulfur ARB diesel fuel on NOx is small.

6.4 Locomotive Activity

Locomotives may have three main activities in any rail yard: service (fueling and engine maintenance), line-haul (originating, terminating or passing), and switching (making up trains or repositioning cars). Locomotive activity during service may consist of idling during simple refueling, or loaded engine test modes before or after engine maintenance. However for the ports in this study only local short-haul and switching activity were discovered.

Line-haul activity is typically associated with origination or termination of train movements. Locomotives might enter the port area and may idle for a significant period while the train is unhooked and before the next train is ready to depart.

Switching engines are usually from a locally based roster from which the activity is derived. Based on the roster, either fuel consumption or hours of operation can be used to characterize the switching engine activity. While it is helpful to have duty cycle information, switching engines are often not configured to record operational events.

7.0 NEXT STEPS

The consulting team proposed a phased approach to this project in an effort to address the uncertainties inherent in estimating the level of effort required for an emissions inventory. The concept was to have an initial step of data collection and workplan development (i.e. find and collect the available data, and then develop a proposed methodology for the inventory based on those data). This report documents the data collection efforts performed and describes the workplan proposed for developing the emissions estimates. Once reviewed and accepted by the Steering Committee, this report would conclude Phases I & II of the project.

The next phases of the work are Phases III and IV. Phase III was described in the consulting team's proposal as:

Phase III – Agency negotiations and methodology approval

> *Once we have developed a detailed workplan methodology based on available data (in Phase II), the Team will work with BPC to obtain agency agreement to the workplan, scope, methodology, and level of detail. This could involve expanding the workplan to include additional data collection efforts if required by the agencies.*

The level of effort necessary for Phase III depends on the number of Steering Committee meetings required to secure approval of the scope and methodology for the remainder of the inventory effort. If the Steering Committee reaches quick consensus, and negotiations with ARB or additional data gathering are not required, then the amount of effort for this phase would be minimal.

Phase IV was described in the consulting team's proposal as:

> *Phase IV would be the execution of the final "agreed-to" workplan resulting from Phase III. Phase IV would include a detailed report with emissions broken down among the various ports, sources and locations of the emissions for each pollutant.*

After review and approval of this report, the team will be prepared to move on to Phase IV. The consulting team can provide a fee proposal for Phases III & IV based on feedback from the Steering Committee on this report. It may be that limited additional effort is required for Phase III, depending on the nature of comments received from the Steering Committee. In the meantime, the consulting team will prepare individual cost estimates for each Port for the execution of Phase IV. The cost estimates will based on the level of effort required at each Port.

8.0 REFERENCES

ARB. 2006a. Email from Dan Donohue of ARB to Chris Lindhjem of ENVIRON, May 9, 2006.

ARB. 2006b. "ARB Rail Yard Emissions Inventory Methodology," July 2006. http://www.arb.ca.gov/railyard/hra/1107ei_guideline.pdf

ARB. Dan Donohue, Air Resources Board, from "Roseville Rail Yard Study," 2004. http://www.arb.ca.gov/diesel/documents/rrstudy.htm. May 9, 2006, *personal communication.*

ARB. 2005a. "2005 Oceangoing Ship Survey Summary Of Results," September 2005, Appendix C, Rulemaking to Consider the Adoption of Proposed Regulations to Reduce Emissions from Auxiliary Diesel Engines and Diesel-Electric Engines Operated on Ocean-Going Vessels Within California Waters and 24 Nautical Miles of the California Baseline, December 8, 2005. http://www.arb.ca.gov/regact/marine2005/marine2005.htm

ARB. 2005b. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking. Regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards", California Air Resources Board, http://www.arb.ca.gov/regact/cargo2005/cargo2005.htm, October, 2005; and "Rulemaking to Consider the Adoption of a Proposed Regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards," December, 2005.

ARB. 2005c. OFFROAD Modeling Change Technical Memo, "Changes to the Locomotive Inventory," prepared by Walter Wong, preliminary draft. March 16, 2005.

ARB. 2004. "Roseville Rail Yard Study," Stationary Source Division of the California Air Resources Board, October 14, 2004.

EPA. 1998. "Locomotive Emission Standards," Regulatory Support Document, United States Environmental Protection Agency, Office of Mobile Sources, April 1998.

ENVIRON. 2008. "Port Of Oakland 2005 Seaport Air Emissions Inventory," Prepared for the Port of Oakland, March, 2008.

Marine Exchange of the SF Bay Region. 2006. Personal communication with Allen Steinbrugge.

San Francisco Bar Pilots. 2006. Personal communication with Ken Levin.

Starcrest. 2005. "Port of Los Angeles Baseline Air Emissions Inventory - 2001," Prepared for: Port Of Los Angeles, Prepared by Starcrest Consulting Group, July, 2005.

SwRI. 2006. Personal communication between S. Fritz of SwRI and C. Lindhjem of ENVIRON, May, 2006.

SwRI. 2005. "Exhaust Plume Study," correspondence with Steve Fritz at SwRI, September 2005 and May 2006.

SwRI. 2000. "Diesel Fuel Effects on Locomotive Exhaust Emissions." Prepared for California Air Resources Board, October 2000.

APPENDIX A

PORT OF BENICIA

PORT OF BENICIA

The primary tenant at the Port of Benicia is AMPORTS. They import new vehicles using RO/RO (roll on/roll off) ships. A second tenant, Kinder Morgan, leases a small terminal on the port, including a silo and some rail tracks, for their petroleum coke export business. There are two other tenants on the port property, Suba Manufacturing and Greenbrier, both of whom conduct non-maritime related operations.

The Port of Benicia conducts a significant amount of tug boat lay berthing. The tug boats that lay over at Benicia are from all different companies operating in the bay. A typical scenario would be a tug who's home berth is somewhere in the central part of the bay who has multiple jobs to do in the north bay and needs a place to tie up between jobs to avoid excess traveling.

Figure A-1 shows an aerial view of the Port of Benicia, with the property boundaries shown in white. The tenants are labeled with the number of ship calls on each berth in 2005.

Figure A-1. Port of Benicia

Figure A-2 is a schematic summary of the amount of cargo, the direction of cargo flow, and the number of ship calls for Benicia in 2005.

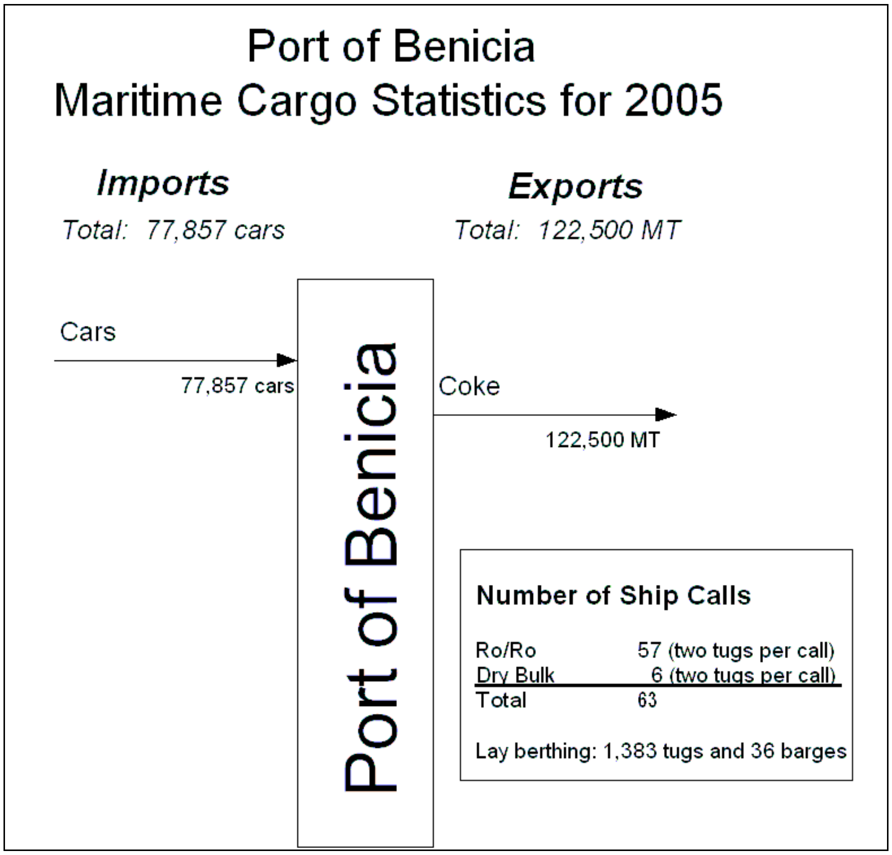

Figure A-2. Schematic of the Port of Benicia cargo flow

The diagram in Figure A-3 lists the tenants at the Port of Benicia, and shows the mode of both waterside and landside transport along with the arrows which indicate the direction of flow of the commodity. The two tenants shown in orange would be included in the inventory. The two tenants in blue would not be included in the inventory because they are privately owned terminals or they are not conducting maritime business, or both.

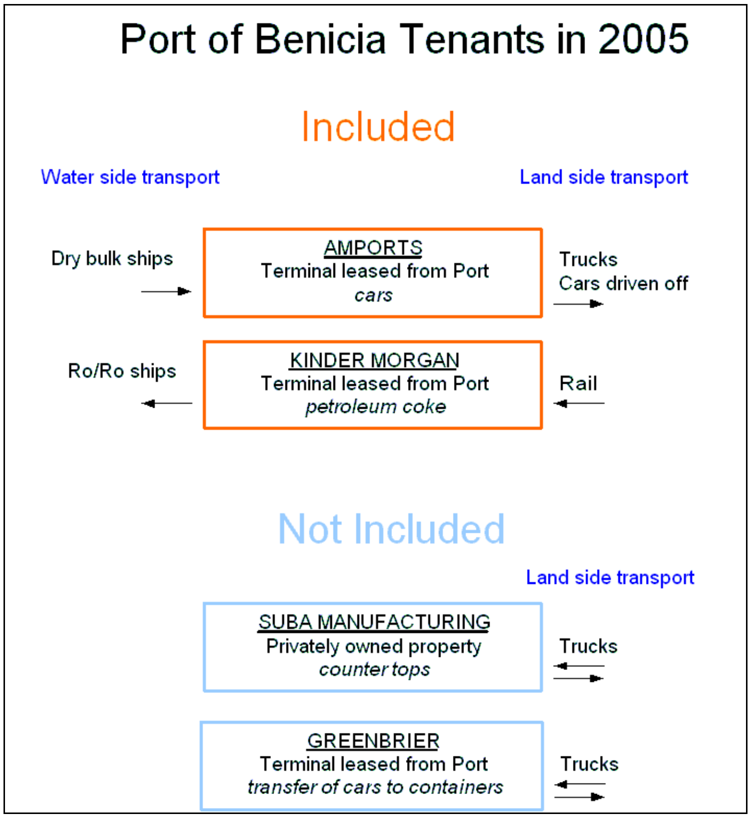

Figure A-3. Terminals and commodity flow modes at the Port of Benicia

A.1 Ocean-Going Vessels

The Port of Benicia provided complete vessel call data for 2005 and 2006. The data include arrival date, arrival time, departure date, departure time, vessel name, vessel operator, ship type, arrival berth, and amount of cargo transferred (file can be found on attached CD: Benicia/OGV/2005-2006 vessels.xls"). These vessel calls would be checked against the ARB database to determine if the vessel's arrival or departure was directly to or from sea or whether it stopped at other Bay Area ports or anchorages along its route.

