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Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Dolores and ICTF Rail Yards, Long Beach, California

prepared for:

Union Pacific Railroad Company

December 2007

prepared by:

Sierra Research, Inc.
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SUMMARY

In accordance with the 2005 California Air Resources Board (CARB)/Railroad Statewide Agreement (MOU), Union Pacific Railroad Company (UPRR) has prepared a facility-wide emission inventory for the Dolores and Intermodal Container Transfer Facility (ICTF) Rail Yards (Yards) in Long Beach, California. The inventory quantifies emissions of criteria pollutants and specified toxic air contaminants (TACs) (including Diesel particulate matter [DPM]) from stationary, mobile, and portable sources at the Yards. The Yards are physically separate facilities, but due to their close proximity to one another, they were treated as one facility for the emission inventory and dispersion modeling analysis. The inventory was prepared in accordance with CARB's *Rail Yard Emission Inventory Methodology* guidelines (July 2006) and UPRR's *Emission Inventory Protocol* (May 2006).

This inventory differs from those prepared for other UPRR rail yards because it is being prepared at a time when a similar inventory has been requested for the ICTF/Dolores yards by the Ports of Los Angeles and Long Beach. To avoid potential confusion associated with having two, similar but different inventories circulated at the same time, the requirements of the Ports have combined with those associated with the MOU to create a single, comprehensive approach to the inventory.

The Dolores Yard serves two primary purposes: flat switching and locomotive servicing. At a flat switching yard, incoming and outbound train sections are stored in different track segments, and separated from and connected to other sections to build new trains. Dolores serves three separate types of trains: manifest (or mixed) freight trains that are handled within the Dolores Yard; intermodal trains that are handled at ICTF; and intermodal and other trains that ostensibly terminate or originate in the Yard, but are in reality handled at on-dock facilities within the Ports of Los Angeles and Long Beach.

The Dolores Yard is also a locomotive servicing facility, which includes a Service Track and a Locomotive Shop, to provide support to ICTF and other yards in the L.A. Basin. Operations include both basic service (refueling, sanding, cleaning, etc.) and major planned and unscheduled maintenance for locomotives serving Dolores, ICTF, and the

on-dock facilities in the Ports. Other facilities and equipment at the Yard include a sand tower, Diesel fuel storage tanks, various oil storage tanks, and a wastewater treatment plant.

The ICTF Yard is an intermodal container facility. Intermodal containers are received, sorted, and distributed from the facility. Intermodal containers may arrive at the facility by truck to be loaded onto trains for transport to distant destinations, or arrive by train and unloaded onto chassis for transport by truck to local destinations. Cargo containers and chassis are also temporarily stored at the Yard.

Facilities at the Yards include classification tracks, a gate complex for inbound and outbound intermodal truck traffic, intermodal loading and unloading tracks, and various buildings and facilities supporting railroad and contractor operations.

Emission sources at the Yards include, but are not limited to, locomotives, heavy-heavy-duty (HHD) Diesel-fueled trucks, cargo handling equipment (CHE), heavy equipment, transport refrigeration units (TRUs) and refrigerated rail cars (reefer cars), and fuel storage tanks. Emissions were calculated on a source-specific and facility-wide basis for the 2005 calendar year. In addition, at the request of the Ports of Los Angeles and Long Beach in the context of the ICTF Modernization Project, the following emission sources were included in the inventory:

- Emissions from locomotives and drayage trucks related to ICTF, and operating within 0.5 miles of the facility, were included in emission inventory and dispersion modeling analysis.
- Diesel-fueled sources that were previously excluded as de minimis or exempt, per the UPRR Emission Inventory Protocol, were included in the emission inventory and dispersion modeling analysis. These sources are an emergency generator and a portable air compressor.
- Toxic air contaminant (TAC) sources that were previously excluded as de minimis or exempt, per the UPRR Emission Inventory Protocol, were included in the emission inventory and dispersion modeling analysis. These sources include,

but are not limited to, a natural gas-fired heater, refueling operations, worker vehicles, a wastewater treatment plant, steam cleaners, and welders.

An air dispersion modeling analysis was also conducted. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs emitted from Yard operations, at receptor locations near the Yards. All emission sources that were included in the inventory, including the offsite locomotive and drayage truck emissions, were also included in the dispersion modeling analysis. The air dispersion modeling was conducted using the AERMOD Gaussian plume dispersion model and surface meteorological data from the St. Peter and Paul School monitoring station in Wilmington, and cloud cover data from the Long Beach Daugherty Field station were used for this project. The upper air data used in the modeling were obtained from Miramar Marine Corps Air Station. The meteorological data were processed using the AERMET program. The modeling analysis was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006).

Toxic Air Contaminant Emission Inventory and Air Dispersion Modeling Report for the Dolores and ICTF Rail Yards Long Beach, California

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PART I. INTRODUCTION

In accordance with the 2005 California Air Resources Board (CARB)/Railroad Statewide Agreement (MOU), Union Pacific Railroad Company (UPRR) has prepared a facility-wide emission inventory for the Dolores and Intermodal Container Transfer Facility (ICTF) Rail Yards (Yards) in Long Beach, California. The inventory quantifies emissions of specified toxic air contaminants (TACs) (including Diesel particulate matter [DPM]) from stationary, mobile, and portable sources at the Yards. The Yards are physically separate facilities, but due to their close proximity to one another, they were treated as one facility for the emission inventory and dispersion modeling analysis. The inventory was prepared in accordance with CARB's *Rail Yard Emission Inventory Methodology* guidelines (July 2006) and UPRR's *Emission Inventory Protocol* (May 2006).

This inventory differs from those prepared for other UPRR rail yards because it is being prepared at a time when a similar inventory has been requested for the ICTF/Dolores yards by the Ports of Los Angeles and Long Beach. To avoid potential confusion associated with having two, similar but different inventories circulated at the same time, the requirements of the Ports have combined with those associated with the MOU to create a single, comprehensive approach to the inventory.

Emission sources at the Yards include, but are not limited to, locomotives, heavy-heavy-duty (HHD) Diesel-fueled trucks, cargo handling equipment (CHE), heavy equipment, transport refrigeration units (TRUs) and refrigerated rail cars (reefer cars), and fuel storage tanks. Emissions were calculated on a source-specific and facility-wide basis for the 2005 calendar year. In addition, at the request of the request of the Ports of Los Angeles and Long Beach in the context of the ICTF Modernization Project, the following emission sources were included in the inventory.

- Emissions from locomotives and drayage trucks related to ICTF, and operating within 0.5 miles of the facility, were included in emission inventory and dispersion modeling analysis.

- Diesel-fueled sources that were previously excluded as de minimis or exempt, per the UPRR Emission Inventory Protocol, were included in the emission inventory and dispersion modeling analysis. These sources are an emergency generator and a portable air compressor.

- Toxic air contaminant (TAC) sources that were previously excluded as de minimis or exempt, per the UPRR Emission Inventory Protocol, were included in the emission inventory and dispersion modeling analysis. These sources include, but are not limited to, a natural gas-fired heater, refueling operations, worker vehicles, a wastewater treatment plant, steam cleaners, and welders.

An air dispersion modeling analysis was also conducted for the Yards. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations near the Yards. All emission sources that were included in the inventory, including the offsite locomotive and drayage truck emissions, were also included in the dispersion modeling analysis. The air dispersion modeling was conducted using the AERMOD Gaussian plume dispersion model and surface meteorological data from the St. Peter and Paul School monitoring station in Wilmington, and cloud cover data from the Long Beach Daugherty Field station were used for this project. The upper air data used in the modeling were obtained from Miramar Marine Corps Air Station.[1] The meteorological data were processed using the AERMET program. The modeling analysis was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006).

[1] ENVIRON. *Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards*, Report 06-12910J, July 25, 2006.

PART II. FACILITY DESCRIPTION

A. Facility Name and Address

Union Pacific Railroad Company
Dolores Rail Yard
2442 E. Carson Street
Long Beach, CA 90810

Union Pacific Railroad Company
Intermodal Container Transfer Facility
2401 E. Sepulveda Blvd.
Long Beach, CA 90810

B. Facility Contact Information

Brock Nelson
Director of Environmental Operations – West
Union Pacific Railroad Company
10031 Foothills Boulevard
Roseville, CA 95747
Phone: (916) 789-6370
Fax: (402) 233-3162
banelson@up.com

C. Main Purpose of the Facility

The Dolores and ICTF Yards handle both "manifest" cargo (mixed freight) and intermodal containers. ICTF is strictly an intermodal container handling facility. Intermodal containers may arrive at ICTF by truck to be loaded onto trains for transport to distant destinations, or arrive by train and unloaded onto chassis for transport by truck to local destinations. Intermodal containers and chassis are also temporarily stored at ICTF. Facilities at the Yard include a gate complex for inbound and outbound intermodal truck traffic, intermodal loading and unloading tracks, and various buildings and facilities supporting railroad and contractor operations.

The Dolores Yard serves two primary purposes: flat switching and locomotive servicing. At a flat switching yard, incoming and outbound train sections are stored in different track segments, and separated from and connected to other sections to build new trains.

Dolores serves three separate types of trains: manifest (or mixed) freight trains that are handled within the Dolores Yard; intermodal trains that are handled at ICTF; and intermodal and other trains that ostensibly terminate or originate in the Yard, but are in reality handled at on-dock facilities within the Ports of Los Angeles and Long Beach. Intermodal rail cars and other freight cars are received, sorted, and distributed from Dolores; containers, however, are neither loaded nor unloaded at Dolores.

The Dolores Yard is also a locomotive servicing facility, which includes a Service Track and a Locomotive Shop, to provide support to ICTF and other yards in the L.A. Basin. Operations include both basic service (refueling, sanding, cleaning, etc.) and major planned and unscheduled maintenance for locomotives serving Dolores, ICTF, and the on-dock facilities in the Ports. Other facilities and equipment at the Yard include a sand tower, Diesel fuel storage tanks, various oil storage tanks, and a wastewater treatment plant.

D. Types of Operations Performed at the Facilities

Activities at ICTF include receiving inbound trains, loading and unloading intermodal trains, storage of intermodal containers and chassis, building and departing outbound trains, and repairing freight cars and intermodal containers/chassis. Activities at the Dolores Yard include receiving inbound trains, building and departing outbound trains, locomotive refueling, locomotive servicing, and sand tower operations. UPRR operates yard switcher locomotives within Dolores and ICTF to support many of these activities. In addition, Pacific Harbor Lines (PHL) operates yard switchers throughout the Ports (although not generally within the boundaries of the ICTF or Dolores Yards). The PHL switchers will pull train sections destined for on-dock handling from the south (or west) end of Dolores, and push train sections that were newly built on-dock back into the south end of Dolores.

The railroad track layout for Dolores and ICTF is primarily linear along a roughly north-south axis, with track to the north heading to central Los Angeles and points north and east, while track to the south heads into the Ports. The Alameda Corridor runs adjacent to the west side of Dolores, and there are leads into and out of Dolores at each end. The north end of the Dolores Yard contains the “900 Track,” a series of parallel tracks approximately 1.4 miles long, as well as a lead from the Alameda Corridor into Dolores and subsequently ICTF. The south end of Dolores contains another set of multiple parallel tracks approximately 0.9 miles long known as the “300 Track.” Both the 900 and 300 Tracks can be used to receive terminating trains or to build originating trains. ICTF is connected at its north end to the central section of Dolores and to the 900 Track. The tracks within ICTF are the principal intermodal loading and unloading tracks, and are serviced by rubber tire gantry (RTG) cranes and a variety of other cargo handling equipment.

Facilities within ICTF include a gate complex for inbound and outbound intermodal truck traffic, intermodal loading and unloading tracks, and various buildings and facilities supporting railroad and contractor operations.

E. Facility Operating Schedule

Both the Dolores and ICTF Yards operate 24 hours per day, 365 days per year.

F. General Land Use Surrounding the Facility

The main portion of the Dolores Yard covers a narrow area approximately one-half mile in length (tracks and train push back areas extend both north and south of the main Yard). Land uses on the west, south, and north sides of the Yard are commercial and industrial. The ICTF Yard is located to the southeast. A number of industrial facilities’ storage tanks are located to the southwest. An overpass for the I-405 freeway passes over the south end of the Yard. Between the east side of the Yard and the I-710 freeway (approximately 1.25 miles from the Yard) is a residential area. The nearest residences are approximately 300 feet from the eastern edge of the Yard. The location of specific receptors is further discussed in Part IX.

The ICTF Yard is located to the southeast of the Dolores Yard. ICTF covers a long, narrow area between E. Sepulveda Blvd. and E 233rd St, just south of the I-405 freeway. As with the Dolores Yard, land uses on the south and west sides of ICTF are commercial and industrial. Between the east side of the Yard and the I-710 freeway (approximately 1 mile from the Yard) is a residential area. The nearest residences are approximately 400 feet from the eastern edge of the Yard. The location of specific receptors is further discussed in Part IX.