A.2 Harbor Craft

Representatives from the port gave us anecdotal information that each Ro/Ro vessel typically uses two assist tugs to berth and two assist tugs to leave. Similarly, each petroleum coke ship uses two assist tugs in and two out.

The Port provided a spreadsheet of their records for lay berthing in 2005. The information is organized with each month as a separate tab, and each day of the month as its own column. The name and company of the berthing tug or barge is reported, along with an "X" for each day that it paid for lay berthing. In Benicia, a tug pays for lay berthing in 24-hour increments; the "X" is placed on the day the 24-hour period begins. A tug can come and go as many times as it wants in the 24-hour period. There is no power supply on the dock, so the tugs run their auxiliary engines the entire time they are at berth. (file can be found on attached CD: Benicia/HC/"2005 Tugs & Barges.xls")

The Port provided a sample week's worth of lay berthing arrival and departure times, which can be used to establish an average length of stay per 24-hour period. The sample period is from January 6 – 12, 2008. According to the Port, there has been no significant change in berthing patterns between 2005 and 2008, so the 2008 sample gives a fair representation of berthing times. (file can be found on attached CD: Benicia/HC/"Tug Hours.xls")

The Port reported that Manson performed their dredging in 2005, and that they moved 39,892 cubic yards in November of that year.

A.3 Cargo Handling and Other Off-road Equipment

The Port of Benicia was provided with a survey for maritime cargo handling and other off-road equipment operations and characteristics as shown in Appendix F. Port of Benicia provided survey responses inclusive of all maritime related cargo handling and off-road equipment. As shown in Table A1, the maritime related equipment fleet consists of a portable crane, forklifts, a backhoe, sweeper, various pumps, a compressor, and a welder. Of the total 14 pieces of equipment, eight pieces of equipment are gasoline fueled, one is propane fueled, and five are diesel fueled. The fleet is generally aged, with only one piece of equipment of model year post 1981. In numerous cases horsepower specifications were not available.

Table A1. Port of Benicia cargo handling and off-road equipment 2005 characteristics

Operator	Berth	Equipment Type	No. of Pieces	Fuel Type	Model Year	Retro-fit	Rated Power (hp)	Activity (hr/year)
Benicia Port Terminal Company	BNC1 & BNC2	portable crane (propulsion)	1	G	1967	N	250	50*
		portable crane (equipment)	1	G	1967	N	100	60
		Forklift	1	G	pre-1975	N	NA	20
		Forklift	1	G	pre-1975	N	NA	100
		Forklift	1	G	pre-1975	N	NA	185
		Forklift	1	P	pre-1975	N	NA	240
		Backhoe	1	D	1972	N	60	144
		Sweeper	1	G	pre-1975	N	28	50
		Fire pump driver	1	D	2003	N	360	26
		Fire pump driver	1	D	1981	N	215	12
		Storm water pump	1	D	1976	N	70	13
		Air compressor	1	G	pre-1975	N	NA	24
		Welder	1	G	pre-1975	N	NA	10
		Air Compressor	1	D	1972	N	NA	110

* activity in miles/year

A.4 Trucking (Freight) and Bus (Passenger)

The Port of Benicia was provided with a survey for trucking operations and characteristics as shown in Appendix G. Port of Benicia provided survey responses inclusive of maritime related trucking activity. As shown in Table A2, in 2005 there were 2,660 visits to the terminal for maritime related truck activity. Anecdotal evidence suggests that the trucking fleet is newer than an average fleet, though license plate information that would allow for the estimation of fleet age distribution is unavailable.

Table A2. Port of Benicia trucking activity 2005 characteristics

				Within Terminal Activity			Outside Terminal
Operator	Berth	Vehicle Type	Annual No. of Visits	Idle Time Per Visit (min)	Average Speed (mph)	Onsite Distance Per Visit (miles)	Idle Time Per Visit (min)
Benicia Port Terminal Company	BNC1 & BNC2	HHDDV	2,660	5	15	0.78	0

Figure A-4 shows the truck route from the berths to the nearest freeway interchange to be used to estimate off terminal truck activity. Mileage and speed along the route would be determined when estimating emissions.

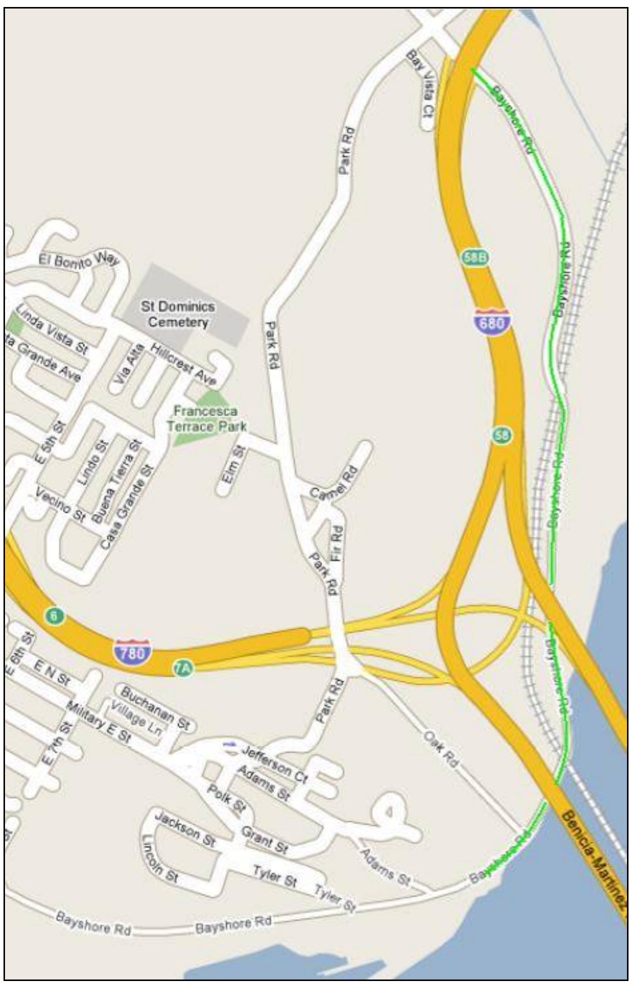

Figure A-4. Benicia truck route (green)

A.5 Locomotive

There is no locomotive activity on the port grounds.

Union Pacific deposits and retrieves cars for the Kinder Morgan depot, but the locomotives never actually arrive on the site, instead staying at the head end off the port grounds. Kinder Morgan has low volume compared with many rail operations. Union Pacific also serves the port with their off-site rail yard for the passenger cars and trucks on the other side of the Benicia – Martinez Bridge.

APPENDIX B

PORT OF REDWOOD CITY

PORT OF REDWOOD CITY

The Port of Redwood City hosts a diverse set of activities, but their main industry is importing bulk materials, like aggregate, sand, bauxite, cement, and gypsum. Their largest tenants, by area, are Cemex Aggregates and Cemex Cement. (Cemex Aggregates terminal was run by Harbor Cement until November of 2005 and Cemex Cement was run by RMC Pacific Materials until November of 2005.) The Cemex Aggregates terminal is split into two areas, with Cemex Cement lying in between. The Cemex Cement terminal is privately owned, however since their maritime cargo crosses a port-owned dock, they are included in the inventory. PABCO and IMI are two other tenants with bulk import operations. SIMS is the only tenant at Redwood City with an export business. They export scrap metal.

Redwood City has a number of tenants who conduct no maritime business, including a swimming pool chemical supplier, a concrete batch plant, a waste fuel processing business, and others. All of these tenants receive and deliver their goods via either truck or rail. The emissions from their operations are not included in this inventory because there is no waterside transport component of their businesses. Essentially, they could be located in any industrial zone, not necessarily a port setting.

Redwood City also has a small amount of excursion vessel and harbor craft traffic. In 2005, the U.S. Geological Survey had a terminal and a research vessel docked there. The Sea Scouts, which takes boys on trips in the bay, has three to four vessels docked in Redwood City, although they do not have a terminal. The Yorktown Clipper is small cruise ship that calls regularly at Redwood City. Passengers typically arrive and depart by bus, and there are supply trucks associated with the vessel's arrival. In 2005 there was also one call by the Hornblower, a charter ship that took passengers from Berkeley to Redwood City where they left via bus to attend the "Big Game" at Stanford University.

The aerial in Figure B-1 below shows the Port of Redwood City, labeled with the tenants and vessel calls included in this study.

Figure B-1. Port of Redwood City

Figure B-2 is a schematic summary of the quantities of goods being shipped through Redwood City in 2005 and shows the direction of flow. It also shows the number and type of ship calls, excluding the smaller excursion vessel outings.

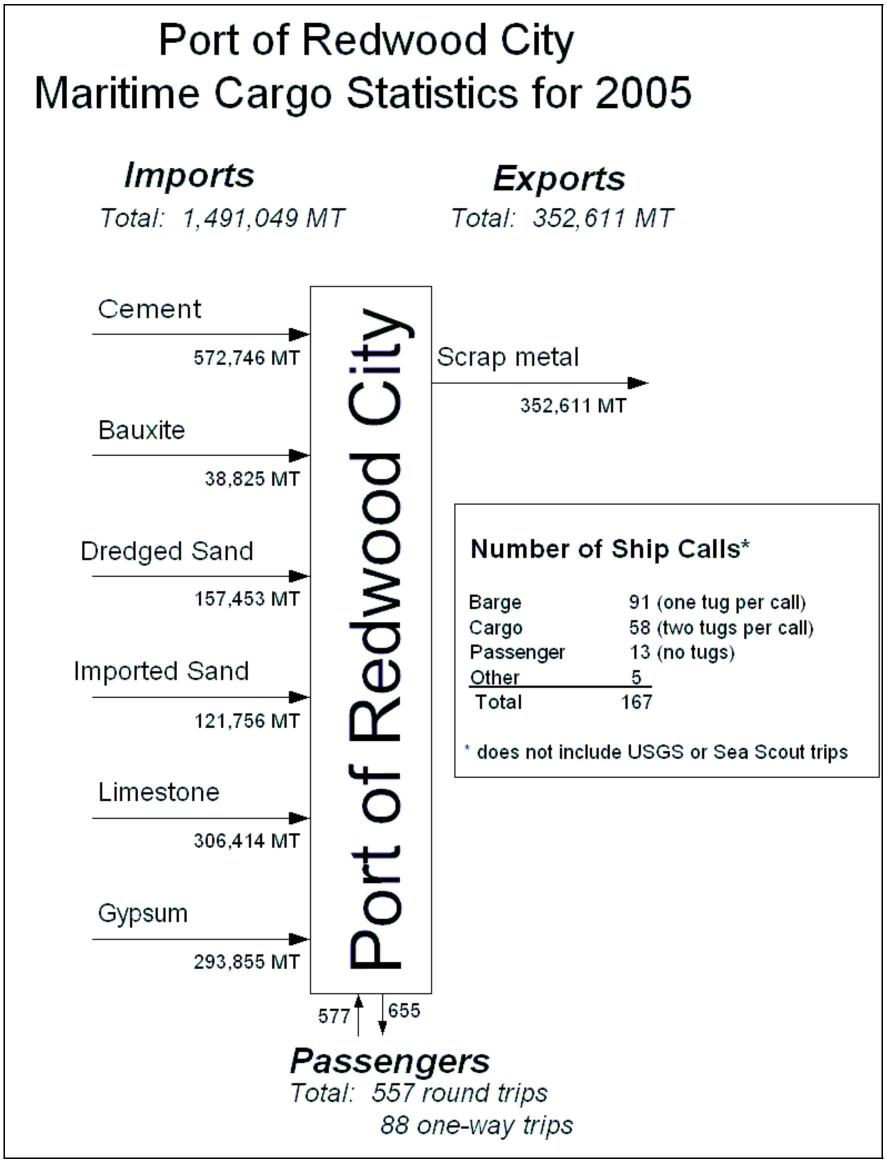

Figure B-2. Schematic of the Port of Redwood City cargo flow

The diagram in Figure B-3 lists the tenants at the Port of Redwood City, and shows the mode of both waterside and landside transport along with arrows which indicate the direction of flow of the commodity. The tenants shown in orange would be included in the inventory. The tenants in blue would not be included in the inventory because they are not conducting maritime business. The five tenants in green with waterside activity would be included in the inventory.

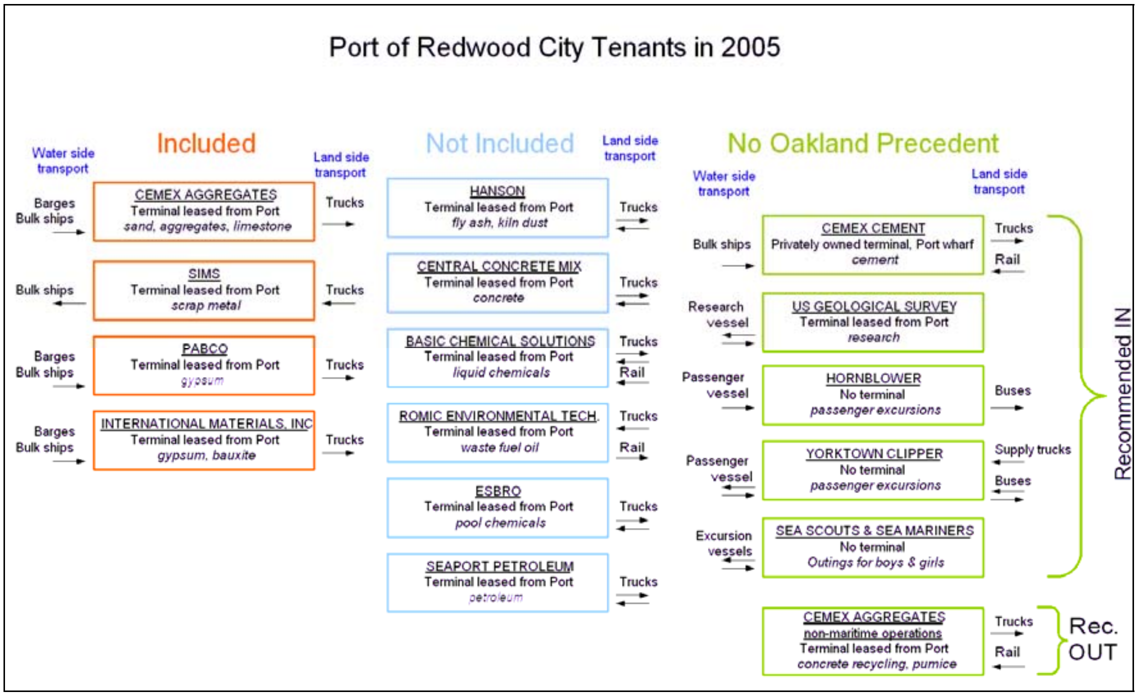

Figure B-3. Terminals and commodity flow modes at the Port of Redwood City

Both Cemex Aggregate and Cemex Cement conduct non-maritime operations on a portion of the backlands of their terminals. In the case of Cemex Aggregates, they have a concrete rubble and recycling operation as well as a lightweight aggregate (pumice) operation that are unrelated to any maritime business. The emissions stemming from the non-maritime portions of those terminals would not be included in the inventory.

B.1 Ocean-Going Vessels

The Port of Redwood City provided their complete vessel call data from 2005. The format is one month per spreadsheet. The column headings include vessel or barge name, voyage number, billing account, arrival date, arrival time, berth location, departure date, departure time, whether it loaded or discharged cargo (embarked or disembarked passengers), the tonnage transferred, and the commodity carried (files can be found on attached CD: Redwood City/OGV/“January05vesseletaetd.xls”, “February05vesseletaetd.xls”, etc. one per month). These vessel calls would be checked against the ARB database to determine if the vessel’s arrival or departure was directly to or from sea or whether it stopped at other Bay Area ports or anchorages along its route.

The Redwood City data includes a monthly summary of the number of ships and barges that called, the total tonnage of each type of commodity carried, and the number of passengers that arrived and departed. The total metric tons or cargo moved is also compared to the same month's records for the two previous years in the spreadsheet.

B.2 Harbor Craft

Representatives from Redwood City report that barge calls are usually accompanied by two tugs, and that the bulk ships typically use one assist tug to berth and one to depart.

Redwood City also provided voyage records for the USGS ship, the Polaris, as well as three Sea Scout vessels. All of these vessels used Redwood City as their home berth in 2005. The information includes vessel name, date and time out and date and time in. It would require further communication with USGS and Sea Scout representatives to determine where these vessels sailed during their outings. Contact information for each organization was provided by the Port. (file can be found on attached CD: Redwood City/HC/"Air Emissions Polaris & Sea Scouts.xls")

Vessel call records indicate that dredging was performed by Dutra in 2005.

B.3 Cargo Handling and Other Off-road Equipment

The Port of Redwood City was provided with an off-road equipment survey intended to query the port for maritime cargo handling and other off-road equipment operations and characteristics as shown in Appendix F. Port of Redwood City provided survey responses for maritime cargo handling and off-road equipment. As shown in Table B1, the maritime-related equipment fleet consists of a crane, forklifts, excavators, a water truck, a man lift and a welder. Of the total 27 pieces of equipment none is gasoline fueled, one is propane fueled, and 26 are diesel fueled. Model year is not available for three pieces of equipment and rated horsepower is not available for two pieces of equipment. Data for Wharf 3 (PABCO, IMI) were submitted for calendar year 2006 rather than 2005. Data for Cemex Cement represents only maritime related activity at the site. Data for Cemex Aggregates may include non-maritime related operations.

Table B1. Port of Redwood City cargo handling and off-road equipment 2005 characteristics

Operator	Wharf	Equipment Type	No. of Pieces	Fuel Type	Model Year	Retrofit	Rated Power (hp)	Activity (hr/year)
SIMS	3 & 4	Excavator	1	D	1996	N	286	5000
		Loader	1	D	1987	N	260	3000
		Loader	1	D	1966	N	275	3000
		Loader	1	D	1994	N	110	3000
		Crane	1	D	1999	N	130	1000
		Forklift	1	D	1999	N	110	2000
		Excavator	1	D	1994	N	285	5000
		Excavator	1	D	NA	N	240	5000
		Loader	1	D	NA	N	75	2000
		Loader	1	D	NA	N	75	2000
		Other, General Industrial Equipment (Man Lift)	1	LPG	1996	N	50	1500
PABCO*	3	Loader	1	D	2006	N	535	1000
		Loader	1	D	2006	N	36.4	25
		Water Truck	1	D	1989	N	240	500
Cemex Cement	1	Loader	1	D	2003	N	NA	480
		Loader	1	D	2003	N	NA	480
IMI*	3	Loader	1	D	2001	N	204	192.5
		Loader	1	D	1999	N	152	310
Cemex Aggr.	1 & 1A	Forklift	1	D	1969	N	175	500
		Loader	1	D	1997	N	350	2000
		Loader	1	D	1995	N	85	300
		Loader	1	D	1981	N	350	1800
		Loader	1	D	1983	N	300	1200
		Loader	1	D	1979	N	300	200
		Loader	1	D	1984	N	350	2000
		Loader	1	D	1993	N	400	2000
		Welder	1	D	2000	N	75	300

* Equipment characteristics and operation for 2006

B.4 Trucking (Freight) and Bus (Passenger)

The Port of Redwood City was provided with a trucking activity survey intended to query the port trucking operations and characteristics as shown in Appendix G. Terminal operators provided survey responses for maritime related trucking activity as shown in Table B2. The team is currently working with the Port of Redwood City to gather remaining information for

PABCO, CEMEX Cement, and CEMEX Aggregates. No information was available regarding truck age distribution. In addition to truck activity, Table B2 lists bus activity associated with two excursion vessel operators.

Table B2. Port of Redwood City trucking activity 2005 characteristics

Operator	Berth	Vehicle Type	Annual No. of Visits	Within Terminal Activity			Outside Terminal
				Idle Time Per Visit (min)	Average Speed (mph)	Onsite Distance Per Visit (miles)	Idle Time Per Visit (min)
SIMS	3 & 4	HHDDV	31,000	5	5	1	10
PABCO	3	HHDDV	IP**	0	5	0.125	0
CEMEX Cement	1	HHDDV	23,853	IP**	IP**	IP**	IP**
CEMEX Aggr.	1	IP**	IP**	IP**	IP**	IP**	IP**
IMI	3	HHDDV	7042*	5	15	0.5	5
Hornblower	5	Bus	1	0	0	0	0
Yorktown Clipper	5	Bus	24	0	0	0	0

* 2006 data for sum total of truck loads during vessel discharge and re-loads for delivery
**IP: In the process of collecting with the Port of Redwood City

Figure B-4 shows the truck route from the Port to the nearest freeway interchange to estimate off terminal truck activity. Mileage and speed along the route would be determined when estimating emissions.