PART III. MAP AND FACILITY PLOT PLAN

Figure 1
Location Map

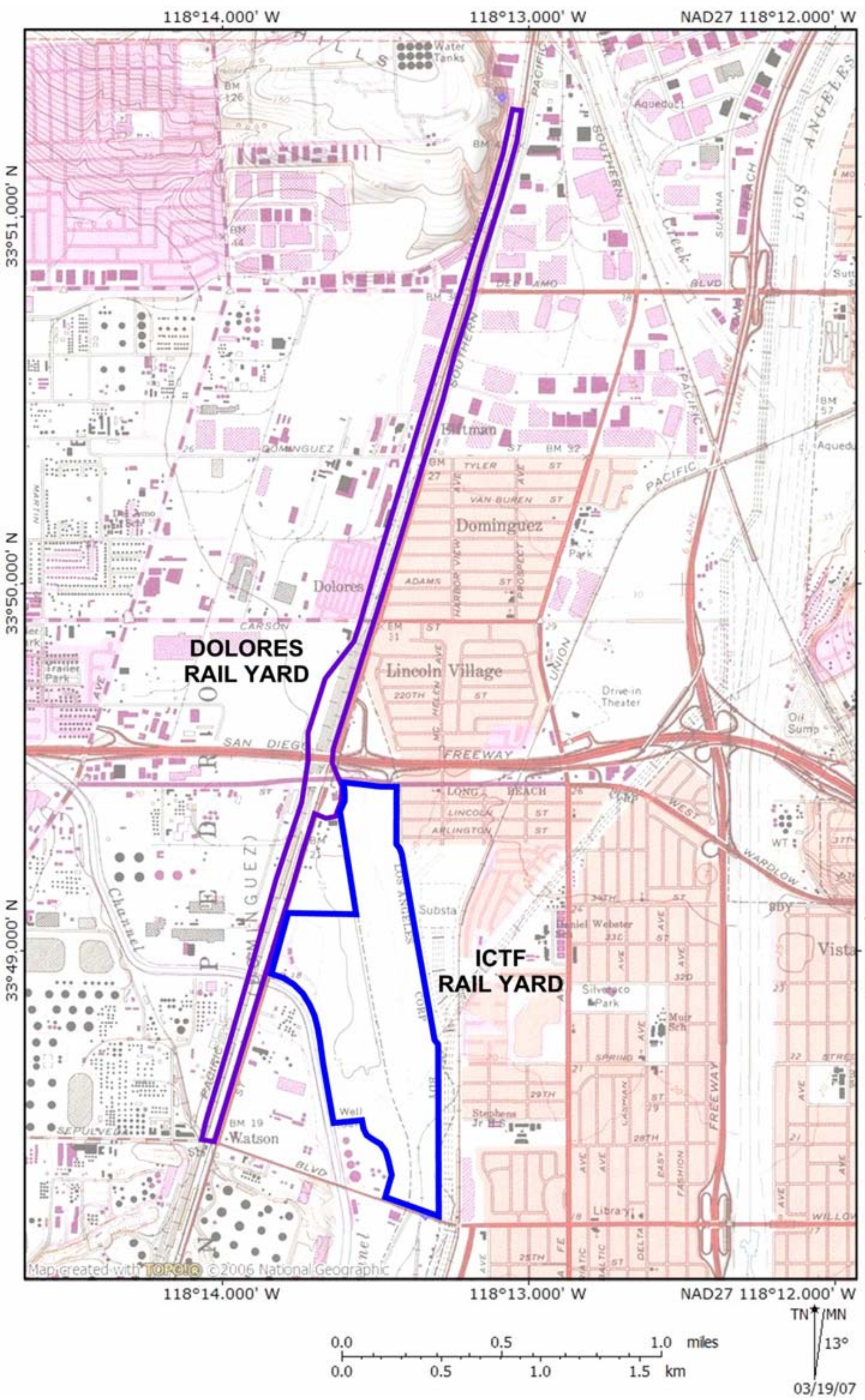

Figure 2
Dolores Rail Yard Layout

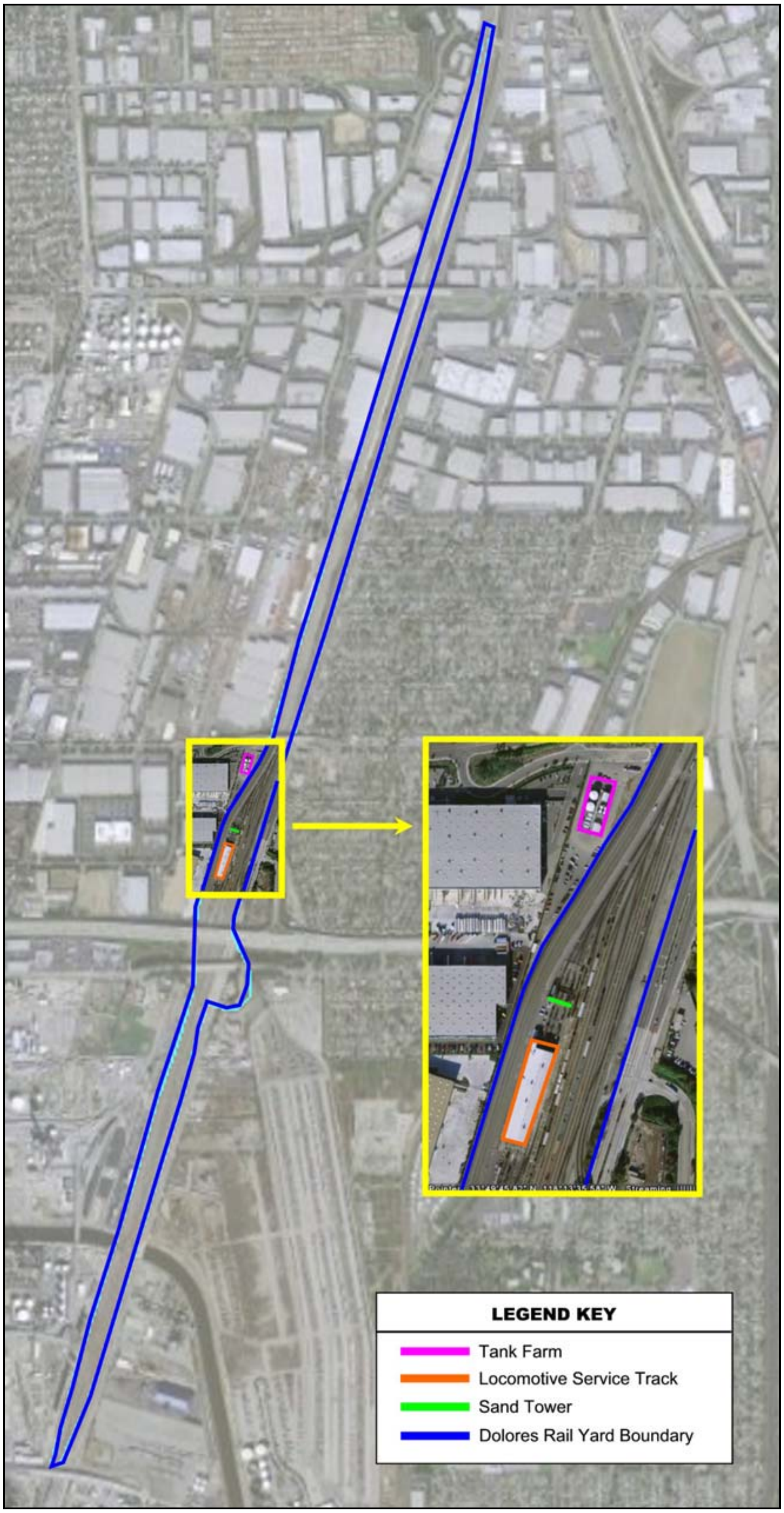

Figure 3
ICTF Rail Yard Layout

PART IV. COVERED SOURCES

This emission inventory quantifies toxic air contaminant (TAC) emissions from the stationary, mobile, and portable sources located or operating at the Dolores and ICTF Yards. Sources include, but are not limited to, locomotives, heavy-heavy-duty (HHD) Diesel-fueled trucks, cargo handling equipment (CHE), heavy equipment, transport refrigeration units (TRUs) and refrigerated railcars (reefer cars), and fuel storage tanks. Site-specific equipment inventories are included in Part V below.

At the request of the Ports of Los Angeles and Long Beach in the context of the ICTF Modernization Project, the emission sources listed below were included in the emission inventory and dispersion modeling analysis. These sources were included to ensure consistency between data submitted to the Ports for the Modernization Project, and to ARB under the MOU.

- Emissions from locomotives and drayage trucks related to ICTF, and operating within 0.5 miles of the facility, are included in the emission inventory and dispersion modeling analysis. Emissions for other locomotives bypassing the Yards in the Alameda Corridor are also included for the segment of the Corridor within 0.5 miles of the facility.

- Diesel-fueled sources that would be excluded as de minimis or exempt, per the UPRR Emission Inventory Protocol, are included in the emission inventory and dispersion modeling analysis. These sources are an emergency generator and a portable air compressor.

- Toxic air contaminant (TAC) sources that would be excluded as de minimis or exempt, per the UPRR Emission Inventory Protocol, are included in the revised emission inventory and dispersion modeling analysis. These sources include, but are not limited to, a natural gas-fired heater, refueling operations, worker vehicles, a wastewater treatment plant, steam cleaners, and welders.

PART V. SITE-SPECIFIC EQUIPMENT INVENTORIES

As discussed in Part IV above, there are a number of mobile, stationary, and portable emissions sources operating at the Dolores and ICTF Rail Yards. The mobile sources include locomotives, heavy-heavy duty (HHD) Diesel-fueled trucks, cargo handling equipment (CHE), and other heavy equipment. The stationary emission sources include storage tanks, a sand tower, a wastewater treatment plant, a heater/furnace, and an emergency generator. Portable equipment operating at the Yard includes transport refrigeration units (TRUs) and refrigerated railcars (reefer cars), welders, air compressors, steam cleaners, a pressure washer, and a generator. Each source group is further discussed below.

A. Locomotives

Locomotive activities at the Yards fall into two basic categories: road power and yard operations. "Road power" units are locomotives used on inbound and outbound freight trains and are generally larger, higher horsepower units (3,000 to 6,000 hp). Locomotives used for operations within a rail yard are called switcher locomotives and are generally low horsepower units (1,500 to 3,000 hp).

Road Power – "Road power" activities include hauling through trains on the main line, pulling arriving trains into the Yard, pulling departing trains out of the Yard, and moving locomotives to and from the Service Track. The Dolores and ICTF Yards handle both manifest freight trains and intermodal trains. Arriving trains enter the Dolores Yard and stop while the railcars are detached from the locomotive. Once the railcars have been detached, the locomotives move to the Service Track for refueling and other service.

Approximately half of the manifest freight trains that terminate at Dolores use the 900 Track. The remaining half of the manifest trains arriving at Dolores use the 300 Track. Originating manifest freight trains are most commonly built in the 900 Track and depart from there. Power is brought to the trains from the Service Track just prior to departure. The train departs after completion of the Federal Railroad Administration (FRA) mandated safety inspections (e.g., air pressure and brakes) and the arrival of the train crew.

Intermodal freight is handled at ICTF. However, due to track congestion and current facilities, only about 20% of terminating intermodal freight trains enter ICTF directly. The majority of the intermodal trains, about 80%, terminate in the 300 Track at Dolores and are pushed into ICTF for handling. Some of the intermodal trains terminating at Dolores are pulled directly from the 300 Track to on-dock facilities within the Ports of Los Angeles and Long Beach by switcher locomotives operated by Pacific Harbor Lines (PHL). Originating intermodal trains depart from either the 300 Track (approximately 20%) or the 900 Track (approximately 80%). The road power moves directly to service after arrival, and consists[2] for departing trains move to the trains from Service just prior to departure. As for terminating trains, some originating trains are handled on-dock rather than within Dolores/ICTF.

Through trains are trains that nominally bypass Dolores using the section of the Alameda Corridor main line adjacent to and on the west side of the Dolores Yard. The Alameda Corridor is the main rail line between the Ports of Los Angeles and Long Beach and central Los Angeles[3]. Data show some through trains enter and leave the yard on the 300 and 900 Tracks, however, with some adding or dropping of rail cars or locomotives. In these cases, the locomotive consist is not disconnected nor moved to the Service Track. These so-called "set-outs" are counted separately from trains on the Alameda Corridor so that the emissions specifically associated with the "set-outs" can be calculated.

Power moves are groups of locomotives that are moved between yards to provide road power for departing trains. Although power moves may have as many as 10 or more locomotives, typically only one or two locomotives are actually operating. For emission

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[2] "Consist" is the term used in the railroad industry to describe the group of coupled locomotives that pull trains.

[3] UPRR does not own or operate the Alameda Corridor. The Alameda Corridor was built and is governed by the Alameda Corridor Transportation Authority. For more information on the Alameda Corridor see *http://www.acta.org*.

calculations, power moves were assumed to have 1.5 operating locomotives (except for power moves involving just one locomotive).[4]

Table 1 shows the number of road power locomotives in operation (arrivals, departures, and through traffic) at ICTF and Dolores during the 2005 calendar year by locomotive model group and type of train, including both working and non-working units (i.e., units that are shut-down).

Table 1
Locomotive Models (Road Power) Identified at the Dolores and ICTF Rail Yards[a]

Locomotive Model Group	Intermodal Trains			Non-Intermodal Trains			Power Moves		
	Thru	Arriving	Departing	Thru	Arriving	Departing	Thru	Arriving	Departing
Switch[b]	0	1	1	5	281	269	0	1	2
GP3x	0	14	3	404	2,034	2,054	0	5	24
GP4x	58	972	846	184	1,446	1,343	15	156	256
GP50	2	88	92	6	53	21	2	10	16
GP60	43	650	403	38	991	1,137	13	95	229
SD7x	411	5,091	3,529	148	832	735	18	410	552
SD90	1	14	16	6	49	49	1	8	15
Dash7	0	5	4	0	3	1	0	2	2
Dash8	62	1,035	900	46	303	186	2	114	169
Dash9	328	1,990	1,402	80	570	519	17	183	369
C60A	6	10	9	0	50	52	1	0	5
Unknown	11	124	113	6	44	32	0	16	27
Total	922	9,994	7,318	923	6,656	6,398	69	1,000	1,666

Notes:
a. Includes all locomotives identified on an arriving, departing, or through train, including both working and non-working units.
b. Does not include the switcher locomotives used for yard operations.

B. <u>HHD Diesel-Fueled Drayage Trucks</u>

A variety of HHD Diesel-fueled trucks operate at ICTF each day. The HHD trucks are used to pick up and deliver intermodal cargo containers. The trucks are owned and

[4] UP personnel report that although the train data records for power moves may show all locomotives "working," in actuality all locomotives except for one at the front and one at the rear end (and more commonly only one at the front end) are shut down, as they are not needed to pull a train that consists only of locomotives. Assuming 1.5 working locomotives per power move may slightly overestimate the actual average number of working locomotives per power move.

operated by many large trucking companies and independent operators (draymen). Therefore, a fleet distribution is not available. For emission calculations, the EMFAC2007 model default fleet distribution for HHD Diesel-fueled operating in Los Angeles County was used.

C. Cargo Handling Equipment

A variety of heavy equipment is used to load, unload, and move cargo containers within ICTF. Table 2 provides the equipment specifications for cargo handling equipment (CHE) operating at the Yard. The Dolores Yard does not handle cargo; therefore, there is no CHE operating at Dolores.