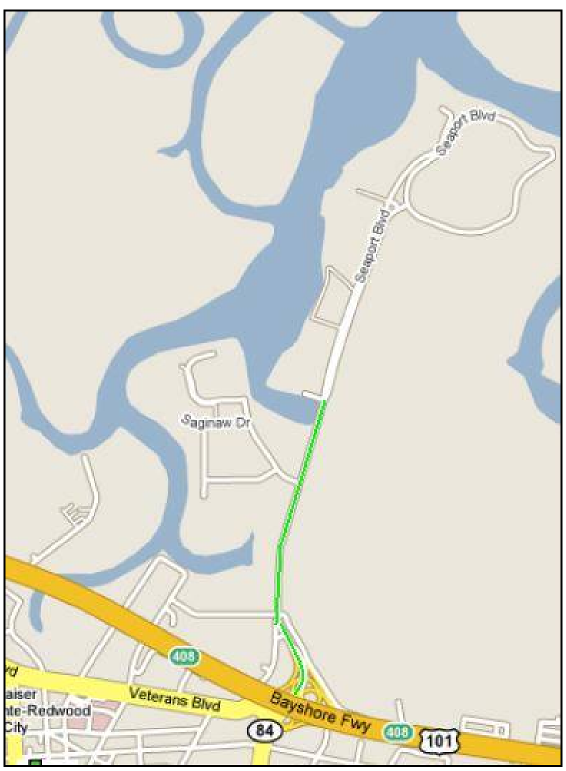

Figure B-4. Redwood City truck route (green)

B.5 Locomotive

Union Pacific serves the Port of Redwood City depositing and retrieving about 40 cars three or four days a week. Union Pacific is supplying locomotive types and a time in notch estimate for those local trains. The activity is small compared with many other rail operations.

APPENDIX C

PORT OF RICHMOND

PORT OF RICHMOND

The Port of Richmond has three active terminals that are publicly owned. The main industry is shipping cars. The SSA terminal ships cars back and forth from Hawaii. They did not start using the Richmond facility until the fall of 2005. Auto Warehousing imports new cars and typically had one to two Ro/Ro calls per week in 2005. The third terminal is run by Cal Oils; they import and export edible oils. They have a privately owned refinery across the street from the public terminal they lease, and the oils are transported via pipeline between the two facilities.

There are many other terminals located in Richmond, but they are all privately owned. The largest operator is Chevron who had more than three times as many vessel calls as all the publicly owned terminals put together. There are at least six other petroleum terminals in the area, as well as bulk handlers (gypsum and scrap metal), boat repair yards, a lumber yard, and liquid chemical tank farms. All of these industries have waterborne activity, but since they are privately owned they are not part of this inventory.

Richmond is the home berth to Foss Maritime, a tug boat company, as well as MSRC, a marine oil spill response and clean up company. Emissions from these two companies would be included in the inventory, although it is worth noting that their berths have shore power so they turn off their auxiliary engines while tied up. A second tug company, Oscar Neimeth Towing is located near Foss, but they would not be included in this inventory because they moved to Richmond in the spring of 2006.

The following aerial in Figure C-1 shows the entire Richmond port area (excluding the Chevron Longwharf which is located to the west of this picture). The three terminals that are part of this study are outlined in white, with the tenants and ship calls labeled. A cropped view of the same aerial is also given below, which zooms in on the publicly owned properties.

Figure C-1. Port of Richmond

The following aerial in Figure C-2 is a closer view of the three terminals owned by the City of Richmond.

Figure C-2. Port of Richmond (detailed)

The schematic diagram in Figure C-3 gives a summary of the quantities of goods being shipped through the public terminals in Richmond and shows the direction of flow. It also shows the number and type of ship calls, excluding the Foss Maritime and MSRC movements.

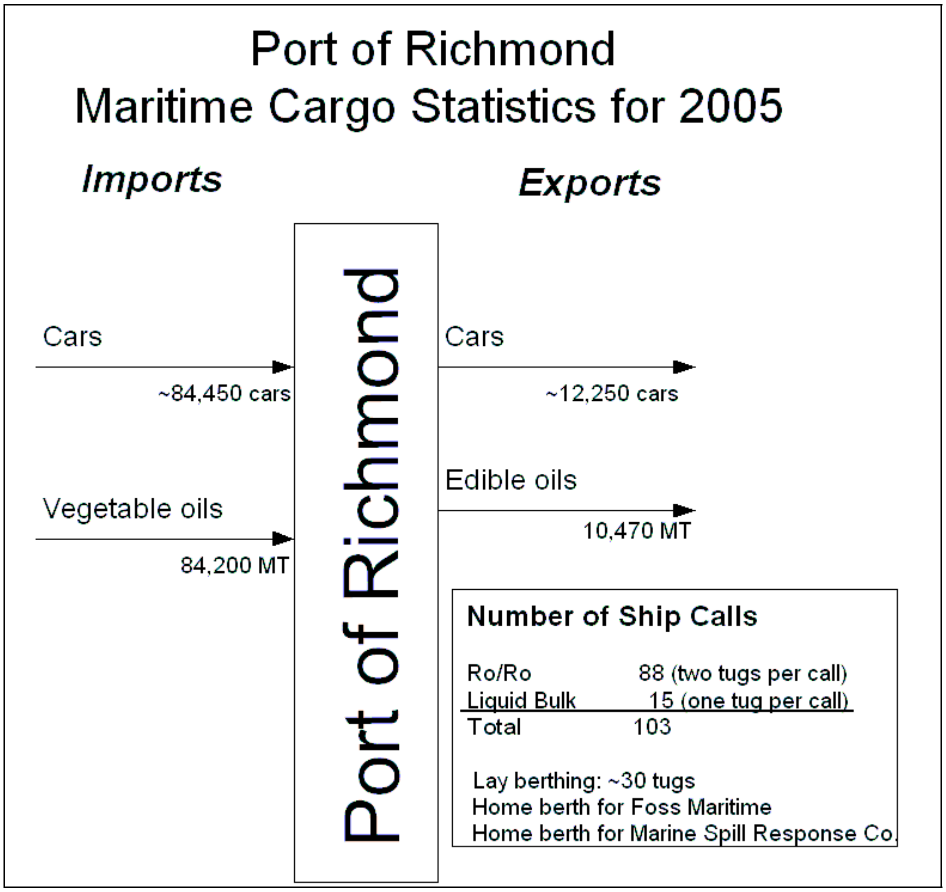

Figure C-3. Schematic of the Port of Richmond cargo flow

The diagram in Figure C-4 lists the tenants at the Port of Richmond, and shows the mode of both waterside and landside transport along with arrows which indicate the direction of flow of the commodity. The three tenants shown in orange would be included in the inventory. The harbor craft of the two tenants in green would be included in the inventory. The long list of tenants in blue highlights the number of privately owned terminals located in Richmond. These would not be included in the inventory as they are not part of the public Port of Richmond, although most of them conduct maritime business.

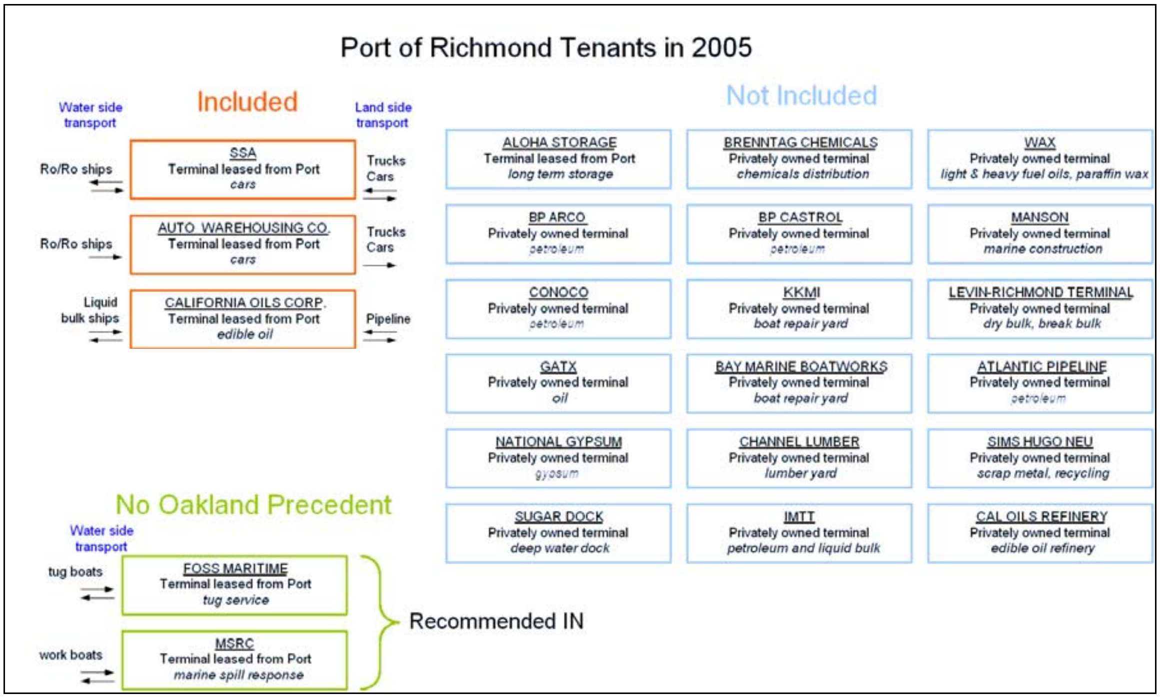

Figure C-4. Terminals and commodity flow modes at the Port of Richmond

C.1 Ocean-Going Vessels

The Port of Richmond was unable to provide ship call data from 2005. The port provided Marine Exchange summaries for the years 2005, 2007, and 2008. The team collected vessel data from the three tenants, Matson (SSA), Auto Warehousing, and Cal Oils.

The Matson data includes the vessel name, arrival date, arrival time, departure date, and departure time (file can be found on attached CD: Richmond/OGV/"2005 Richmond data.xls").

The Auto Warehousing data includes the vessel name, arrival date, manufacture name, and number of cars imported. Although they do not record arrival and departure times, a representative from Auto Warehousing stated that the ships usually arrive at 1800 and leave at 1800 the next day. Ships with volume more than 2,100 units take two days to discharge (file can be found on attached CD: Richmond/OGV/"03.25.08 Copy of 2005richmondships B.xls").

The Cal Oils data includes vessel name, arrival month, import tonnage, export tonnage, and total tonnage. It should be noted that the Cal Oils reported vessel schedule does not match the 2005

Marine Express data in terms of the number of calls. When it was further cross-checked against CARB's database, none of the three sources agreed. The team would have more conversations with CARB and Cal Oils to resolve the discrepancies and determine which is the more accurate data set for that terminal (file can be found on attached CD: Richmond/OGV/"Cal Oils Vessel Traffic-2005.xls").

All of Richmond's vessel calls would be checked against the ARB database to determine if the vessel's arrival or departure was directly to or from sea or whether it stopped at other Bay Area ports or anchorages along its route.

C.2 Harbor Craft

The Richmond terminal manager reported that the Matson and SSA ships always use two assist tugs in and two out. He reported that the Cal Oil ships use one or two tugs per call, depending on the circumstances.

The two harbor craft tenants at Richmond in 2005, Foss Maritime and MSRC (Marine Spill Response Co) both have shore power at their docks. Those vessels always turn their engines off while at berth.

The terminal manager reports that MSRC has one vessel excursion per week, for 50 weeks out of the year, and the excursion lasts for 6 hours. He reports that the vessel has Caterpillar 3208 engines.

A survey has been sent to Foss Maritime requesting fuel usage and engine running hours for their Richmond fleet in 2005. To date, the survey has not been returned. Persistence in calling the Foss Maritime engineer would be used to get the survey data completed.

The terminal manager also recalled about 30 instances of lay berthing in Richmond in 2005. Although there are no records to rely on, he estimates approximately 40 days of total lay berthing for those 30 instances, all on non-electrified docks.

Dredging was performed in Richmond in 2005 by Great Lakes Dredge & Dock.

C.3 Cargo Handling and Other Off-road Equipment

Port of Richmond terminal operators were queried regarding the presence of cargo handling and/or other off-road equipment on-site. The terminal operator at Terminal 2 (California Oils) indicated that equipment on-site consisted of only electric pumps. The terminal operator at Terminal 3 (SSA) indicated that there is no cargo handling or off-road equipment at the site. The terminal operator at PPMT (Auto Warehousing Company) indicated the presence of off-road equipment. The off-road equipment survey was provided directly to the terminal operator at PPMT as shown in Appendix F. Auto Warehousing Co. provided survey responses for maritime related cargo handling and off-road equipment.

As shown in Table C1, the maritime related equipment fleet consists of a portable crane, forklifts, a backhoe, sweeper, various pumps, a compressor, and a welder. Of the total five pieces of equipment, two pieces of equipment are propane fueled and three are diesel fueled. The fleet is generally aged, with only one of 14 pieces of equipment of model year post 1981. In numerous cases horsepower specifications were not available.

Table C1. Port of Richmond cargo handling and off-road equipment 2005 characteristics

Company	Berth	Equipment Type	No. of Equipment	Fuel Type	Model Year	Retrofit	Rated Power (hp)	Activity (hr/year)
Auto Warehousing Company	8	Forklift	1	LPG	1982	N	NA	550
		Forklift	1	LPG	1984	N	NA	260
		Tower Lights	3	Diesel	1988	N	10	60

C.4 Trucking (Freight) and Bus (Passenger)

Terminal operators were queried to determine whether truck activity occurred at terminals included in this study. Each terminal with trucking activity was provided a survey as shown in Appendix G. Information gathered for trucking is shown in Table C2. The terminal operator at Terminal 2 (California Oils) indicated that there was no trucking or bus traffic to or from their terminal. The other two terminal operators supplied trucking activity associated with transporting autos to and from their facilities.

Table C2. Port of Richmond trucking activity 2005 characteristics

Berth	Vehicle Type	Annual No. of Visits	Within Terminal Activity			
			Idle Time Per Visit (min)	Average Speed (mph)	Onsite Distance Per Visit (miles)	Idle Time Per Visit (min)
8	HHDDV	3,483	5	12.5	0.1	0
3	HHDDV	2,714*	0	10	0.1	0

* Actual 2005 visits not available. Visits estimated based on a 2005 vehicle throughput of approximately 19,000 vehicles (including imports and exports) and an average of 7 vehicles transported per truck visit.

Figure C-5 shows the truck routes from the terminals to the nearest freeway interchange which would be used to estimate off terminal truck activity. Mileage and speed along the route would be determined when estimating emissions.

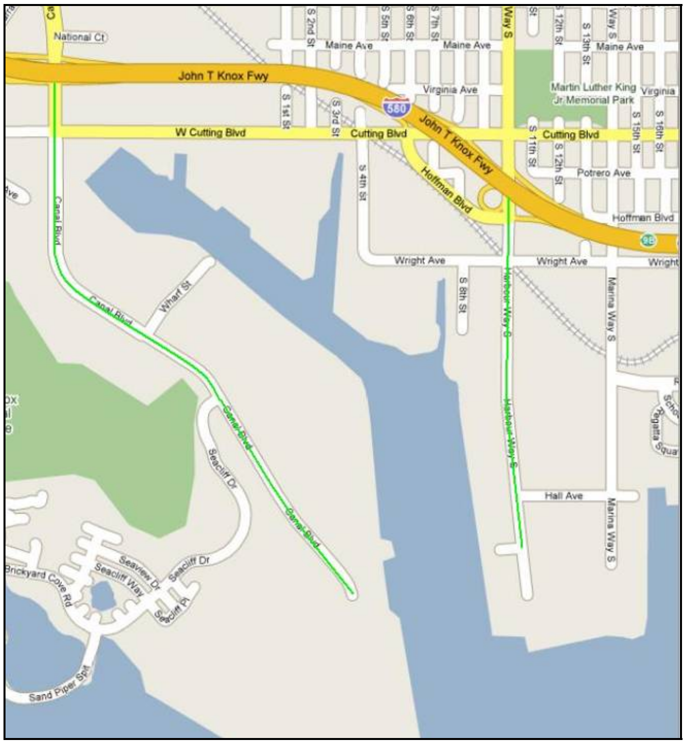

Figure C-5. Richmond truck routes (green)

C.5 Locomotive

There was no on-port locomotive activity at Richmond public terminals. BNSF serves the public terminals of the Port of Richmond with an off-port yard. BNSF and Richmond Pacific Railroads serve the private terminals at the Port of Richmond.

APPENDIX D

PORT OF SAN FRANCISCO

PORT OF SAN FRANCISCO

The Port of San Francisco owns about 7.5 miles of coastline, from the Hyde Street Pier in the north, across the Fisherman's Wharf tourist area, the Ferry Building, the base of the Bay Bridge, the baseball park, and then down through the industrial areas up to the Islais Creek area ending at Berth 96. The port has over 500 tenants, conducting a wide variety of businesses. The majority of the tenants, although located near the water, have no waterside activity. Examples of these businesses include parking lots, restaurants, retailers, shops, a baseball park, offices, etc. The Port has small boat marinas and a ferry terminal, however, similar to Oakland, these are not included in the inventory

The port sees two types of ocean-going vessel traffic, cruise ships and cargo ships. There is a large and busy cruise ship dock at Berth 35. The industrial area south of the ball park includes several cargo terminals, some lay berthing of large military supply vessels, and a large ship dry dock and repair yard. The cargo activity is bulk and break bulk, mainly imports. One terminal, Darling International, exports tallow.

The port has a large amount of harbor craft activity. The SF Bar Pilots lease a terminal, as well as several excursion vessel companies. There is a commercial and charter boat fishing fleet and a fish processing shed with many individual fish processing tenants. Two different tug companies are home-berthed in San Francisco. Finally, there are some historic vessels which have occasional outings.

The following three aerials in Figure D-1 show the Port of San Francisco property piecewise, starting at the Hyde St. Pier and ending at Berth 96. The tenants included in this study are outlined in white.

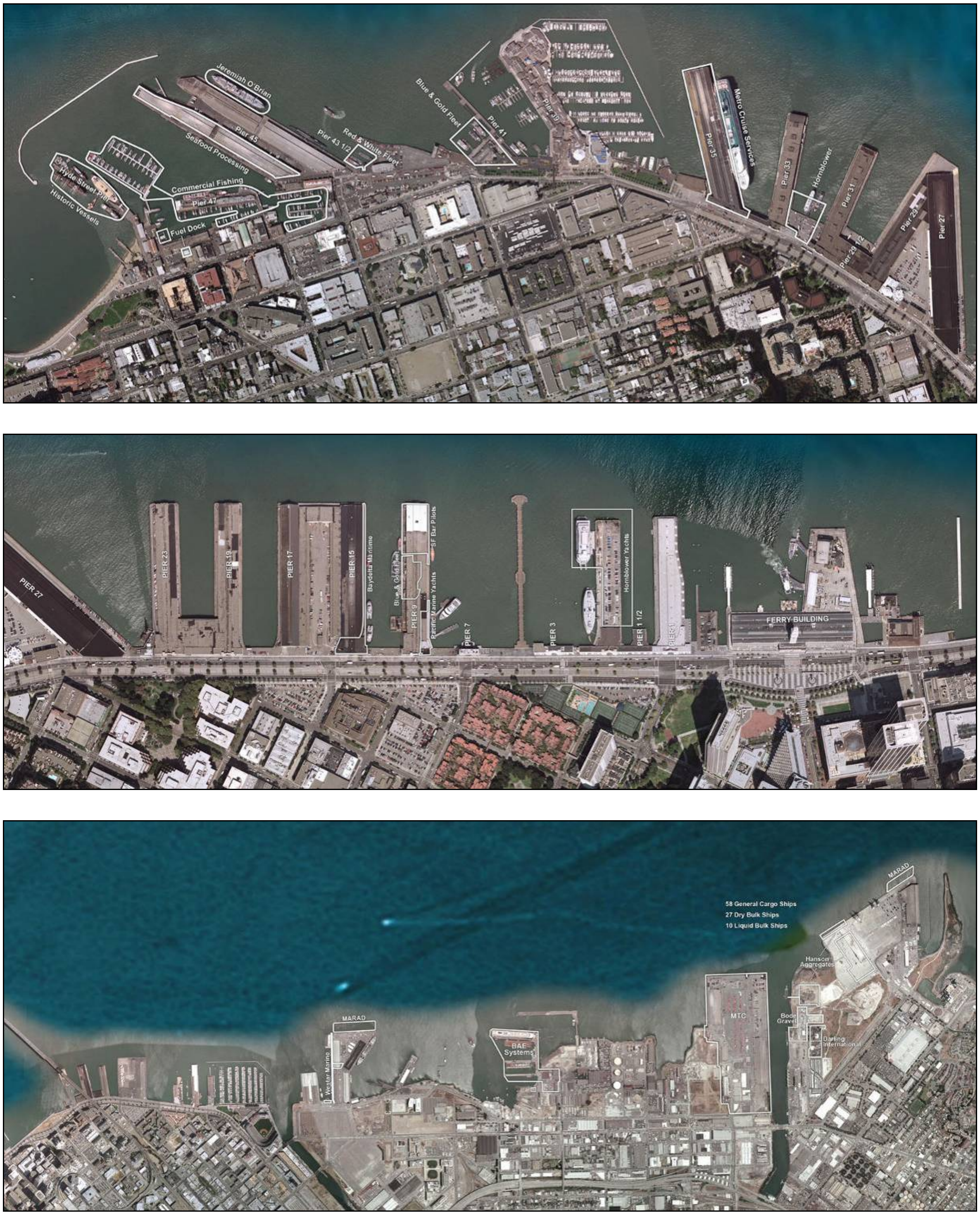

Figure D-1. Port of San Francisco (north to south, top to bottom)

The schematic diagram in Figure D-2 gives a summary of the quantities of goods being shipped through San Francisco and shows the direction of flow. Numbers of passengers for the cruise industry are shown near the bottom of the diagram. It also shows the number and type of ocean-going ship calls. It does not include the harbor craft activity.