Table 2
Equipment Specifications for Cargo Handling Equipment
ICTF Rail Yard

Equipment Type	Make/Model	Engine Make/Model	Model Year	Rating (hp)	No. of Units
Forklift	Toyota 6FDU25	Toyota	1997	85	1
RTG[a]	Mi Jack 850R	Detroit DDEC	1997	300	1
RTG[a]	Mi Jack 1000R	Detroit 671N	1988	250	1
RTG[a]	Mi Jack 1000R	Detroit 671TA	1995	300	4
RTG[a]	Mi Jack 1000RC	Detroit DDEC	2002	300	2
RTG[a]	Mi Jack 1200R	Detroit DDEC	2005	350	1
Top Pick	Mi Jack PC-90	Cummins NA335	1972	335	1
Top Pick	Taylor Tay-950	Cummins L-10	1988	350	1
Top Pick	Taylor Tay-950	Cummins L-10	1989	350	1
Yard Hostler	Capacity TJ5000	Caterpillar 3116	1999	150	15
Yard Hostler	Capacity TJ5000	Caterpillar 3116	2005	173	58
Total					**86**

Notes:
a. Rubber Tire Gantry Crane.

D. Heavy Equipment

In addition to the CHE discussed above, Diesel-fueled heavy equipment is used at ICTF. The heavy equipment is used for non-cargo-related activities at the Yard, such as locomotive maintenance, RTG maintenance, handling of parts and Company material, and, derailments. Table 3 provides detailed information for the heavy equipment used at

ICTF. Also, two propane-fueled forklifts are used at the locomotive shop at the Dolores Yard.

Table 3 Equipment Specifications for Heavy Equipment Dolores and ICTF Rail Yards							
Yard	Location	Equipment Type	Make/Model	Fuel Type	Model Year	Rating (hp)	No. of Units
ICTF	Car Department	Crane	Grove RT600E	Diesel	2004	173	1
ICTF	Crane Maintenance	Forklift	Taylor 850	Diesel	2005	155	2
ICTF	Crane Maintenance	Forklift	Taylor 850	Diesel	1998	154	1
ICTF	Crane Maintenance	Man Lift	Unknown	Diesel	1985	29	1
Dolores	Locomotive Shop	Forklift	Yale GP060	Propane	Unknown	150	2
Total							**7**

E. <u>TRUs and Reefer Cars</u>

Transport refrigeration units (TRUs) and refrigerated railcars (reefer cars) are used to transport perishable and frozen goods. TRUs and reefer cars are transferred in and out of, and are temporarily stored at, ICTF. The TRUs are owned by a variety of independent shipping companies, and equipment-specific data are not available. Therefore, the default equipment rating and distribution contained in the OFFROAD2007 model were used for emission calculations. It was assumed that the number of TRUs and reefer cars in the Yard at any one time remained constant during the year, with individual units cycling in and out of the Yard.

F. <u>HHD Diesel-Fueled Delivery Trucks</u>

HHD Diesel-fueled trucks deliver Diesel fuel, oil, sand, and soap[5] to the Dolores Yard and gasoline, Diesel fuel, and oil to ICTF. The trucks are owned by independent

[5] A large volume of liquid soap is used at the locomotive wash rack at the Dolores Yard. The soap is delivered to the facility by HHD Diesel truck and stored onsite in an 8,000 gallon tank.

operators; therefore, a fleet distribution is not available. For emission calculations, the EMFAC2007 model default fleet distribution for HHD Diesel-fueled operating in Los Angeles County was used.

G. Yard Trucks

A number of light-duty and medium-duty gasoline-fueled trucks are used by the staff at the ICTF and Dolores Yards. Table 4 provides the equipment specifications for the yard trucks.

Table 4
Equipment Specifications for Gasoline-Fueled Yard Trucks
Dolores and ICTF Rail Yards

Yard	Equipment Type	Equipment ID	Vehicle Class	Make/Model	Model Year
ICTF	SUV	1915-53287	LDT	Jeep Cherokee	2000
ICTF	Pickup Truck	1915-55536	LDT	Chevy Extended Cab	2003
ICTF	SUV	1915-19952	LDT	Chevy Trailblazer 370	2003
ICTF	Pickup Truck	1915-19971	LDT	Chevy Extended Cab	2004
ICTF	Van	1915-19975	LHDT 1	Chevy 15 Passenger Van	2004
Dolores	Service Truck	73152	MHD	Chevy C4500	2003
Dolores	Mgr Truck	Unknown	LDT	Chevy Trailblazer	2004
Dolores	Mgr Truck	73167	LDT	Chevy Blazer	2004
Dolores	Pickup Truck	73396	LDT	Ford F-150	2005

H. Diesel-Fueled IC Engines

A stationary Diesel-fueled emergency generator is located at the ICTF Yard office building to provide emergency power when electrical service from the local power provider is disrupted. The generator is a 269 horsepower, Diesel-fueled unit manufactured by Caterpillar. In addition to the generator, the ICTF mechanical department operates a portable 49 hp Diesel-fueled air compressor, manufactured by Ingersoll-Rand, at various locations within the Yard.

I. <u>Tanks</u>

There are a number of tanks at both the Dolores and ICTF Yards that are used to store liquid petroleum and other products such as Diesel fuel, gasoline, lubricating oils, and recovered oil. Table 5 provides detailed information for all storage tanks located at each facility.

Table 5
Storage Tank Specifications
Dolores and ICTF Rail Yards

Yard	Tank No.	Tank Location	Material Stored	Tank Capacity (gallons)
Dolores	TNKO-0001	Tank Farm	Lube Oil	12,000
Dolores	TNKO-0002	Tank Farm	Recovered Oil	10,000
Dolores	TNKO-0003	Tank Farm	Drain Oil	12,000
Dolores	TNKO-0004	Tank Farm	Journal Box Oil	8,000
Dolores	TNKS-0005	Tank Farm	Stormwater	25,000
Dolores	TNKS-0006	Tank Farm	Stormwater	25,000
Dolores	TNKS-0007	Tank Farm	Stormwater	25,000
Dolores	TNKS-0008	Tank Farm	Stormwater	25,000
Dolores	TNKS-0010	Tank Farm	Soap	8,000
Dolores	TNKD-0068	Tank Farm	Diesel Fuel	160,000
Dolores	TNKD-0069	Tank Farm	Diesel Fuel	160,000
Dolores	TNKO-0184	Service Track	Recovered Oil	6,000
Dolores	NA	WWTP	Sludge	1,000
Dolores	NA	WWTP	Nalco Chemicals	380
ICTF	TNKD-9901	Crane Maintenance	Offroad Diesel	20,000
ICTF	TBA-1	Crane Maintenance	CARB Diesel	1,000
ICTF	TBA-2	Crane Maintenance	Gasoline	2,000
ICTF	TBA-3	Tractor Maintenance	SAE 15W-40 Oil	500
ICTF	TBA-4	Crane Maintenance	Used Oil	300
ICTF	TBA-5	Crane Maintenance	Motor Oil	243
ICTF	TBA-6	Crane Maintenance	Hydraulic Oil	300
ICTF	TBA-7	Tractor Maintenance	Auto. Transmission Fluid	243
ICTF	TBA-8	Tractor Maintenance	SAE 20W-50 Oil	202
ICTF	TBA-9	Tractor Maintenance	Used Oil	300
ICTF	TBA-10	Tractor Maintenance	Used Oil	300
ICTF	TBA-11	Tractor Maintenance	Hydraulic Fluid	240

J. Refueling Operations

Refueling operations occur at the crane maintenance area of ICTF and at the locomotive shop at the Dolores Yard. Refueling emissions are based on the type of fuel and the annual fuel throughput. The capacity of each storage tank and the type of material stored are shown in Table 5 above.

K. Sand Tower

Locomotives use sand for traction and braking. The sand tower system located at the Dolores Yard consists of a storage system and a transfer system to dispense sand into locomotives. The storage system includes a pneumatic delivery system and a storage silo. The transfer system includes a pneumatic transfer system, an elevated receiving silo, and a moving hopper and gantry system. The system is equipped with a baghouse for emissions control.

L. Wastewater Treatment Plant

The Dolores Yard also has a wastewater treatment plant (WWTP). Equipment at the WWTP includes basins, two oil/water separators, a dissolved air flotation (DAF) unit, pumps, and storage tanks. Air emission sources at the WWTP are the basins, the oil/water separators, and the DAF.

M. Steam Cleaners

Portable steam cleaners are used for a variety of activities at the Dolores Yard. Emissions from steam cleaners are based on the hours of operation, the fuel type and rated capacity of the heater, and the fuel type and rated capacity of the pump. The equipment specifications for the steam cleaners operated at the Dolores Yard are shown in Table 6. There were no steam cleaners operating at ICTF during 2005.

Table 6 **Equipment Specifications for Steam Cleaners** **Dolores Rail Yard**				
Equipment Location	Make	Emission Unit	Fuel Type	Rating (MMBtu/hr or hp)
Service Track	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.35
Locomotive Shop	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.35
Locomotive Shop	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.35
Service Track	Hydroblaster	Pump	Gasoline	11
		Heater	Propane	0.35

N. Natural Gas-Fired Heater

There is a natural gas-fired heater/furnace located at the ICTF administrative building. The heater is used to provide comfort heating for the building. The unit is rated at 0.76 MMBtu/hr and is fired exclusively with natural gas.

O. Propane-Fueled Welder

A propane-fueled welder is used for locomotive service and repair operations at the Dolores Yard. Emissions from the welder are based on the fuel type, rated capacity, and hours of operation for the unit. The welder has a rated capacity of 18 hp.

P. Miscellaneous Gasoline-Fueled Equipment

A variety of small, portable, gasoline-fueled, equipment is used at ICTF each day. Emissions from the portable equipment are based on the fuel type, rated capacity, and hours of operation of each unit. The equipment specification for miscellaneous gasoline-fueled equipment is shown in Table 7.

Table 7 Portable Equipment Specifications ICTF Rail Yards					
Yard	Equipment Location	Equipment Type	Number of Units	Fuel Type	Rated Capacity (hp)
ICTF	WEBCO Area	Welder	1	Gasoline	8
ICTF	Mechanical Dept.	Welder	1	Gasoline	13
ICTF	Mechanical Dept.	Welder	1	Gasoline	12.5
ICTF	Mechanical Dept.	Welder	1	Gasoline	18
ICTF	Crane Maintenance	Welder	1	Gasoline	20
ICTF	Crane Maintenance	Pressure Washer	1	Gasoline	18
ICTF	WEBCO Area	Air Compressor	1	Gasoline	5.5
ICTF	Mechanical Dept.	Air Compressor	1	Diesel	49
ICTF	Mechanical Dept.	Air Compressor	1	Gasoline	30
ICTF	Crane Maintenance	Generator[a]	1	Gasoline	<50

Notes:
a. The exact rating of this unit could not be determined.

Q. Worker Vehicles

Emissions were calculated from employee vehicles that arrive at and depart from the ICTF and Dolores Yards each day. The number of vehicle trips was based on employee force counts for each yard and assumes no ridesharing. Since the model year distribution is not known, the EMFAC2007 default distribution for gasoline-fueled passenger cars and light-duty trucks operating in Los Angeles County was used.

R. Road Dust

Particulate matter emissions were calculated for paved roadways in both the ICTF and Dolores rail yards. Particulate emissions occur when loose material on road surfaces is resuspended as vehicles travel over a roadway. Emissions are based on the number of vehicles driving on the road, the length of the road, and the amount of loose material on the road surface.

PART VI. Activity Data

Emissions from mobile sources are based on the number and type of equipment, equipment size, load factor, and operation during the 2005 calendar year. Since fuel consumption data were not available, the default load factors from the OFFROAD2007 model and operating data were used for emission calculations. For sources where operating data weren't available, an average operating mode (AOM) was developed based on employee interviews.

A. Locomotives

Road Power – Locomotive emissions were based on the number, model distribution, and operating conditions (idling, throttle notch, and speeds of movements, etc). Table 8 summarizes the activity data for locomotives operating on trains at ICTF and Dolores during the 2005 calendar year. Power moves into and out of rail yards occur under train symbols if the regular train crew is still in the locomotives following termination of a train. In addition, some power moves occur without train symbols if the power is being ferried between yards by "hostlers" and not regular train crews. Such power moves do not appear in the train database since they do not have train symbols assigned to them. To ensure that the emissions calculations were based on the same number of locomotives arriving and departing from the yard in a given year, the number of arriving or departing power moves was adjusted upward by an amount such that the total number of arriving and departing locomotives was the same.

Table 8 Train Activity Summary Dolores and ICTF Rail Yards									
	East Bound			West Bound					
Train Type	No. of Trains	Locos per Train	No. of Setouts	No. of Trains	Locos per Train	No. of Setouts	Speed (mph)	Idle per Train (hours)	Idle per Setout (hours)
Intermodal Through	74	3.365	22	215	2.916	166	10	0	0.5
Intermodal Terminating	0	--	--	2,045	3.267	--	10	0.5	--
Intermodal Originating	3,557	2.663	--	0	--	--	10	0.5	--
Non-Intermodal Through	403	1.548	384	101	2.574	79	10	0	0.5
Non-Intermodal Terminating	865	1.751	--	1,824	2.438	--	10	0.5	--
Non-Intermodal Originating	2,145	2.297	--	865	1.837	--	10	0.5	--
Power Moves Through	17	2.941	--	7	2.286	--	10	0	--
Power Moves Terminating	393	3.074	--	424	3.495	--	10	0	--
Power Moves Originating	624	3.857	--	1,604	3.324	--	10	0	--

Notes:
a. In addition to the activities described above, ten switchers operate in the Yard.

Yard Switching – Yard operations include movements of intermodal and manifest freight cars within the Yard. At the ICTF and Dolores Yards, the yard operations are performed by five sets of two GP-38 switchers. Three of these sets are assigned to Dolores manifest freight activities as well as other nearby industry jobs. These sets work within the full length of Dolores approximately 15 hours per day each, with the remaining time spent working outside the Yard. The other two sets serve ICTF intermodal freight exclusively. One set works the "bottom end" or south end of the 300 Track, while the other works the "top end" including the north end of the 300 Track, the 900 Track, and the lead from Dolores into ICTF. These two sets are assumed to be working 23 hours per day each within their assigned areas.

Service and Maintenance – The Locomotive servicing and maintenance activities performed at the Dolores Yard involve both road power and yard locomotives. Service activities include idling associated with refueling, sanding, oiling, and waiting to move to outbound trains, with additional periods of idling and higher throttle settings during load test events following specific maintenance tasks. Following service, locomotives are taken as consists to departing trains. In order to be sure that the lead locomotive is facing in the correct direction, approximately 25% of locomotives leaving service travel to the "wye"[6] at the south end of the 300 Track to "turn the power."

A separate database provided information on each locomotive handled by the Service Track and Shop at Dolores. These data show service events for all locomotives, including Dolores manifest freight units, ICTF intermodal units, and other units serviced for "on-dock" trains and other yards. Based on detailed information on the reason and type of service or maintenance performed, separate counts of service and maintenance activities were developed. Routine service of locomotives involves idling and short movements in the service area associated with sanding, refueling, oiling, and other service activities prior to their movement to the Ready Track where locomotives are consisted for outbound trains. Some locomotive service events occur elsewhere in the Yard, with little or no idling, as only simple service items and refueling are involved.

[6] A "wye" is a set of track segments arranged in a triangular configuration with a lead at each corner. A consist can enter the "wye" from one lead, exit from another, then back up through the "wye" and out the other lead, and then return through the third leg of the triangle with the direction of the consist reversed.

Depending on the type of maintenance, load testing prior to and after maintenance is performed. The number of these test events was determined based on the service codes for each locomotive maintenance event in the database. The specific nature (duration and throttle setting) of such load testing events is described in Table 9.

Table 9
Locomotive Service and Shop Releases and Load Tests
Dolores Rail Yard

Activity	Number of Events	Extra Non-ZTR Idling[a] (min)	ZTR and Non-ZTR Idling[b] (min)	N1 time (min)	N8 time (min)
Locomotive Pre-service	8,294	0	30	0	0
Locomotive Service	8,294	0	60	0	0
Ready Track	8,294	15	30	0	0
Yard Service	4,643	0	0	0	0
In Shop	2,815	0	30	0	0
Planned Maintenance Pre-Test	281	0	2	0	8
Planned Maintenance Post-Test	281	0	10	10	10
Quarterly Maintenance Test	430	0	2	0	8
Unscheduled Maintenance Diagnostic	6	0	10	0	10
Unscheduled Maintenance Post-Test	777	0	15	0	45

Notes:
a. "Extra Non-ZTR idling" duration is the number of minutes per event during which only locomotives not equipped with automated idling controls (ZTR SmartStart or AESS) are idling
b. "ZRT and Non-ZRT Idling" duration is the number of minutes per event during which all locomotives are idling, regardless of technology.

B. <u>HHD Diesel-Fueled Drayage Trucks</u>

1. <u>Onsite Operation</u>

Emissions from HHD Diesel-fueled drayage trucks are based on the number of truck trips, the length of each trip, and the amount of time spent idling. The number of truck trips was based on the 2005 lift count,[7] a gate count balancing factor,[8] and the assumption

[7] Provided by UPRR.
[8] The gate balancing factor is equal to the "in-gate" container count divided by the total number of containers passing through the "in-gate" and "out-gate" of ICTF. In 2005, the gate balancing factor was 63%.

that 40% of the trucks entering ICTF with a container also leave the facility with a container.[9] See Appendix B-1 for a detailed discussion on the calculation methodology.

In addition to the traveling emissions, an average idling time of 30 minutes per HHD truck trip was assumed to account for emissions during truck queuing, staging, loading and/or unloading. Based on discussions with the Intermodal Operations Manager, the average queuing time at the gate at ICTF is less than 10 minutes per truck. In addition to idling during queuing, it was assumed that each truck idles an average of 15 minutes per trip while the chassis is connected/disconnected from the truck cab. An additional 5 minutes of idle per trip was included to account for any other delays. Table 10 summarizes the activity data, such as annual VMT and idling time, for HHD Diesel-fueled drayage trucks operating at ICTF.

Table 10
Activity Data for HHD Diesel-Fueled Drayage Trucks – Onsite Operations
ICTF Rail Yard

Number of HHD Truck Trips[a]	VMT per HHD Truck Trip (mi/trip)[b]	Annual VMT (mi/yr)	Idling Time (min/trip)[b]	Idling Time (hr/yr)
938,074	1.75	1,641,629.50	30	469,037

Notes:
a. Number of truck trips based on 2005 lift and were estimated by HDR. See Appendix B-1 for details.
b. Trip length estimate from aerial photos of the Yard.
c. Engineering estimate based on personal communication with the Intermodal Operations Manager for the ICTF, Commerce, LATC, and Oakland Yards.

2. Offsite Operation

Emissions from ICTF-related drayage trucks operating within 0.5 miles of the facility were based on the number of truck trips, the percentage of trucks traveling on each route,[9] and the length of each truck route. Emissions from offsite truck idling were included with the traveling emissions. The length of each road segment was estimated from aerial photos. The activity data for offsite drayage truck operations are shown in Table 11.

[9] Personal communication from Greg Chiodo of HDR on September 24, 2007.

Table 11 Activity for HHD Diesel-Fueled Drayage Trucks – Offsite Operations ICTF Rail Yard			
Road Segment	No. of Truck Trips [a,b]	VMT per Truck Trip (mi/trip)[c]	Annual VMT (mi/yr)
Route A			
Gate - L of Sepulveda to T.I. Fwy Entrance	647,271	0.13	84,145.23
S on T.I. Fwy	647,271	0.50	323,635.51
Route B			
Gate - R on Sepulveda to Alameda St	215,757	0.74	159,660.18
R on Alameda to I-405	215,757	1.40	302,059.81
I-405 S towards I-710	215,757	0.50	107,878.50
Route C			
Gate - R on Sepulveda to Alameda St	75,046	0.74	55,533.98
R on Alameda towards West Basin Area	75,046	2.20	165,101.01
Total	938,074		1,198,014.22

Notes:

a. Number of truck trips is equal to the total number of drayage trucks multiplied by the percentage of trucks following each route.
b. Percentage of trucks following each route from the HDR Preliminary Traffic Study for the ICTF Modernization Project.
c. Road segment lengths estimated from aerial photos.

C. Cargo Handling Equipment

Emissions from CHE operating at ICTF are based on the number and type of equipment, equipment model year, equipment size, and the annual hours of operation. Activity data for CHE are summarized in Table 12.

Table 12 Activity Data for Cargo Handling Equipment ICTF Rail Yard					
Equipment Type	Make/Model	Model Year	Rating (hp)	No. of Units	Hours of Operation (hr/yr per unit)[a]
Forklift	Toyota 6FDU25	1997	85	1	730
RTG	Mi Jack 850R	1997	300	1	2,448[b]
RTG	Mi Jack 1000R	1988	250	1	2,448[b]
RTG	Mi Jack 1000R	1995	300	4	2,448[b]
RTG	Mi Jack 1000RC	2002	300	2	2,448[b]
RTG	Mi Jack 1200R	2005	350	1	2,448[b]
Top Pick	Mi Jack PC-90	1972	335	1	208[c]
Top Pick	Taylor Tay-950	1988	350	1	2,190[c]
Top Pick	Taylor Tay-950	1989	350	1	2,190[c]
Yard Hostler	Capacity TJ5000	1999	150	15	468[d]
Yard Hostler	Capacity TJ5000	2005	173	58	4,680[d]

Notes:
a. Assumptions used to calculate the hours of operation were provided by UPRR staff.
b. Assumed each RTG operates 7 hours per day, based on data collected at the UPRR Commerce Rail Yard.
c. Assumed the Taylor top picks operated 12 hours per day each and the Mi Jack top pick is used infrequently.
d. Assumed the 173 hp Yard Hostlers operate 4,680 hours per year, based on data collected at the UPRR Commerce Rail Yard. The 150 hp Yard Hostlers are backup units; it was assumed they operate 10% of the time that the main Yard Hostlers operate.

D. Heavy Equipment

Emissions from heavy equipment operating at the Yards are based on the number and type of equipment, equipment model year, equipment size, and the annual hours of operation. Activity data for heavy equipment are summarized in Table 13.

Table 13 Activity Data for Heavy Equipment Dolores and ICTF Rail Yards							
Yard	Equipment Type	Make/Model	Fuel Type	Model Year	Rating (hp)	No. of Units	Hours of Operation (hr/yr/unit)[a]
ICTF	Crane	Grove RT600E	Diesel	2004	173	1	1,095[b]
ICTF	Forklift	Taylor 850	Diesel	2005	155	2	7,300[c]
ICTF	Forklift	Taylor 850	Diesel	1998	154	1	7,300[c]
ICTF	Man Lift	Unknown	Diesel	1985	29	1	1,825[d]
Dolores	Forklift	Yale GP060	Propane	Unknown	150	2	3,285[e]
Total						7	

Notes:
a. Assumption used to calculate hours of operation from interviews with UPRR staff.
b. Assumed that the Grove crane operates 3 hours per day.
c. Assumed that the Taylor forklifts operate 20 per day each.
d. Assumed that the man lift operates 5 hours per day.
e. Assumed that the forklifts at the Dolores Yard operate 9 hours per day each.

E. TRUs and Reefer Cars

Emissions from TRUs and reefer cars are based on average size of the units, the average number of units in the Yard, and the hours of operation for each unit. Activity data for TRUs and reefer cars are summarized in Table 14.

Table 14 **Activity Data for TRUs and Reefer Cars** **ICTF Rail Yard**				
Equipment Type	Average Rating (hp)[a]	Average No. of Units in Yard[b]	Hours of Operation	
			(hr/day)[c]	(hr/yr)[d]
Container	28.56	70	4	1,460
Railcar	34	10	4	1,460

Notes:

a. Based on the average horsepower distribution in the OFFROAD2007 model.
b. UPRR staff estimates and car data reports indicate that there are approximately 35 TRUs and 2-5 reefer cars in the Yard at any given time. To be conservative, these estimates were increased by 100%.
c. From CARB's *Staff Report: Initial Statement of Reason for Proposed Rulemaking for Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate*, October 2003.
d. It was assumed that the number of units and the annual hours of operation remain constant, with individual units cycling in and out of the Yard.

F. <u>HHD Diesel-Fueled Delivery Trucks</u>

HHD Diesel-fueled trucks deliver Diesel fuel, oil, sand, and soap to the Dolores Yard and gasoline, Diesel fuel, and oil to ICTF. The annual number of delivery truck trips was calculated based on the facility gasoline, Diesel fuel, oil, and soap throughput and a tanker truck capacity of 8,000 gallons per truck. The annual number of sand delivery truck trips was based on the discussions with UPRR staff. Per the Dolores Yard Operations Manager, the facility receives 2 to 3 sand deliveries per week. The VMT per trip was estimated from aerial photos of the Yards. Activity data for the HHD delivery trucks are summarized in Table 15.

Table 15 Activity Data for HHD Delivery Trucks Dolores and ICTF Rail Yard						
Yard	Delivery Type	Number of HHD Truck Trips[a,b]	VMT per HHD Truck Trip (mi/trip)[c]	Annual VMT (mi/yr)	Idling Time (min/trip)[d]	Idling Time (hr/yr)
Dolores	Diesel Fuel	2,625	0.06	157.50	10	437.50
Dolores	Sand	156	2.2	343.20	30	78.00
Dolores	Oil	24	0.06	1.44	10	4.00
Dolores	Soap	3	0.06	0.17	10	0.47
ICTF	Gasoline	11	0.5	5.43	10	1.81
ICTF	Diesel Fuel	22	0.5	10.75	10	3.58
ICTF	Oil	2	0.5	1.00	10	0.33

Notes:
Number of truck trips for liquid products based on the material throughput and a tanker truck volume of 8,000 gallons per truck.
Number of sand truck trips based on personal communication with UPRR staff.
VMT per trip estimated from aerial photos of each Yard.
Engineering estimate based on personal communication with UPRR staff.

G. Yard Trucks

Emissions from yard trucks are based on the annual number of miles driven within the Yards. The annual number of miles driven was determined by dividing the vehicle's odometer reading by the age of the vehicle or through interviews with UPRR staff. The activity data for the yard trucks are summarized in Table 16.

Table 16
Activity Data for Gasoline-Fueled Yard Trucks
Dolores and ICTF Rail Yards

Yard	Equipment Type	Equipment ID	Vehicle Class	Make/Model	Model Year	Annual VMT (mi/yr)[a]	Idling (hr/yr)[c]
ICTF	SUV	1915-53287	LDT	Jeep Cherokee	2000	73,000	NA
ICTF	Pickup Truck	1915-55536	LDT	Chevy Extended Cab	2003	73,000	NA
ICTF	SUV	1915-19952	LDT	Chevy Trailblazer 370	2003	73,000	NA
ICTF	Pickup Truck	1915-19971	LDT	Chevy Extended Cab	2004	73,000	NA
ICTF	Van	1915-19975	LHDT 1	Chevy 15 Passenger Van	2004	73,000	91.25
Dolores	Service Truck	73152	MHD	Chevy C4500	2003	12,644	91.25
Dolores	Mgr Truck	Unknown	LDT	Chevy Trailblazer	2004	45,000	NA
Dolores	Mgr Truck	73167	LDT	Chevy Blazer	2004	36,608	NA
Dolores	Pickup Truck	73396	LDT	Ford F-150	2005	23,756	NA

Notes:

a. Annual VMT estimated from either the odometer reading divided by the age of the vehicle or interviews with UPRR staff.

b. Calculated using the EMFAC2007 model.

c. Idling time is an engineering estimate. Idling emissions from light-duty trucks are negligible; therefore, idling time data for these vehicles were not collected.

H. I.C. Engines

Emissions from the emergency generator and the air compressor are based on the rated capacity of the unit and the annual hours of operation. The equipment specifications and activity data for the emergency generator and air compressor are shown in Table 17.

Table 17
Equipment Specifications for Diesel-Fueled IC Engines
ICTF Rail Yard

Equipment Type	Make	Rating (hp)	Hours of Operation (hr/yr)[a,b]
Emergency Generator	Caterpillar 3208	269	20
Air Compressor	Ingersoll-Rand	49	1,000

Notes:

a. Hours of operation for the emergency generator are based on CARB's ATCM for Stationary Compression Ignition Engines. The ATCM limits non-emergency operation to 20 hours per year. UP personnel estimate that this engine is operated no more than 30 minutes/month. The 20 hours/yr estimate was used to be conservative.

b. Hours of operation for the air compressor are an engineering estimate.

c. Annual fuel use based on a bsfc of 7,000 Btu/hp-hr, a Diesel fuel HHV of 19,500 lb/Btu, and a Diesel fuel density of 7.1 lb/gal

I. Tanks

Emissions from the storage tanks at the Yards are based on the size of the tank, material stored, and annual throughput. Activity data for the tanks are shown in Table 18.