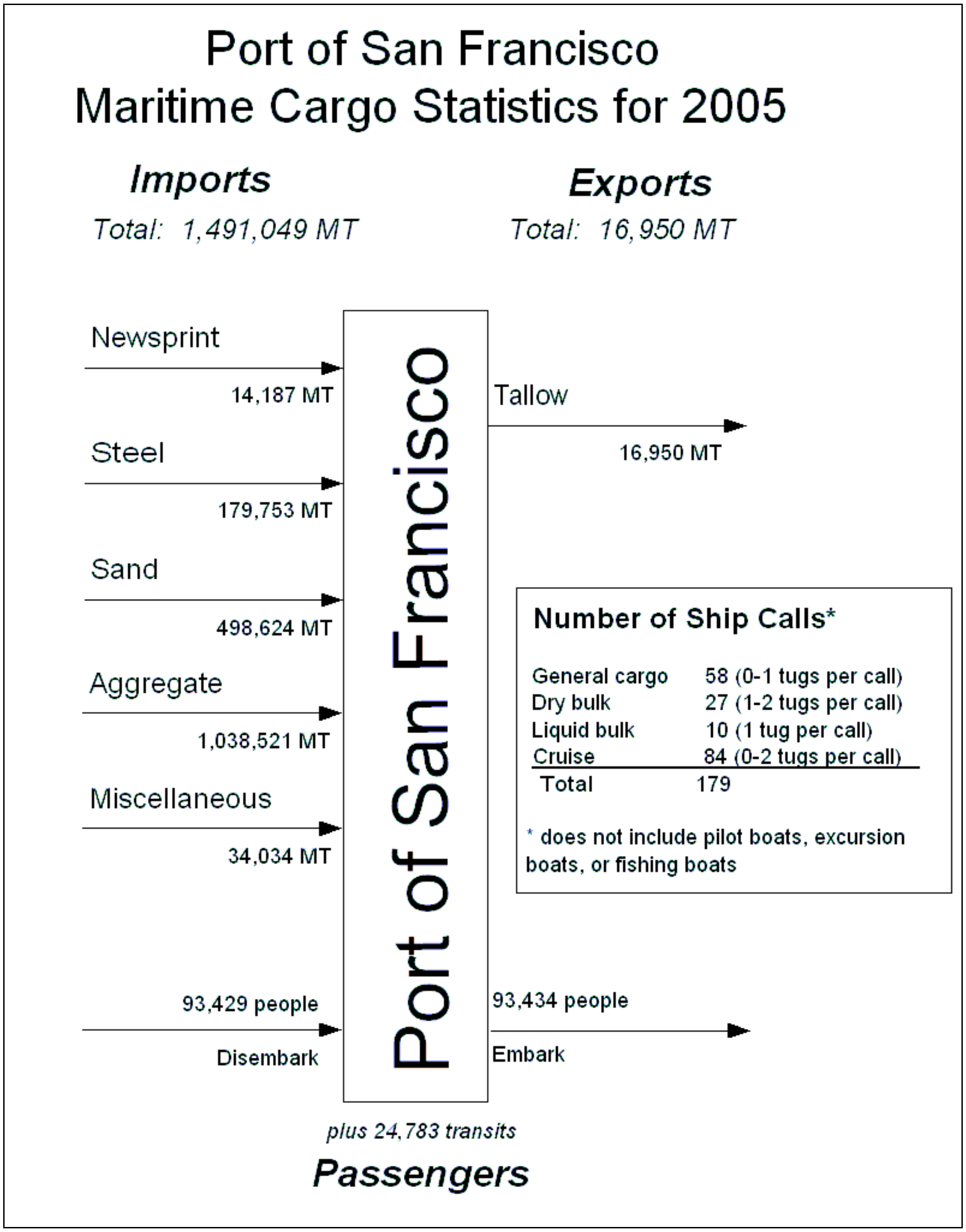

Figure D-2. Schematic of the Port of San Francisco cargo flow

The diagram in Figure D-3 lists the tenants at the Port of San Francisco, and shows the mode of both waterside and landside transport along with arrows which indicate the direction of flow of the commodity. The five tenants shown in orange would be included in the inventory. The harbor craft associated with the tenants in green would also be included in the inventory. The listings in blue give examples of some of the types of businesses in San Francisco that would not be included in this inventory. Either they have no maritime connection, or, like the marinas, were not included in Oakland's inventory.

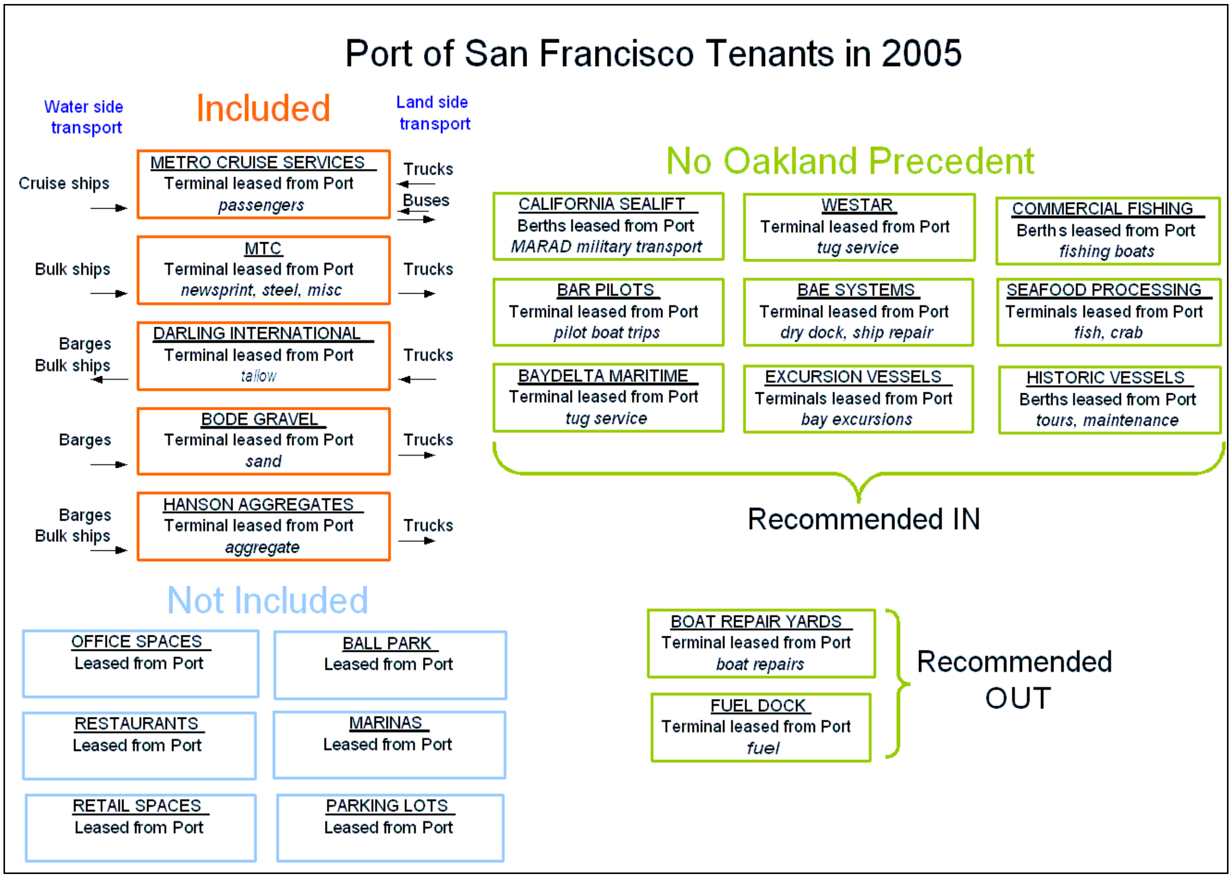

Figure D-3. Terminals and commodity flow modes at the Port of San Francisco

D.1 Ocean-Going Vessels

The Port of San Francisco provided complete cruise ship call data for every year from 2003 to 2007. The cruise ship data includes vessel name, arrival day, date and time, previous port of call, departure day, date and time, next port of call, number of hours in port, name of cruise line, and a brief description of the itinerary. It also records the number of passengers debarking, transiting, and embarking.

The Port also provided cargo ship calls for the years 2003 to 2006. Those data include carrier name, ship type, ship name, berth, arrival date and time, and departure date and time. A separate spreadsheet gives a summary of the types and quantities of cargo transferred at their cargo facilities.

These vessel calls would be checked against the ARB database to determine if the vessel's arrival or departure was directly to or from sea or whether it stopped at other Bay Area ports or anchorages along its route. For example, the small cruise ship Yorktown Clipper calls at both Redwood City and San Francisco. Those calls would not be counted twice.

D.2 Harbor Craft

Assist tugs
According to Port employees familiar with the cruise operation, the large cruise ships typically use two assist tugs to berth and one to two assist tugs to depart, depending on the currents, tides, and weather conditions.

Bunkering tugs
San Francisco provided detailed bunkering records for 2005. They show 28 instances of bunkering at their cruise and cargo facilities. The records list the start and end dates and time for the bunkering as well as the name of the bunker barge. The Port of Oakland did not include bunkering in their emissions inventory, so the recommendation is to not include it for San Francisco.

Barges (cargo) tugs
San Francisco does not keep track of the barge traffic at their cargo facilities. However, they can give us the monthly tonnage of cargo transferred. The number of barges (and hence tugs) would be estimated by dividing the volume of cargo transferred in 2005 by the average capacity of the barges.

Fishing fleet
The team proposes using the CARB's estimate of charter and commercial fishing emissions for the Bay Area as a basis for estimating the emissions from San Francisco's fishing fleet. Conversations with CARB and San Francisco's fishing dock harbor master would be used to determine how the fishing fleet emissions were calculated and what proportion should be allocated to San Francisco. Anecdotal information would be used to determine how much charter and commercial fishing is based in other marinas throughout the Bay such as Emeryville, Berkeley, Alameda, and Sausalito.

Excursion vessels
The operational managers of the Red & White Fleet, the Blue & Gold Fleet, Signature Yachts, and Hornblower have been sent surveys to determine their fuel usage in 2005 and other fleet information. To date, none of the surveys has been returned. Persistence in contacting those companies will be needed to get the surveys completed. Excursion routes are available on the company websites.