Table 18 Activity Data for Storage Tanks Dolores and ICTF Rail Yards						
Yard	Tank No.	Tank Location	Material Stored	Tank Capacity (gallons)	Tank Dimensions (ft)	Annual Throughput (gal/yr)
ICTF	TNKD-9901	Crane Maintenance	Offroad Diesel	20,000	34.5 x 10	120,000[b]
ICTF	TBA-1	Crane Maintenance	CARB Diesel	1,000	7 x 4	52,000[b]
ICTF	TBA-2	Crane Maintenance	Gasoline	2,000	11.83 x 6.92 x 4.75	86,808[a]
ICTF	TBA-3	Tractor Maintenance	SAE 15W-40 Motor Oil	500	6 x 4	2,000[b]
ICTF	TBA-4	Crane Maintenance	Used Oil	300	4 x 4	1,800[b]
ICTF	TBA-5	Crane Maintenance	Motor Oil	243	2.5 x 3 x 4.3	972[b]
ICTF	TBA-6	Crane Maintenance	Hydraulic Oil	300	6 x 2.5 x 3	1,200[b]
ICTF	TBA-7	Tractor Maintenance	Auto. Transmission Fluid	243	2.5 x 3 x 4.3	972[b]
ICTF	TBA-8	Tractor Maintenance	SAE 20W-50 Motor Oil	202	3 x 3 x 3	808[b]
ICTF	TBA-9	Tractor Maintenance	Used Motor Oil	300	4 x 2	1,200[b]
ICTF	TBA-10	Tractor Maintenance	Used Motor Oil	300	4 x 2	1,200[b]
ICTF	TBA-11	Tractor Maintenance	Hydraulic Oil	240	3 x 2.7 x 4.3	960[b]
Dolores	TNKD-0069	Tank Farm	Diesel	160,000	24 x 34	10,500,000[a]
Dolores	TNKD-0068	Tank Farm	Diesel	160,000	24 x 34	10,500,000[a]
Dolores	TNKO-0002	Tank Farm	Recovered Oil	10,000	16 x 10	40,000[b]
Dolores	TNKO-0003	Tank Farm	Drain Oil	12,000	20.5 x 10	48,000[b]
Dolores	TNKO-0004	Tank Farm	Journal Box Oil	8,000	21.3 x 8	32,000[b]
Dolores	TNKO-0001	Tank Farm	Lube Oil	12,000	20.5 x 10	48,000[b]
Dolores	TNKO-0184	Service Track	Recovered Oil	6,000	20.5 x 7	24,000[b]
Dolores	TNKS-0005	Tank Farm	Stormwater	25,000	30 x 12 x 12	980,100[a]
Dolores	TNKS-0006	Tank Farm	Stormwater	25,000	30 x 12 x 12	980,100[a]
Dolores	TNKS-0007	Tank Farm	Stormwater	25,000	30 x 12 x 12	980,100[a]
Dolores	TNKS-0008	Tank Farm	Stormwater	25,000	30 x 12 x 12	980,100[a]
Dolores	TNKS-0010	Tank Farm	Soap	8,000	8 x8	22,785[a]
Dolores	NA	WWTP	Sludge	1,000	6.5 x 5 x 5	NA

Notes:

a. Annual throughput provided by UPRR.
b. Annual throughput based on the assumptions contained in Trinity Reports.
c. Annual throughput based on the assumptions contained in Trinity Reports.

J. Refueling Operations

Refueling operations occur at the crane maintenance area of ICTF and at the locomotive shop at the Dolores Yard. Refueling emissions are based on the type of fuel, annual fuel throughput, and VOC emission factors from the SCAQMD. The activity data from refueling operations during 2005 are shown in Table 19.

Table 19
Activity Data for Refueling Operations
Dolores and ICTF Rail Yards

Yard	Tank No.	Tank Location	Material Stored	Throughput (gal/yr)
ICTF	TNKD-9901	Crane Maintenance	Offroad Diesel	120,000
ICTF	TBA-1	Crane Maintenance	CARB Diesel	52,000
ICTF	TBA-2	Crane Maintenance	Gasoline	86,808
Dolores	TNKD-0069	Tank Farm	Diesel	10,500,000
Dolores	TNKD-0068	Tank Farm	Diesel	10,500,000
Total				**21,258,808**

K. Sand Tower

Emissions from the sand tower are based on the annual sand throughput. The 2005 sand throughput for the Dolores Yard was 3,120 tons.

L. Wastewater Treatment Plant

Emissions from the WWTP are based on the annual wastewater flow rate. In 2005, the wastewater flow rate at the Dolores Yard was 980,100 gallons.

M. Steam Cleaners

Emissions from steam cleaners are based on the hours of operation, the fuel type and rated capacity of the heater, and the fuel type and rated capacity of the pump. The activity data for the steam cleaners operated at the Dolores Yard are shown in Table 20.

Table 20 Activity Data for Steam Cleaners Dolores Rail Yard							
Equipment Location	Make	Emission Unit	Fuel Type	Rating[a] (MMBtu/hr)	Rating[a] (hp)	Hours of Operation (hrs/yr)[b]	Fuel Use (gal/yr)
Service Track	Hydroblaster	Pump	Electric	NA	NA	1,000	NA
		Heater	Propane	0.35	NA	1,000	3,844[c]
Locomotive Shop	Hydroblaster	Pump	Electric	NA	NA	1,000	NA
		Heater	Propane	0.35	NA	1,000	3,844[c]
Locomotive Shop	Hydroblaster	Pump	Electric	NA	NA	1,000	NA
		Heater	Propane	0.35	NA	1,000	3,844[c]
Service Track	Hydroblaster	Pump[b]	Gasoline	NA	11	1,000	628[d]
		Heater	Propane	0.35	NA	1,000	3,844[c]

Notes:
a. Equipment rating provided by UPRR.
b. Hours of operation are an engineering estimate based on interviews with UPRR staff.
c. Based on a propane HHV of 3.824 MMBtu/barrel (from CARB Draft Emission Factors for Mandatory Reporting Programs, August 10, 2007) and 42 gallons per barrel.
d. Based on a bsfc of 7,000 Btu/hp-hr (from AP-42) and a gasoline HHV of 122,697 Btu/gal (from Transportation Energy Data Book, Edition 26, US DOE, 2007).

N. Natural Gas-Fired Heater

There is a natural gas-fired heater located at the ICTF administrative building. The heater is used to provide comfort heating for the building. Emissions from the heater are based on the equipment's rated capacity, fuel type, and hours of operation. The activity data are shown in Table 21.

Table 21 Activity Data for Natural Gas-Fired Heater ICTF Rail Yard					
Location	Fuel Type	Rating (MMBtu/hr)	Hours of Operation (hr/yr)[a]	Fuel Use (MMBtu/yr)	Fuel Use (MMcf/yr)[b]
Admin. Building	Natural Gas	0.76	2,190	1,664.40	1.66

Notes:
a. Hours of operation equal to 3 months per year.
b. Annual fuel use based on a natural gas HHV of 1,000 Btu/scf.

O. Propane-Fueled Welder

A propane-fueled welder is used for locomotive service and repair operations at the Dolores Yard. Emissions from the welder are based on the fuel type, rated capacity, and hours of operation for the unit. The activity data for the welder are shown in Table 22.

Table 22
Activity Data for the Propane-Fueled Welder
Dolores Rail Yard

Location	Fuel Type	Rating (hp)	Hours of Operation (hr/yr)[a]	Fuel Use[b] (MMBtu/yr)	Fuel Use[b] (gal/yr)
Service Track	Propane	18	1,000	126	1,383.89

Notes:
a. Hours of operation is an engineering estimate based on interviews with UPRR staff.
b. Annual fuel use based on a bsfc of 7,000 Btu/hp-hr (from AP-42), a propane HHV of 3,824 MMBtu/barrel (from CARB *Draft Emission Factors for Mandatory Reporting Programs*, August 10, 2007), and 42 gallons per barrel.

P. Miscellaneous Gasoline-Fueled Equipment

A variety of portable, gasoline-fueled, small equipment is used at ICTF each day. Emissions from the portable equipment are based on the fuel type, rated capacity, and hours of operation of each unit. The activity data for miscellaneous gasoline-fueled equipment are shown in Table 23.

Table 23 Activity Data for Miscellaneous Gasoline-Fueled Equipment ICTF Rail Yard				
Equipment Location	Equipment Type	Number of Units	Rated Capacity (hp)	Hours of Operation (hr/yr)[b]
WEBCO Area	Welder	1	8	1,000
Mechanical Dept.	Welder	1	13	1,000
Mechanical Dept.	Welder	1	12.5	1,000
Mechanical Dept.	Welder	1	18	1,000
Crane Maintenance	Welder	1	20	1,000
Crane Maintenance	Pressure Washer	1	18	1,000
WEBCO Area	Air Compressor	1	5.5	1,000
Mechanical Dept.	Air Compressor	1	30	1,000
Crane Maintenance	Generator[a]	1	<50	1,000

Notes:
a. The exact rating of this unit could not be determined.
b. Hours of operation are an engineering estimate based on interviews with UPRR staff.

Q. Worker Vehicles

Emissions were calculated from employee vehicles that arrive at and depart from the ICTF and Dolores Yards each day. The number of vehicle trips was based on employee force counts for each yard and assumes no ridesharing.[10] The miles per trip were estimated from aerial photos of the Yards and include on-site travel only. Activity data for worker vehicles are summarized in Table 24.

Table 24 Activity Data for Work Vehicles Dolores and ICTF Rail Yards			
Yard	No. of Trips (trips/yr)[a]	VMT (mi/trip)[b]	VMT (mi/yr)
ICTF	152,935	2.5	382,337.5
Dolores	32,850	0.5	16,425.0
Total	**185,785**		**398,762.5**

Notes:
a. Based on employee force count reports. Assumes no ridesharing and 365 work days per year.
b. VMT for onsite travel estimated from aerial photos of each yard.

[10] Personal communication from Jon Germer of UPRR on August 24, 2007.

R. Road Dust

Particulate matter emissions were calculated for paved roadways in both the ICTF and Dolores rail yards. Particulate emissions occur when loose material on road surfaces is resuspended as vehicles travel over a roadway. Emissions are based on the number of vehicles driving on the road, the length of the road, and the amount of loose material on the road surface. Activity data for vehicles driving on paved roadways at the Yards are summarized in Table 25.

Table 25
Activity Data for Vehicles Operating on Paved Roadways
Dolores and ICTF Rail Yards

Yard	Vehicle Type	Annual VMT (mi/yr)[a]
ICTF	Drayage Trucks	1,641,629.38
ICTF	Delivery Trucks	17.18
ICTF	Yard Truck	365,000.00
ICTF	Worker Vehicles	382,337.50
Dolores	Delivery Trucks	502.31
Dolores	Yard Truck	118,007.00
Dolores	Worker Vehicles	16,425.00
Total		2,523,918.37

Notes:
a. See source-specific sections for discussions on the calculation of annual VMT.

PART VII. EMISSIONS

A. Calculation Methodology and Emission Factors

Emission calculations were based on the site-specific equipment inventory, equipment activity data, and the source-specific emission factors. The calculation methodology and emission factors for each specific source type are further discussed below. Emissions were calculated in accordance with CARB Guidelines (July 2006) and the UPRR *Emission Inventory Protocol* (May 2006).

1. Locomotives

Emission Factors

Notch-specific criteria pollutant emission factors were assembled from a number of sources. These included emission factors presented in CARB's *Roseville Rail Yard Study* (October, 2004), as well as EPA certification data and other testing by Southwest Research Institute of newer-technology locomotives. Emission factors for HC and CO are shown in Tables 26 and 27. Emissions of HC and CO are not sensitive to the fuel characteristics discussed here.

Nitrogen oxides emissions are sensitive to the aromatic fraction of fuel, which is lower in all California fuel (regardless of and independent of sulfur content) than 47-state fuel. As discussed in Appendix A-7, the lower aromatic content of California fuel since the mid-1990s results in NOx emission rates approximately 6% lower than those for 47-state fuel. This factor was applied to the emission rates reported in locomotive testing using 47-state fuel to obtain emission factors for California fuel. The NOx emission factors for locomotives are shown in Table 28.

Table 26
Hydrocarbon Emission Factors (g/hr) for Locomotives
ICTF and Dolores Rail Yard

Model Group	Tier	Throttle Setting										Source[a]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	99.0	145.0	93.2	116.5	145.2	194.0	274.4	377.1	521.4	666.1	EPA RSD[a]
GP-3x	N	124.1	269.0	121.5	149.9	188.5	261.3	371.5	468.8	651.6	807.1	EPA RSD[a]
GP-4x	N	185.0	295.3	155.4	201.5	247.0	320.5	423.7	611.0	878.1	1168.8	EPA RSD[a]
GP-50	N	76.0	279.0	39.0	209.0	311.6	351.8	487.8	663.8	932.6	1082.5	EPA RSD[a]
GP-60	N	113.4	158.4	11.6	175.6	304.1	408.3	500.4	645.7	1062.3	1351.0	EPA RSD[a]
GP-60	0	100.8	162.5	113.7	153.9	240.3	287.4	366.0	475.5	749.1	901.7	SwRI[b] (KCS733)
SD-7x	N	117.6	174.1	116.8	166.6	264.6	319.1	421.5	605.4	804.2	1052.2	SwRI[c]
SD-7x	0	62.2	64.6	90.9	138.5	297.6	393.4	500.9	894.2	1229.9	1433.4	GM EMD[d]
SD-7x	1	167.0	241.0	182.0	203.8	388.0	524.9	648.0	900.6	1115.3	1294.3	SwRI[e] (NS2630)
SD-7x	2	99.8	129.2	93.3	115.4	165.7	194.7	231.8	231.8	351.1	483.7	SwRI[e] (UP8353)
SD-90	0	340.4	247.4	227.1	403.9	948.2	1538.7	2371.2	1522.9	1703.8	3485.4	GM EMD[d]
Dash 7	N	259.1	422.4	124.7	98.9	276.1	286.7	346.6	499.0	697.5	750.0	EPA RSD[a]
Dash 8	0	268.6	627.2	330.8	357.8	394.8	418.8	655.4	613.6	737.7	861.2	GE[d]
Dash 9	N	212.6	239.7	138.1	200.8	403.4	389.8	572.3	740.8	908.0	1063.3	SWRI 2000
Dash 9	0	99.6	159.5	141.2	226.5	583.9	984.6	1452.4	869.8	998.5	1239.1	Average of GE & SwRI[f]
Dash 9	1	54.8	309.1	210.4	297.8	606.1	713.7	789.0	931.1	978.2	1094.0	SwRI[b] (CSXT595)
Dash 9	2	22.8	64.6	62.2	120.0	220.4	224.2	311.2	407.6	487.6	619.4	SwRI[b] (BNSF 7736)
C60-A	0	282.4	603.8	171.1	264.8	596.0	635.4	938.4	1164.9	1250.0	1624.2	GE[d] (UP7555)

Notes:
a. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by CARB and ENVIRON
b. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
c. SwRI final report "Emissions Measurements – Locomotives" by Steve Fritz, August 1995.
d. Manufacturers' emissions test data as tabulated by CARB.
e. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006, 2007).
f. Average of manufacturers' emissions test data as tabulated by CARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

Table 27 Carbon Monoxide Emission Factors (g/hr) for Locomotives ICTF and Dolores Rail Yards												
Model Group	Tier	Throttle Setting										Source[a]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	181.0	350.0	182.9	294.0	339.0	354.0	416.0	676.0	2085.0	5710.0	EPA RSD[a]
GP-3x	N	283.0	699.0	240.0	429.0	430.0	479.0	604.0	926.0	1773.0	3973.0	EPA RSD[a]
GP-4x	N	564.1	659.6	266.7	292.3	329.3	434.3	759.7	1911.9	5029.3	5907.3	EPA RSD[a]
GP-50	N	99.0	407.5	59.0	228.0	744.0	1083.0	1932.0	1743.0	1520.0	1817.0	EPA RSD[a]
GP-60	N	144.0	192.2	105.6	131.7	313.9	516.8	1108.4	2213.3	1699.6	1597.0	EPA RSD[a]
GP-60	0	96.6	232.6	146.8	185.5	247.9	347.1	945.3	2678.3	2442.8	1989.2	SwRI[b] (KCS733)
SD-7x	N	237.1	344.2	242.5	263.4	290.3	598.1	1209.6	2005.0	1733.0	2469.9	SwRI[c]
SD-7x	0	83.7	90.1	186.2	293.3	336.0	407.0	434.1	3045.8	1440.7	1515.3	GM EMD[d]
SD-7x	1	80.3	135.5	122.9	203.8	396.1	431.1	617.1	1734.3	1100.7	1732.4	SwRI[e] (NS2630)
SD-7x	2	289.2	524.1	225.9	234.2	288.9	310.5	374.1	374.1	744.8	1342.4	SwRI[e] (UP8353)
SD-90	0	252.7	263.2	233.5	351.4	973.9	3616.7	4498.6	5692.3	5386.1	2065.4	GM EMD[d]
Dash 7	N	354.0	532.0	198.7	338.1	1489.4	2949.1	5515.6	4550.9	3294.9	3000.0	EPA RSD[a]
Dash 8	0	366.5	1113.2	688.3	873.6	1974.0	2373.2	1843.2	1867.6	2011.8	2870.7	GE[d]
Dash 9	N	261.2	393.9	142.6	331.8	1485.9	4647.1	8054.7	10143.3	9510.9	10644.1	SWRI 2000
Dash 9	0	83.5	196.8	123.8	482.6	1121.2	6157.3	6713.1	3143.1	3790.3	4214.6	Average of GE & SwRI[f]
Dash 9	1	49.4	461.4	243.5	368.0	895.5	1505.0	1788.4	2014.4	2713.7	3356.1	SwRI[b] (CSXT595)
Dash 9	2	28.0	120.3	141.8	239.4	607.3	805.9	479.2	537.4	790.1	1033.9	SwRI[b] (BNSF 7736)
C60-A	0	233.4	568.0	220.9	407.4	1589.3	2033.3	2542.7	2370.0	1600.0	1124.5	GE[d] (UP7555)

Notes:

a. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by CARB and ENVIRON.
b. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
c. SwRI final report "Emissions Measurements – Locomotives" by Steve Fritz, August 1995.
d. Manufacturers' emissions test data as tabulated by CARB.
e. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006, 2007).
f. Average of manufacturers' emissions test data as tabulated by CARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

Table 28
Nitrogen Oxides Emission Factors (g/hr) for Locomotives[a]
ICTF and Dolores Rail Yards

Model Group	Tier	Throttle Setting: Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	Source[b]
Switchers	N	987.0	3415.0	1239.8	2775.0	5715.6	9794.2	14135.0	17999.1	21891.0	24027.9	EPA RSD[b]
GP-3x	N	1247.0	2803.0	1824.8	4335.7	8137.0	12410.0	16974.0	23232.0	29605.0	34755.0	EPA RSD[b]
GP-4x	N	1635.1	4133.8	2807.7	6039.6	10180.2	15406.6	20892.3	25563.9	31186.9	36928.7	EPA RSD[b]
GP-50	N	999.0	2847.0	1104.0	7818.5	14060.0	18769.0	24388.0	42575.0	54573.0	57021.0	EPA RSD[b]
GP-60	N	1915.2	2290.8	3820.5	6624.5	11154.0	14765.5	18161.1	24209.1	39158.6	42295.5	EPA RSD[b]
GP-60	0	687.8	967.3	2267.0	4695.9	8500.6	11090.3	12849.7	13830.5	25626.3	27621.4	SwRI[c] (KCS733)
SD-7x	N	1475.4	1728.0	2532.7	5520.0	13366.7	21349.5	27710.4	43213.0	57587.4	56252.3	SwRI[d]
SD-7x	0	933.6	1066.4	2881.6	5381.8	9984.0	13308.2	14891.9	23611.8	31134.0	33417.6	GM EMD[e]
SD-7x	1	694.4	943.2	2028.9	2910.2	5231.1	7371.2	9468.0	15134.0	20925.3	26463.0	SwRI[f] (NS2630)
SD-7x	2	752.6	2896.9	2409.1	4038.4	5745.0	6600.0	7863.5	7863.5	14642.2	20133.2	SwRI[f] (UP8353)
SD-90	0	687.8	2572.9	2347.5	5626.9	12975.7	18571.9	25398.5	32729.7	42788.5	49746.1	GM EMD[e]
Dash 7	N	306.0	493.4	830.2	1416.4	5367.1	9738.2	16320.8	22974.0	25108.2	33000.0	EPA RSD[b]
Dash 8	0	746.5	2063.4	3403.4	4617.6	7426.0	9911.6	14745.6	18676.0	22800.4	29527.2	GE[e]
Dash 9	N	442.1	940.0	2121.0	5494.9	14999.2	22069.1	31371.6	36876.2	42904.6	46971.1	SWRI 2000
Dash 9	0	782.2	1010.3	2510.8	4806.2	13850.8	37326.0	27325.3	21113.3	25088.8	31154.3	Average of GE & SwRI[g]
Dash 9	1	375.9	2035.5	1538.4	4671.8	14368.6	16071.1	13854.8	18020.0	20886.3	23912.8	SwRI[b] (CSXT595)
Dash 9	2	347.6	656.7	1134.9	2730.2	5310.1	7246.1	9611.9	13454.9	16005.1	18565.9	SwRI[b] (BNSF 7736)
C60-A	0	571.9	1413.7	2027.5	5794.8	11306.0	17308.3	22996.4	28482.7	35651.8	42823.8	GE[e] (UP7555)

Notes:
a. Emission factors are based on test data for 47-state fuel. The emission factors for California fuel are 6% lower.
b. EPA Regulatory Support Document, “Locomotive Emissions Regulation,” Appendix B, 12/17/97, as tabulated by CARB and ENVIRON.
c. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
d. SwRI final report “Emissions Measurements – Locomotives” by Steve Fritz, August 1995.
e. Manufacturers’ emissions test data as tabulated by CARB.
f. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006, 2007).
g. Average of manufacturers’ emissions test data as tabulated by CARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

Fuel sulfur content affects the emission rates for Diesel particulate matter from locomotives. To develop emission inventories for locomotive activity, an initial collection of locomotive model- and notch-specific DPM emissions data were adjusted based on sulfur content. Although there is no official guidance available for calculating this effect, a draft CARB document provides equations to calculate the effect of sulfur content on DPM emission rates at specific throttle settings, and for 2-stroke and 4-stroke engines (Wong, undated). These equations can be used to calculate adjustment factors for different fuels as described in Appendix A-7. The adjustment factors are linear with sulfur content, allowing emission rates for a specific mixture of California and non-California fuels to be calculated as a weighted average of the emission rates for each of the fuels. Adjustment factors were developed and used to prepare tables of emission factors for two different fuel sulfur levels: 221 ppm for locomotives operated on California fuel; and 2,639 ppm for locomotives operating on non-California fuel. These results are shown in Tables 29 and 30. Sample emission calculations are shown in Appendices A-3 and A-4. The calculations of sulfur adjustments and the Wong Technical Memo are shown in Appendix A-7.

Table 29
Locomotive Diesel Particulate Matter Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 221 PPM
Dolores and ICTF Rail Yards

Model Group	Tier	Throttle Setting										Source[a]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	129.2	140.6	173.3	272.7	315.6	409.1	CARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	174.1	187.5	230.2	369.1	423.5	555.1	CARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	211.9	228.6	289.7	488.5	584.2	749.9	CARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	282.3	275.2	339.6	587.7	663.5	847.2	CARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	266.3	264.8	323.5	571.6	680.2	859.8	CARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	224.1	311.5	446.4	641.6	1029.9	1205.1	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	146.8	215.0	276.8	331.8	434.7	538.0	CARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	215.7	335.9	388.6	766.8	932.1	1009.6	CARB and ENVIRON
SD-7x	1	29.2	31.8	37.1	66.2	205.3	261.7	376.5	631.4	716.4	774.0	NS2630[c]
SD-7x	2	55.4	59.5	38.3	134.2	254.4	265.7	289.0	488.2	614.7	643.0	UP8353[c]
SD-90	0	61.1	108.5	50.1	99.1	239.5	374.7	484.1	291.5	236.1	852.4	EMD 16V265H
Dash 7	N	65.0	180.5	108.2	121.2	306.9	292.4	297.5	255.3	249.0	307.7	CARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	248.7	261.6	294.1	318.5	347.1	450.7	CARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	187.7	258.0	332.5	373.2	359.5	517.0	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	195.7	235.4	552.7	489.3	449.6	415.1	Average of CARB & CN2508[a]
Dash 9	1	16.9	88.4	62.1	140.2	259.5	342.2	380.4	443.5	402.7	570.0	CSXT595[b]
Dash 9	2	7.7	42.0	69.3	145.8	259.8	325.7	363.6	356.7	379.7	445.1	BNSF 7736[b]
C60-A	0	71.0	83.9	68.6	78.6	237.2	208.9	247.7	265.5	168.6	265.7	CARB and ENVIRON

Notes:

a. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by CARB and ENVIRON
b. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
c. SwRI final report "Emissions Measurements – Locomotives" by Steve Fritz, August 1995.
d. Manufacturers' emissions test data as tabulated by CARB.
e. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
f. Average of manufacturer's emissions test data as tabulated by CARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

Table 30
Locomotive Diesel Particulate Matter Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 2,639 PPM
Dolores and ICTF Rail Yards

Model Group	Tier	Throttle Setting										Source[a]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	136.9	156.6	197.4	303.4	341.2	442.9	CARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	184.5	208.8	262.2	410.8	457.9	601.1	CARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	224.5	254.6	330.0	543.7	631.6	812.1	CARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	299.0	306.5	386.9	653.9	717.3	917.4	CARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	282.1	294.9	368.5	636.1	735.4	931.0	CARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	237.4	346.9	508.5	714.0	1113.4	1304.9	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	155.5	239.4	315.4	369.2	469.9	582.6	CARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	228.5	374.1	442.7	853.3	1007.8	1093.2	CARB and ENVIRON
SD-7x	1	29.2	31.8	37.1	66.2	217.5	291.5	428.9	702.6	774.5	838.1	NS2630[c]
SD-7x	2	55.4	59.5	38.3	134.2	269.4	295.9	329.2	543.3	664.6	696.2	UP8353[c]
SD-90	0	61.1	108.5	50.1	99.1	253.7	417.3	551.5	324.4	255.3	923.1	EMD 16V265H
Dash 7	N	65.0	180.5	108.2	121.2	352.7	323.1	327.1	293.7	325.3	405.4	CARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	285.9	289.1	323.3	366.4	453.5	593.8	CARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	215.7	285.1	365.6	429.3	469.7	681.2	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	224.9	260.1	607.7	562.9	587.4	546.9	Average of CARB & CN2508[a]
Dash 9	1	16.9	88.4	62.1	140.2	298.2	378.1	418.3	510.2	526.2	751.1	CSXT595[b]
Dash 9	2	7.7	42.0	69.3	145.8	298.5	359.9	399.8	410.4	496.1	586.4	BNSF 7736[b]
C60-A	0	71.0	83.9	68.6	78.6	272.6	230.8	272.3	305.4	220.3	350.1	CARB and ENVIRON

Notes:

a. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by CARB and ENVIRON
b. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
c. SwRI final report "Emissions Measurements – Locomotives" by Steve Fritz, August 1995.
d. Manufacturers' emissions test data as tabulated by CARB.
e. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
f. Average of manufacturer's emissions test data as tabulated by CARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

Data regarding the sulfur content of 2005 UPRR Diesel fuel deliveries within and outside of California were not available. To develop locomotive emission factors for different types of activities, estimates of fuel sulfur content were developed, and base case emission factors from the primary information sources (e.g., EPA certification data, with an assumed nominal fuel sulfur content of 3,000 ppm) were adjusted based on the estimated sulfur content of in-use fuels. The sulfur content of Diesel fuel varies with the type of fuel produced (e.g., California on-road fuel, 49-state off-road fuel, 49-state on-road fuel), the refinery configuration where it is produced, the sulfur content of the crude oil being refined, and the extent to which it may be mixed with fuel from other sources during transport. As a result, it is extremely difficult to determine with precision the sulfur content of the fuel being used by any given locomotive at a specific time, and assumptions were made to estimate sulfur content for different types of activities.