Dry Dock
Data have not yet been collected for this tenant. The team will request a list of vessels that arrived and departed in 2005. Mike Murphy of BAAQMD is looking into whether BAE Systems has a permit with them, in which case the activity data might already be available.

<u>California Sealift (MARAD)</u>
Data have not yet been collected for this tenant. A list of vessels that arrived and departed in 2005 will be requested. According to the Port, all MARAD vessels use shore power when they are at berth, so data on the length of stay are not needed. Only the vessel transits will be included in the inventory. The CARB database would be used for vessel transits if they are not available from California Sealift.

<u>SF Bar Pilots</u>
The operational manager for the Bar Pilots was sent a survey to determine their fuel usage in 2005 and other fleet information. To date, the survey has not been returned. Persistence will be required to get information back.

<u>Tug fleets with home berth in SF</u>
Baydelta and Westar have both been sent surveys to gather fleet information and fuel usage in 2005. To date these surveys have not been returned. Persistence will be required to get information back.

<u>Historic vessels</u>
The Jeremiah O'Brien is the main historic vessel in San Francisco that is still used for outings. Information from their website would be used to determine their annually scheduled cruises (ex. Fleet Week, July 4th Fireworks, Tall Ships). Their engineer would be sent a survey to collect any other useful information such as fuel usage and engine running hours for 2005.

<u>Dredging</u>
Dredging for 2005 was performed by Dutra. Details about the vessels and operating hours would be obtained from Moffatt & Nichol records.

D.3 Cargo Handling and Other Off-road Equipment

The project team is currently in the process of surveying fish processors located at Pier 45 for operational characteristics for their cargo handling equipment and other off-road equipment.

Additionally, the team has provided surveys to gather operational characteristics for cargo handling equipment and other off-road equipment operated by Darling International at Pier 90/92, Bode Gravel at Pier 90/92, Hanson Aggregates at Pier 94 and Seawall Lot 352, and Ports of America (formerly Marine Terminals Corporation) at Pier 80.

To date, only one of the surveys has been returned. Persistence in contacting those companies will be needed to get the surveys completed.

D.4 Trucking (Freight) and Bus (Passenger)

The team is currently in the process of surveying fish processors located at Pier 45 for operational characteristics associated with their trucking activity.

Additionally, the team has provided surveys to gather activity data for trucking operations for Darling International at Pier 90/92, Bode Gravel at Pier 90/92, Hanson Aggregates at Pier 94 and Seawall Lot 352, and Ports of America (formerly Marine Terminals Corporation) at Pier 80.

To date, only one of the surveys has been returned. We propose persistence in contacting these companies, as well as enlisting the help of the Port to get information back.

Additionally, delivery truck and bus trips associated with excursion vessels operators would be included if these operators indicate the presence of such activity.

D.5 Locomotive

The San Francisco Bay Railroad (SFBR) operates two small switch engines at the Port of San Francisco. These engines were reported to burn 450 gallons per quarter or 1,800 gallons per year. The Air Resources Board is conducting emission testing on these older switch engines, and those results would be used to estimate emissions.

According to Union Pacific, it does not operate locomotives on the Port of San Francisco grounds, but would pull the cars that SFBR assembles to and on its main line.

APPENDIX E

LOCOMOTIVE EMISSION AND ADJUSTMENT FACTORS

LOCOMOTIVE EMISSION AND ADJUSTMENT FACTORS

Table E.1. Locomotive – Diesel PM emission factors for locomotives to be used in the study, assuming default fuel sulfur content (0.3%).

Locomotive Model Group	Cert Tier[a]	PM Emission Factors (g/hr) by Throttle Notch									
		Idle	DB[b]	1	2	3	4	5	6	7	8
Switchers[1]	Precntl	31.0	56.0	23.0	76.0	138.0	159.0	201.0	308.0	345.0	448.0
GP-3x[1]	Precntl	38.0	72.0	31.0	110.0	186.0	212.0	267.0	417.0	463.0	608.0
GP-4x[1]	Precntl	47.9	80.0	35.7	134.3	226.4	258.5	336.0	551.9	638.6	821.3
GP-50[1]	Precntl	26.0	64.1	51.3	142.5	301.5	311.2	394.0	663.8	725.3	927.8
GP-60[1]	Precntl	48.6	98.5	48.7	131.7	284.5	299.4	375.3	645.7	743.6	941.6
SD-7x[1]	Precntl	24.0	4.8	41.0	65.7	156.8	243.1	321.1	374.8	475.2	589.2
Dash-7[1]	Precntl	65.0	180.5	108.2	121.2	359.5	327.7	331.5	299.4	336.7	420.0
Dash-9[2]	Precntl	32.1	53.9	54.2	108.1	219.9	289.1	370.6	437.7	486.1	705.7
GP-60[3]	0	21.1	25.4	37.6	75.5	239.4	352.2	517.8	724.8	1,125.9	1,319.8
SD-7x[1]	0	14.8	15.1	36.8	61.1	230.4	379.8	450.8	866.2	1,019.1	1,105.7
Dash-8[1]	0	37.0	147.5	86.0	133.1	291.4	293.2	327.7	373.5	469.4	615.2
Dash-9[4]	0	33.8	50.7	56.1	117.4	229.2	263.8	615.9	573.9	608.0	566.6
Dash-9[3]	1	16.9	88.4	62.1	140.2	304.0	383.5	423.9	520.2	544.6	778.1
ES44/Dash-9[3]	2	7.7	42.0	69.3	145.8	304.3	365.0	405.2	418.4	513.5	607.5

[1] Final locomotive emission factors (an update to the Roseville study emission factors Table B-1) received via email from Dan Donohue of ARB, May 9, 2006. (ARB, 2006c)
[2] "Diesel Fuel Effects on Locomotive Exhaust Emissions", Southwest Research Institute, October 2000. (SwRI, 2000)
[3] Confidential data from SwRI, 2005.
[4] Average of ARB and confidential source.
[a] Precntl: Precontrolled
[b] DB: Dynamic Braking

Table E.2. Locomotive - Fuel sulfur emission reductions by notch and engine type.

Notch	B	A	Fuel Sulfur 0.3% EF (g/hp-hr)	Fuel Sulfur 0.105% EF (g/hp-hr)	Reduction
GE 4-stroke Engine					
8	0.00001308	0.0967	0.13594	0.110434	18.76%
7	0.00001102	0.0845	0.11756	0.096071	18.28%
6	0.00000654	0.1037	0.12332	0.110567	10.34%
5	0.00000548	0.132	0.14844	0.137754	7.20%
4	0.00000663	0.1513	0.17119	0.1582615	7.55%
3	0.00000979	0.1565	0.18587	0.1667795	10.27%
EMD 2-stroke engine					
8	0.0000123	0.3563	0.3932	0.369215	6.10%
7	0.0000096	0.284	0.3128	0.29408	5.98%
6	0.0000134	0.2843	0.3245	0.29837	8.05%
5	0.000015	0.2572	0.3022	0.27295	9.68%
4	0.0000125	0.2629	0.3004	0.276025	8.11%
3	0.0000065	0.2635	0.283	0.270325	4.48%

Source: ARB (2005d)

Table E.3. Locomotive – HC Emission Factors for locomotives to be used in the study.

Locomotive Model Group	Cert Tier[a]	HC Emission Factors (g/hr) by Throttle Notch									
		Idle	DB[b]	1	2	3	4	5	6	7	8
Switchers[1]	Precntl	99	145	93	117	145	194	274	377	521	666
GP-3x[1]	Precntl	124	269	122	150	188	261	372	469	652	807
GP-4x[1]	Precntl	185	295	155	201	247	321	424	611	878	1,169
GP-50[1]	Precntl	76	279	39	209	312	352	488	664	933	1,082
GP-60[1]	Precntl	113	158	12	176	304	408	500	646	1,062	1,351
SD-7x[1]	Precntl	118	174	117	167	265	319	421	605	804	1,052
Dash-7[1]	Precntl	259	422	125	99	276	287	347	499	697	750
Dash-9[2]	Precntl	184	240	138	201	403	390	572	741	908	1,063
GP-60[3]	0	120	163	114	154	240	287	366	476	749	902
SD-7x[1]	0	62	65	91	139	298	393	501	894	1,230	1,433
Dash-8[1]	0	269	627	331	358	395	419	655	614	738	861
Dash-9[4]	0	109	160	141	227	584	492	726	870	999	1,239
Dash-9[3]	1	55	309	210	298	606	714	789	931	978	1,094
ES44/Dash-9[3]	2	24	65	62	120	220	224	311	408	488	619

[1] Final locomotive emission factors (an update to the Roseville study emission factors Table B-1) received via email from Dan Donohue of ARB, May 9, 2006. (ARB, 2006c)
[2] "Diesel Fuel Effects on Locomotive Exhaust Emissions", Southwest Research Institute, October 2000. (SwRI, 2000)
[3] Confidential data from SwRI, 2005.
[4] Average of ARB and confidential source.
[a] Precntl: Precontrolled
[b] DB: Dynamic Braking

Table E.4. Locomotive – CO Emission Factors for locomotives to be used in the study, adjusted for reduced fuel sulfur content (0.105%).

Locomotive Model Group	Cert Tier[a]	CO Emission Factors (g/hr) by Throttle Notch									
		Idle	DB[b]	1	2	3	4	5	6	7	8
Switchers[1]	Precntl	181	350	183	294	339	354	416	676	2,085	5,710
GP-3x[1]	Precntl	283	699	240	429	430	479	604	926	1,773	3,973
GP-4x[1]	Precntl	564	660	267	292	329	434	760	1,912	5,029	5,907
GP-50[1]	Precntl	99	408	59	228	744	1,083	1,932	1,743	1,520	1,817
GP-60[1]	Precntl	144	192	106	132	314	517	1,108	2,213	1,700	1,597
SD-7x[1]	Precntl	237	344	243	263	290	598	1,210	2,005	1,733	2,470
Dash-7[1]	Precntl	354	485	199	338	1,489	2,949	5,516	4,551	3,295	3,000
Dash-9[2]	Precntl	276	394	143	332	1,486	4,647	8,055	10,143	9,511	10,644
GP-60[3]	0	118	233	147	186	248	347	945	2,678	2,443	1,989
SD-7x[1]	0	84	90	186	293	336	407	434	3,046	1,441	1,515
Dash-8[1]	0	367	1,113	688	874	1,974	2,373	1,843	1,868	2,012	2,871
Dash-9[4]	0	95	197	139	310	831	2,136	2,801	2,502	2,932	3,250
Dash-9[3]	1	49	461	244	368	896	1,505	1,788	2,014	2,714	3,356
ES44/Dash-9[3]	2	30	120	142	239	607	806	479	537	790	1,034

[1] Final locomotive emission factors (an update to the Roseville study emission factors Table B-1) received via email from Dan Donohue of ARB, May 9, 2006. ARB, 2006c)
[2] "Diesel Fuel Effects on Locomotive Exhaust Emissions", Southwest Research Institute, October 2000. (SwRI, 2000)
[3] Confidential data from SwRI, 2005.
[4] Average of ARB and confidential source.
[a] Precntl: Precontrolled
[b] DB: Dynamic Braking

Table E.5. Locomotive – NOx Emission Factors for locomotives to be used in the study.