To estimate the fuel sulfur content for UPRR locomotives in California during 2005, the following assumptions were made:

- "Captive" locomotives and consists in use on local trains (e.g., commuter rail) use only Diesel fuel produced in California.
- Trains arriving and terminating at California rail yards (with the exception of local trains) use fuel produced outside of California, and arrive with remaining fuel in their tanks at 10 percent of capacity.
- On arrival, consists are refueled with California Diesel fuel, resulting in a 90:10 mixture of California and non-California fuel, and this mixture is representative of fuel on departing trains as well as trains undergoing load testing (if conducted at a specific yard).
- The average composition of fuel used in through trains bypassing a yard, and in trains both arriving and departing from a yard on the same day, is 50 percent California fuel and 50 percent non-California fuel.

In 2005, Chevron was Union Pacific Railroad's principal supplier of Diesel fuel in California. Chevron's California refineries produced only one grade ("low sulfur Diesel" or LSD) in 2005. Quarterly average sulfur content for these refineries ranged from 59 ppm to 400 ppm, with an average of 221 ppm.[11] This value is assumed to be representative of California fuel used by UPRR. Non-California Diesel fuel for 2005 is assumed to have a sulfur content of 2,639 ppm. This is the estimated 49-state average fuel sulfur content used by the U.S. Environmental Protection Agency in its 2004 regulatory impact analysis in support of regulation of nonroad Diesel engines (EPA, 2004).

The locomotive test data also report horsepower and fuel consumption rates by notch for each locomotive tested. The fuel consumption rates were used to calculate total fuel consumption by fuel type. Sulfur oxides emissions were calculated from fuel consumption and fuel sulfur content, assuming a constant factor of 8.83×10^{-4} grams of sulfur oxides per ppm sulfur in fuel per pound of fuel (e.g., a fuel rate of 100 lbs/hr of 100 ppm S fuel yields an emission rate of 8.83 g/hr of sulfur oxides).[12] SOx emission calculations include consideration of the fraction of fuel burned by sulfur content. Table 31 shows the fuel consumption rates in pounds per hour, and the SOx emission factors are shown in Table 32.

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[11] Personal communication from Theron Hinckley of Chevron Products Company to Jon Germer of UPRR and Rob Ireson, December 13, 2006.

[12] This factor is calculated from the 2005 locomotive fuel usage, sulfur content and total emissions in Table 3.1-6a of the 2004 EPA regulatory impact analysis for non-road Diesel engine emissions regulations (EPA420-R-04-007), assuming a fuel density of 7.13 lbs/gallon, the density observed by SwRI for California low sulfur fuel in the CARB locomotive fuel effects study.

Table 31
Fuel Consumption Rates (lbs/hr) for Locomotives – ICTF and Dolores Rail Yards
2005 Baseline Year

Model Group	Tier	Throttle Setting										Source[a]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	26.0	80.0	41.0	95.0	167.0	249.0	332.0	419.0	529.0	630.0	EPA RSD[a]
GP-3x	N	40.0	114.0	64.0	167.0	275.0	404.0	556.0	740.0	994.0	1177.0	EPA RSD[a]
GP-4x	N	279.0	126.0	296.0	361.0	432.0	528.0	657.0	827.0	1066.0	1186.0	EPA RSD[a]
GP-50	N	22.0	91.0	92.0	179.0	363.0	480.0	652.0	919.0	1136.0	1281.0	EPA RSD[a]
GP-60	N	23.0	134.0	88.0	167.0	351.0	478.0	635.0	888.0	1147.0	1328.0	EPA RSD[a]
GP-60	0	23.0	39.0	87.0	165.0	356.0	486.0	632.0	795.0	1202.0	1394.0	SwRI[b] (KCS733)
SD-7x	N	25.0	39.1	98.7	184.4	366.3	531.4	679.3	945.1	1213.2	1412.2	SwRI[c]
SD-7x	0	36.0	54.0	86.6	167.6	355.5	538.4	700.7	980.9	1200.3	1376.4	GM EMD[v]
SD-7x	1	27.5	43.0	91.0	167.0	357.6	517.2	700.8	987.6	1203.6	1366.8	SwRI[e] (NS2630)
SD-7x	2	33.9	133.5	106.8	234.5	433.5	600.5	767.5	767.5	1305.5	1523.5	SwRI[e] (UP8353)
SD-90	0	78.3	1209.8	141.2	291.3	546.0	790.3	1089.4	1400.4	1695.3	2035.3	GM EMD[d]
Dash 7	N	23.9	130.0	65.8	132.8	259.0	405.0	576.0	746.0	882.0	1090.0	EPA RSD[a]
Dash 8	0	25.9	188.9	74.6	163.8	314.5	486.0	685.6	891.6	1051.6	1308.0	GE[d]
Dash 9	N	22.9	41.9	81.0	189.3	395.3	571.5	798.2	1014.0	1240.1	1539.1	SWRI 2000
Dash 9	0	25.6	41.2	84.0	187.3	392.4	569.1	796.4	1009.5	1183.6	1535.8	Average of GE & SwRI[f]
Dash 9	1	19.8	54.6	86.4	185.0	373.0	512.0	725.0	945.0	1169.0	1470.0	SwRI[b] (CSXT595)
Dash 9	2	18.5	44.0	102.0	210.0	449.0	615.0	830.0	1067.0	1319.0	1609.0	SwRI[b] (BNSF 7736)
C60-A	0	29.8	52.7	82.6	257.7	542.4	781.1	1087.2	1385.2	1688.6	2141.3	GE[d] (UP7555)

Notes:

a. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by CARB and ENVIRON
b. Base rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
c. SwRI final report "Emissions Measurements – Locomotives" by Steve Fritz, August 1995.
d. Manufacturers' emissions test data as tabulated by CARB.
e. Base SD-70 rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006, 2007).
f. Average of manufacturers' emissions test data as tabulated by CARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON..

Table 32 SOx Emission Factors for Locomotives – ICTF and Dolores Rail Yards 2005 Baseline Year			
Fuel Sulfur Content (ppm)		SOx Emission Factor (g/lb of fuel)[a]	
CA Diesel	47-State Diesel	CA Diesel	47-State Diesel
221	2,639	0.195	2.33

Notes:
a. Based on 8.83 x 10^{-4} g of SOx per ppm-lb of fuel.

Emissions

Emissions were calculated for both UPRR-owned and -operated locomotives, as well as "foreign" locomotives[13] operating in the rail yard, and through trains on the main line. Procedures for calculating in-yard emissions followed the methods described in Ireson et al. (2005).[14] A copy of Ireson et al. is contained in Appendix A-6.

Emissions from locomotive activities were calculated based on the number of working locomotives, time spent in each notch setting, and locomotive model-group distributions, with model groups defined by manufacturer and engine type.[15] A separate calculation was performed for each type of locomotive activity, including line-haul or switcher locomotive operations, consist movements, locomotive refueling, and pre- and post-locomotive service and maintenance testing.

For road power locomotives, speed, movement duration, and throttle notch values were obtained from UPRR personnel for the ICTF and Dolores Yards for different types of activities. Movement durations were calculated from distance traveled and speed. Detailed counts of locomotive by model, technology tier, and train type are shown in

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[13] Foreign locomotives are locomotives not owned by UPRR, including passenger trains and locomotives owned by other railroads that are brought onto the UPRR system via interchange.

[14] Ireson, R.G., M.J. Germer, L.A. Schmid (2005). "Development of Detailed Railyard Emissions to Capture Activity, Technology, and Operational Changes." Proceedings of the USEPA 14th Annual Emission Inventory Conference, *http://www.epa.gov/ttn/chief/conference/ei14/session8/ireson.pdf*, Las Vegas NV, April 14, 2006.

[15] Emission estimates are based on the total number of working locomotives. Therefore, the total number of locomotives used in the emission calculations will be slightly lower than the total number of locomotives shown in Table 1. See Appendix A for detailed emission calculations

Appendices A-1 and A-2. Maps detailing the principal locomotive routes at the Yards are contained in Appendix A-5.

For line haul operations, yard-specific average consist composition (number of units, number of units operating, model distribution, locomotive tier distribution, fraction equipped with auto start/stop technology[16]) was developed from UPRR data for different train types. The data showed that intermodal trains and power moves used predominately newer, high-horsepower SD-70 and Dash 9 locomotives, while non-intermodal trains used a mix of older medium- and high-horsepower and newer high-horsepower locomotives. Average horsepower was lowest among "dockside" non-intermodal trains (arriving from or departing toward the Ports of Los Angeles and Long Beach), with average horsepower for "landside" non-intermodal trains (arriving from or departing toward central Los Angeles) being somewhat higher. Therefore, locomotive model distributions were developed for these three separate groups for use in the emission calculations.

Movement speed, duration, and notch estimates were developed for arriving, departing, through train, and in-yard movements. All road power movements within the Yard were assumed to be at 10 mph in throttle notches 1 and 2 (50% each). Idle duration was estimated based on UPRR operator estimates for units not equipped with auto start/stop. Units that were equipped with AESS/ZTR technology were assumed to idle for 30 minutes per extended idle event, with other locomotives idling for the remaining duration of the event. Numbers of arrivals and departures were developed from UPRR data. Emissions were calculated separately for through intermodal trains; originating and terminating intermodal trains; non-intermodal trains through, originating, and terminating; and power moves through, originating, and terminating.

[16] There are two primary types of auto start/stop technology—"Auto Engine Start Stop" (AESS), which is factory-installed on recent model high horsepower units; and the ZTR "SmartStart" system (ZTR), which is a retrofit option for other locomotives. Both are programmed to turn off the Diesel engine after 15 to 30 minutes of idling, provided that various criteria (air pressure, battery charge, and others) are met. The engine automatically restarts if required by one of the monitored parameters. We assume that an AESS/ZTR-equipped locomotive will shut down after 30 minutes of idling in an extended idle event.

2. HHD Diesel-Fueled Trucks

a. Onsite Operations

Emission factors for the HHD Diesel-fueled drayage trucks operating within the ICTF were obtained from CARB's EMFAC2007 model. Per CARB guidelines, the emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling analysis for these modes. A fleet average emission factor for traveling exhaust emissions was calculated using the EMFAC2007 model with the BURDEN output option and assume an average drayage truck speed of 15 miles per hour. Since the fleet distribution is not known, the EMFAC2007 default distribution for Los Angeles County was used. Idling emission factors were calculated using the EMFAC2007 model with the EMFAC output option. The emission factors for the HHD Diesel-fueled trucks are shown in Table 33. Detailed emission factor derivation calculations and the EMFAC2007 output are contained in Appendix B-2.

Table 33
Emission Factors for HHD Diesel-Fueled Drayage Trucks[a] – Onsite Operations
ICTF Rail Yards

Operating Mode	Fleet Average Emission Factors					
	ROG	CO	NOx	PM_{10}[d]	DPM[d,e]	SOx
Traveling (g/mi)[b]	6.40	17.23	28.68	2.53	2.47	0.24
Idling (g/hr)[c]	16.16	52.99	100.38	2.85	2.85	0.55

Notes:
a. See Part V for vehicle specifications.
b. Emission factors calculated using the EMFAC2007 model with the BURDEN output option and assume an average speed of 15 mph. The default model year distribution for Los Angeles County was used.
c. Emission factors calculated using the EMFAC2007 model with the EMFAC output option. The default model year distribution for Los Angeles County was used.
d. The PM10 emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.
e. Diesel PM_{10} (DPM) is a TAC.

b. Offsite Operations

Emission factors for the HHD Diesel-fueled drayage trucks operating within 0.5 miles of the ICTF were obtained from CARB's EMFAC2007 model. For offsite travel, emissions from idling were included with the traveling emissions. A fleet average emission factors were calculated using the EMFAC2007 model with the BURDEN output option and the EMFAC2007 default speed profile for HHD trucks. Since the fleet distribution is not known, the EMFAC2007 default distribution for Los Angeles County was used. The emission factors for offsite drayage truck operations are shown in Table 34. Detailed emission factor derivation calculations and the EMFAC2007 output are contained in Appendix B-3.

Table 34
Emission Factors for HHD Diesel-Fueled Drayage Trucks[a] – Offsite Operations
ICTF Rail Yards

Operating Mode	Fleet Average Emission Factors					
	ROG	CO	NOx	PM_{10}[c]	DPM[c,d]	SOx
Traveling (g/mi)[b]	1.95	7.53	22.04	1.24	1.18	0.16

Notes:
a. See Part V for vehicle specifications.
b. Emission factors were calculated using the EMFAC2007 model with the BURDEN output option and assume an average speed of 15 mph. The default model year distribution for Los Angeles County was used.
c. The PM_{10} emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.
d. Diesel PM_{10} (DPM) is a TAC.

3. Cargo Handling Equipment

Emission factors for CHE were calculated using a spreadsheet provided by CARB staff and are based on the OFFROAD2007 model. The emission factors for the CHE are shown in Table 35. Detailed emission factor derivation calculations and the CARB spreadsheet are contained in Appendix C.

Table 35 Emission Factors for Cargo Handling Equipment ICTF Rail Yard								
Equipment Type	Make/Model	Model Year	Emission Factors (g/hp-hr)[a]					
			VOC	CO	NOx	PM_{10}	DPM	SOx
Forklift	Toyota 6FDU25	1997	0.803	3.741	8.818	0.679	0.679	0.062
RTG[1]	Mi Jack 850R	1997	0.281	1.035	6.547	0.165	0.165	0.052
RTG[1]	Mi Jack 1000R	1988	0.705	3.375	9.194	0.476	0.476	0.060
RTG[1]	Mi Jack 1000R	1995	0.621	3.113	8.573	0.402	0.402	0.052
RTG[1]	Mi Jack 1000RC	2002	0.111	0.971	4.475	0.104	0.104	0.052
RTG[1]	Mi Jack 1200R	2005	0.074	0.933	3.836	0.094	0.094	0.052
Top Pick	Mi Jack PC-90	1972	1.252	6.183	15.587	0.901	0.901	0.060
Top Pick	Taylor Tay-950	1988	0.705	3.375	9.194	0.476	0.476	0.060
Top Pick	Taylor Tay-950	1989	0.693	3.338	9.105	0.465	0.465	0.060
Yard Hostler	Capacity TJ5000	1999	0.610	3.078	7.342	0.433	0.433	0.060
Yard Hostler	Capacity TJ5000	2005	0.119	2.754	4.283	0.139	0.139	0.060

Notes:
a. Emission factors calculated using a spreadsheet provided by CARB staff and are based on the OFFROAD2007 model.