Locomotive Model Group	Cert Tier[a]	Emission Factors (g/hr) by Throttle Notch									
		Idle	DB[b]	1	2	3	4	5	6	7	8
Switchers[1]	Precntl	987	3,415	1,240	2,775	5,716	9,794	14,135	17,999	21,891	24,028
GP-3x[1]	Precntl	1,247	2,803	1,825	4,336	8,137	12,410	16,974	23,232	29,605	34,755
GP-4x[1]	Precntl	1,635	4,134	2,808	6,040	10,180	15,407	20,892	25,564	31,187	36,929
GP-50[1]	Precntl	999	2,847	1,104	7,819	14,060	18,769	24,388	42,575	54,573	57,021
GP-60[1]	Precntl	999	2,847	1,104	7,819	14,060	18,769	24,388	42,575	54,573	57,021
SD-7x[1]	Precntl	1,475	1,728	2,533	5,520	13,367	21,349	27,710	43,213	57,587	56,252
Dash-7[1]	Precntl	306	493	830	1,416	5,367	9,738	16,321	22,974	25,108	33,000
Dash-9[2]	Precntl	595	940	2,121	5,495	14,999	22,069	31,372	36,876	42,905	46,971
GP-60[3]	0	731	967	2,267	4,696	8,501	11,090	12,850	13,831	25,626	27,621
SD-7x[1]	0	934	1,066	2,882	5,382	9,984	13,308	14,892	23,612	31,134	33,418
Dash-8[1]	0	746	2,063	3,403	4,618	7,426	9,912	14,746	18,676	22,800	29,527
Dash-9[4]	0	928	1,010	2,511	4,806	13,851	18,663	13,663	21,113	25,089	31,154
Dash-9[3]	1	376	2,036	1,538	4,672	14,369	16,071	13,855	18,020	20,886	23,913
ES44/Dash-9[3]	2	329	657	1,135	2,730	5,310	7,246	9,612	13,455	16,005	18,566

[1] Final locomotive emission factors (an update to the Roseville study emission factors Table B-1) received via email from Dan Donohue of ARB, May 9, 2006. (ARB, 2006c)
[2] "Diesel Fuel Effects on Locomotive Exhaust Emissions", Southwest Research Institute, October 2000. (SwRI, 2000)
[3] Confidential data from SwRI, 2005.
[4] Average of ARB and confidential source.
[a] Precntl: Precontrolled
[b] DB: Dynamic Braking

Table E.6. Locomotive – Fuel consumption factors for locomotives to be used in the study.

Locomotive Model Group	Cert Tier[a]	Fuel Consumption Factors (lb/hr) by Throttle Notch									
		Idle	DB[b]	1	2	3	4	5	6	7	8
Switchers[1]	Precntl	26	80	41	95	167	249	332	419	529	630
GP-3x[1]	Precntl	32	103	55	137	226	331	442	567	710	854
GP-4x[1]	Precntl	40	114	64	167	275	404	556	740	994	1,177
GP-50[1]	Precntl	22	91	92	179	363	480	652	919	1,136	1,281
GP-60[1]	Precntl	26	107	91	171	354	479	623	799	1,190	1,383
SD-7x[1]	Precntl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dash-7[1]	Precntl	18	98	60	121	236	368	523	679	802	991
Dash-9[2]	Precntl	26	42	81	189	395	572	798	1,014	1,240	1,539
GP-60[3]	0	26	39	87	164	354	483	628	790	1,194	1,385
SD-7x[1]	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dash-8[1]	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dash-9[4]	0	27	43	81	186	388	562	812	1,018	1,254	1,564
Dash-9[3]	1	20	54	86	184	371	510	720	938	1,161	1,461
ES44/Dash-9[3]	2	20	44	102	209	447	612	825	1,060	1,310	1,598

[1] Final locomotive emission factors (an update to the Roseville study emission factors Table B-1) received via email from Dan Donohue of ARB, May 9, 2006. (ARB, 2006c)
[2] "Diesel Fuel Effects on Locomotive Exhaust Emissions", Southwest Research Institute, October 2000. (SwRI, 2000)
[3] Confidential data from SwRI, 2005.
[4] Average of ARB and confidential source.
[a] Precntl: Precontrolled
[b] DB: Dynamic Braking

APPENDIX F

CARGO HANDLING AND OTHER OFF-ROAD EQUIPMENT SURVEY

CARGO HANDLING AND OTHER OFF-ROAD EQUIPMENT SURVEY

Bay Ports Off-Road Equipment Survey

Purpose

To identify off-road equipment activity in-use during 2005 with sufficient information to calculate emissions.

Calendar Year

If the year 2005 data is not available, then provide the data for the calendar year closest to 2005. Then the terminal activity (such as tons of freight) for the calendar years must be also provided.

- 2005 data provided below? Y or N
- If 2005 data is not provide, what year? ____________

Equipment Use Survey

Please provide us with more specific information about each vehicle or piece of off-road equipment operating on a regular basis at your terminal. Enter as much information as possible into table below. Please make copies of this page if you will need additional space.

1) Company Name ____
2) Terminal ____
3) Berths Served ____
4) Contact Name ____
5) Contact Phone Number_______________________________________
6) Fax Number ____

What is your terminal's total yearly off-road equipment fuel consumption by fuel type? (Useful for determining load factors)

Diesel – Highway (undyed gallons): ________________; Calendar Year _________

Diesel – Off-road (red dyed gallons): _______________

Gasoline (gallons used in nonroad equipment): ________

Compressed Natural Gas (CNG): __________________

Liquid Natural Gas (LNG): _______________________

Propane: _____________________________________

On-road Vehicle Profiles

Vehicle Make	Vehicle Model	Fuel Type: Gasoline (G) or Diesel (D) or LNG, or CNG or Propane	Vehicle Age / Model Year	Annual Mileage	Cumulative Mileage
Example: *Ford*	*F-350*	*D*	*1988*	*8,000*	*140,000*

Additional comments ____

Examples of equipment are provided in the list below.

Yard trucks
RTG cranes
Cranes (not RTG) Diesel
Top Picks
Side Picks
Reach Stackers
Forklifts
Sweepers/Scrubbers

Other Off-road Equipment types (if used) add equipment types as needed

Generator Sets
Pumps
Air Compressors
Gas Compressors
Welders
Pressure Washers
Aerial Lifts
AC\Refrigeration
Rubber-Tire Loaders
Skid Steer Loaders
Excavators
Dozers
Tractors/Loaders/Backhoes
Crawler Tractor/Dozers
Graders
Signal Boards/Light Plants

Offroad Equipment Profiles: Calendar Year for which data is available ______?

Equipment Type	# of Equip.	Chassis Make & Model	Chassis Model Year	Engine Model	Engine Retrofit or Repower? (Y/N)	Engine Model Year and (Service Start Date ∗)	Gasoline (G) or Diesel (D) or LNG or CNG or Propane	Engine Rated HP	Estimated or Measured Hours of Use per Week or Year (per piece)	Estimated or Measured Weeks of Use per Year	Cumulative Hours on Engine (Estimated Life)	Typical Fuel Use in Gallons (optional) ∗∗
Example: *Top Handler*	*2*	*Taylor 950*	*1989*	*Cummins LT10C5.9*	*N*	*1989 (June '89)*	*D*	*250*	*1800 hours/yr*	*Annual*	*28,800 (40,000)*	*150 Gal. for 35 Hrs.*

∗ Especially important if the engine is newer than the equipment
∗∗ If available please indicate the gallons by one of the following: hourly, daily, weekly, monthly or annually

Additional comments ____

Please return the survey to: John Grant, ENVIRON International Corporation:
Phone: 415-899-0700
jgrant@environcorp.com via email, or
415-899-0707 via fax

APPENDIX G

TRUCKING ACTIVITY SURVEY

Truck Survey - Air Emission Inventory

Name of Marine Terminal ________________________ **Berths** __________

The Port is conducting a survey of basic truck movements within terminals. This information will be used to assess the extent of the emissions from these sources.

- **2005 data provided below (Y/N)?** _____
- **If 2005 data is not provide, what year?** __________
- Percentage of trucks with gross vehicle weight rating of at least 33,000 _______%

Brief description of truck route to terminal____________________

Brief description of from terminal ________________________________

Terminal Truck Gate Movements

Our goal is to determine on-road heavy-duty truck engine emissions by counting the number of trucks (in whatever configuration they occur) moving through the facility. If the breakdown of movements for each category cannot be determined, please provide as much information as possible and indicate which categories are combined.

Please enter truck gate counts for terminals in 2005:

Truck Configuration	Gate – In	Gate – Out
Cab and Chassis with Container		
Cab with bare chassis (no container)		
Cab only (bobtail)		
Total Trucks		

Please enter average per-truck activity for each terminal visit:

Truck Activity	Estimate per Visit
Average Mileage by an Individual Tractor Trip within the Fence Line of the Terminal	Miles
Average Speed, when not Idling, on Terminal Site (such as 5, 10, 15, 20, 25 mph)	Miles/Hour
Average Idle Time in Queue Outside Gate (if known)	Minutes
Average Idle Time within Terminal (may be estimated from time stamp in and out of facility minus travel time)	Minutes

Please estimate an average truck's activity, mileage and idle time, within the fence line of the terminal.

Can you provide truck license plates? _______

Please return the survey to:

John Grant, ENVIRON International Corporation:
Phone: 415-899-0700
jgrant@environcorp.com via email, or
415-899-0707 via fax

2005 Transport Refrigeration Units (TRU) (Reefers or Reefer Containers)

Diesel engine-powered transport refrigeration units (reefer containers) are a potentially important emission source category and much effort has been spent to reduce those emissions by providing plug-ins for reefer containers spending a significant amount of time at the terminal. The Port would like to determine the current reefer containers operating on engine power and those using electrical power.

Please provide:

(1) Number of TRU containers entering or handled by the facility (specify the yearly total, or average day if yearly total is not available): ____

(2) Average time spent on site by each reefer container: ______________________ hours

(3) Fraction/percentage of TRUs plugged in to electrical power instead of running on engine at any given time: ________________
OR total hours of all containers plugged in for the year: ______________________ hours

Please return the survey to:

John Grant, ENVIRON International Corporation:
Phone: 415-899-0700
jgrant@environcorp.com via email, or
415-899-0707 via fax

MOFFATT & NICHOL

2001 N. Main Street
Suite 360
Walnut Creek, CA 94596
Ph: (925) 944-5411
Fx: (925) 944-4732