4. Heavy Equipment

Emission factors for heavy equipment were calculated using OFFROAD2007 model. The emission factors for heavy equipment are shown in Table 36. Detailed emission factor derivation calculations and OFFROAD2007 output are contained in Appendix D.

Table 36 Emission Factors for Heavy Equipment Dolores and ICTF Rail Yards									
Yard	Equipment Type	Make/Model	Model Year	Emission Factors (g/hp-hr)[a,b]					
				ROG[b]	CO	NOx	PM_{10}	DPM	SOx
ICTF	Crane	Grove RT600E	2004	0.32	2.83	4.61	0.18	0.18	0.05
ICTF	Forklift	Taylor 850	2005	0.22	2.76	4.26	0.14	0.14	0.05
ICTF	Forklift	Taylor 850	1998	1.33	3.66	8.59	0.62	0.62	0.05
ICTF	Manlift	Unknown	1985	5.11	10.26	7.51	1.02	1.02	0.06
Dolores	Forklift	Yale GP-060	ALL[c]	0.11	23.38	7.30	0.06	0.00	0.00

Notes:

a. Emission factors from the OFFROAD2007 model.
b. Evaporative emissions for these sources are negligible.
c. Dolores forklifts are modeled as the calendar year 2005 fleet average model year group from the OFFROAD2007 model.

CARB's speciation profile database[17] was used to determine the fraction of each TAC in the total ROG emissions from the propane-fueled forklifts. The database does not contain a profile for propane combusted in an internal combustion engine. Therefore, the speciation profile for natural gas-fired reciprocating engines[18] was used. All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program[19] have been included. The TAC speciation profile and annual emissions of each TAC are shown in Table 37. The relevant sections of the speciation profile database are included in Appendix D.

Table 37
TAC Emissions from Propane-Fueled Forklifts
Dolores Rail Yard

CAS	Pollutant[a]	Organic Fraction (by weight)[b,c]
95636	1,2,4-trimethylbenzene	0.00001
75070	acetaldehyde	0.00003
71432	benzene	0.00010
110827	cyclohexane	0.00001
100414	ethylbenzene	0.00001
74851	ethylene	0.00058
50000	formaldehyde	0.00074
108383	m-xylene	0.00001
110543	n-hexane	0.00002
95476	o-xylene	0.00001
115071	propylene	0.00154
108883	toluene	0.00004
1330207	xylene	0.00002

Notes:
a. Emissions were calculated for only those chemicals that were in both the CARB SPECIATE database and the AB 2588 list.
b. Organic fraction data are from CARB's SPECIATE database. Data are from profile #719 "I.C.E. reciprocating – natural gas". A speciation profile for propane was not included in the database.
c. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.0914

5. <u>TRUs and Reefer Cars</u>

Emission factors for the Diesel-fueled TRUs and reefer cars are from the OFFROAD2007 model. The emission factors are shown in Table 38. Detailed emission

[17] Available at *http://www.arb.ca.gov/ei/speciate/speciate.htm*.
[18] Speciation profile number 719 was used to calculate TAC emissions from this source.
[19] Available at *http://www.arb.ca.gov/ab2588/2588guid.htm*.

factor derivation calculations and the OFFROAD2007 output are contained in Appendix E.

Table 38 Emission Factors for TRUs and Reefer Cars ICTF Rail Yard						
Equipment Type	Emissions (g/hp-hr-unit)[a]					
	HC[b]	CO	NOx	PM_{10}	DPM	SOx[c]
TRU	2.85	6.78	6.43	0.71	0.71	0.07
Reefer Car	3.23	7.49	6.71	0.79	0.79	0.07

Notes:
a. Emission factors from OFFROAD2007 model.
b. Evaporative emissions from this source are negligible.
c. Emission factor based on a Diesel fuel sulfur content of 130 ppm.

6. HHD Diesel-Fueled Delivery Trucks

Emission factors for the HHD Diesel-fueled delivery trucks were obtained from CARB's EMFAC2007 model. Per CARB guidelines, the emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling analysis for these modes. A fleet average emission factor for traveling exhaust emissions was calculated using the EMFAC2007 model with the BURDEN output option. Since the fleet distribution is not known, the EMFAC2007 default distribution for Los Angeles County was used. Idling emission factors were calculated using the EMFAC2007 model with the EMFAC output option. The emission factors for the HHD Diesel-fueled trucks are shown in Table 39. Detailed emission factor derivation calculations and the EMFAC2007 output are contained in Appendix F.

Table 39 Emission Factors for HHD Diesel-Fueled Delivery Trucks[a] Dolores and ICTF Rail Yards						
Operating Mode	Fleet Average Emission Factors					
	ROG	CO	NOx	PM_{10}[d]	DPM[d,e]	SOx
Traveling (g/mi)[b]	6.40	17.23	28.68	2.53	2.47	0.24
Idling (g/hr)[c]	16.16	52.99	100.38	2.85	2.85	0.55

Notes:

a. See Part V for vehicle specifications.

b. Emission factors were calculated using the EMFAC2007 model with the BURDEN output option and assume an average speed of 15 mph. The default model year distribution for Los Angeles County was used.

c. Emission factors were calculated using the EMFAC2007 model with the EMFAC output option. The default model year distribution for Los Angeles County was used.

d. The PM_{10} emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.

e. Diesel PM_{10} (DPM) is a TAC.

7. Yard Trucks

Vehicle specific criteria pollutant emission factors for each yard truck were obtained from CARB's EMFAC2007 model. The emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling analysis for these modes. Traveling exhaust emission factors were calculated using the EMFAC2007 model with the BURDEN output option and an average speed of 15 mph. Idling emission factors for the light-heavy duty and medium-heavy duty vehicles were calculated using the EMFAC2007 model with the EMFAC output option. The idling emissions from light duty trucks were negligible. The emission factors for the yard trucks are shown in Table 40. Detailed emission factor derivation calculations and the EMFAC2007 output are contained in Appendix G.

Table 40
Emission Factors for Yard Trucks
Dolores and ICTF Rail Yards

Yard	Equipment Type	Make/Model	Vehicle Class	Model Year	Traveling Emission Factors (g/mi)[a]					Idling Emission Factors (g/hr)[b]				
					ROG	CO	NOx	PM_{10}	SOx	ROG	CO	NOx	PM_{10}	SOx
ICTF	SUV	Jeep Cherokee	LDT	2000	0.07	3.00	0.22	0.04	0.01	NA	NA	NA	NA	NA
ICTF	Pickup Truck	Chevy Ext. Cab	LDT	2003	0.05	1.97	0.16	0.03	0.01	NA	NA	NA	NA	NA
ICTF	SUV	Chevy Trailblazer	LDT	2003	0.05	1.97	0.16	0.03	0.01	NA	NA	NA	NA	NA
ICTF	Pickup Truck	Chevy Ext. Cab	LDT	2004	0.04	1.51	0.12	0.03	0.01	NA	NA	NA	NA	NA
ICTF	Van	Chevy Van	LHDT 1	2004	0.03	0.35	0.12	0.03	0.00	23.10	141.99	1.56	0.00	0.05
Dolores	Service Truck	Chevy C4500	MHD	2003	0.88	11.41	2.19	0.02	0.00	23.10	141.99	1.56	0.00	0.05
Dolores	Mgr Truck	Chevy Trailblazer	LDT	2004	0.05	1.97	0.16	0.03	0.01	NA	NA	NA	NA	NA
Dolores	Mgr Truck	Chevy Blazer	LDT	2004	0.05	1.97	0.16	0.03	0.01	NA	NA	NA	NA	NA
Dolores	Pickup Truck	Ford F-150	LDT	2005	0.02	0.89	0.07	0.02	0.01	NA	NA	NA	NA	NA

Notes:

a. Traveling exhaust emissions calculated using the EMFAC2007 model with the BURDEN output option at a vehicle speed of 15 mph.

b. Idling exhaust emissions factors for LHDT1 and MHD vehicles calculated using the EMFAC2007 model with the EMFAC output option. Idling exhaust emissions from light duty trucks (LDT) are negligible.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from each yard truck.[20] All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC speciation profiles and emission rates for the yard trucks are shown in Table 41. A copy of the relevant sections of SPECIATE database and detailed calculations are included in Appendix G.

Table 41
TAC Emissions Factors for Gasoline-Fueled Yard Trucks
ICTF and Dolores Rail Yards

CAS	Chemical Name[a]	Organic Fraction of VOC (by weight)[b]
95636	1,2,4-trimethylbenzene	0.0120
106990	1,3-butadiene	0.0068
540841	2,2,4-trimethylpentane	0.0288
75070	acetaldehyde	0.0035
107028	acrolein (2-propenal)	0.0017
71432	benzene	0.0309
4170303	crotonaldehyde	0.0004
110827	cyclohexane	0.0077
100414	ethylbenzene	0.0131
74851	ethylene	0.0794
50000	formaldehyde	0.0197
78795	isoprene	0.0018
98828	isopropylbenzene (cumene)	0.0001
67561	methyl alcohol	0.0015
78933	methyl ethyl ketone (mek)	0.0002
108383	m-xylene	0.0445
91203	naphthalene	0.0006
110543	n-hexane	0.0200
95476	o-xylene	0.0155
115071	propylene	0.0382
100425	styrene	0.0015
108883	toluene	0.0718

Notes:
a. Organic fraction information is from CARB's SPECIATE database. Data used are from the "Cat stabilized exhaust 2005 SSD etoh 2% O (MTBE phaseout)" profile.
b. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.8012.

[20] Speciation profile number 2105 was used to calculate TAC emissions from this source.

8. Diesel-Fueled I.C. Engines

Criteria pollutant and DPM emission factors for the stationary emergency generator and portable air compressor are from AP-42, Table 3.3.-1 (10/96).[21] The emission factors are shown in Table 42. Detailed emission factor calculations are shown in Appendix H.

Table 42
Emission Factors for the Diesel-Fueled IC Engines
ICTF Rail Yard

Unit	Emission Factors (g/hp-hr)[a]					
	ROG	CO	NOx	PM_{10}	DPM	SOx
Emergency Generator	1.14	3.03	14.06	1.00	1.00	0.93
Air Compressor	1.14	3.03	14.06	1.00	1.00	0.93

Notes:
a. Criteria pollutant and DPM emission factors from AP-42, Table 3.3-1, 10/96.

9. Tanks

VOC emissions from the storage tanks were calculated using EPA's TANKS program. The emissions from small oil tanks,[22] stormwater tanks, and the sludge tank were assumed to be negligible. Also, the TANKS program does not calculate emissions from oil storage tanks. Therefore, the emissions from oil storage tanks were estimated by modeling the liquid contents as Diesel fuel, resulting in conservative estimates. CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from the storage tanks. CARB's speciation database does not include information on TAC fractions from Diesel fuel or lubricating oil storage tanks. Therefore, TAC emissions were calculated for the gasoline storage tank (Tank TBA-2) at ICTF only. All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC speciation profile[23] and emission rates for Tank TBA-2 are shown in Table 43. The TANKS output and the relevant sections of CARB's speciation database are included in Appendix I.

[21] Available at *http://www.epa.gov/ttn/chief/ap42/*.
[22] The TANKS program requires a minimum shell length of 5 feet for horizontal tanks and a minimum shell height of 5 feet for vertical tanks to calculate emissions. Emissions from tanks with a shell length/height of 5 feet or less are considered to be negligible.
[23] Speciation profile number 661 was used to calculate TAC emissions from this source.

Table 43 TAC Emission Factors for Gasoline Storage Tank ICTF Rail Yard		
CAS	Chemical Name[b]	Organic Fraction of VOC (by weight)[a,c]
540841	2,2,4-trimethylpentane	0.0130
71432	Benzene	0.0036
110827	Cyclohexane	0.0103
100414	Ethylbenzene	0.0012
78784	Isopentane	0.3747
98828	Isopropylbenzene (cumene)	0.0001
108383	m-Xylene	0.0034
110543	n-Hexane	0.0155
95476	o-Xylene	0.0013
106423	p-Xylene	0.0011
108883	Toluene	0.0171
Total		**0.44**

Notes:

a. The organic fraction information is from CARB's speciation database. Data are from the "Headspace vapors 1996 SSD etoh 2.0% (MTBE phaseout)" option.

b. Emissions were calculated only for chemicals that were in both CARB's speciation database and the AB 2588 list.

c. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.9963).

10. Refueling Operations

Refueling emissions are based on the type of fuel, annual fuel throughput, and VOC emission factors from *Supplemental Instructions for Liquid Organic Storage Tanks* document of the South Coast Air Quality Management District's (SCAQMD) *General Instruction Book for the AQMD 2006-2007 Annual Emissions Reporting Program.*[24] The VOC emission factors from refueling operations are shown in Table 44. A copy of the relevant section of the SCAQMD document is contained in Appendix J-1 and detailed emission calculations are shown in Appendix J-2.

[24] Available at *http://www.ecotek.com/aqmd/download.htm*.

Table 44
VOC Emission Factors for Refueling Operations
Dolores and ICTF Rail Yards

Yard	Tank No.	Tank Location	Material Stored	VOC Emission Factor (lb/1000 gal)[b]
ICTF	TNKD-9901	Crane Maintenance	Offroad Diesel	0.028
ICTF	TBA-1	Crane Maintenance	CARB Diesel	0.028
ICTF	TBA-2	Crane Maintenance	Gasoline	1.8
Dolores	TNKD-0069	Tank Farm	Diesel	0.028
Dolores	TNKD-0068	Tank Farm	Diesel	0.028

Notes:
a. Emission factors from the Supplemental Instructions for Liquid Organic Storage Tanks document of the SCAQMD's General Instruction Book for the AQMD 2006-2007 Annual Emissions Reporting Program.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from the refueling operations. CARB's speciation database does not include information on TAC fractions from Diesel fuel. Therefore, TAC emissions were calculated for the gasoline refueling operations at ICTF only.[25] All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC speciation profile and emission rates for the gasoline refueling operations are shown in Table 45. A copy of the relevant sections of the SPECIATE database is included in Appendix J-2.

[25] Speciation profile number 661 was used to calculate TAC emissions from this source.

Table 45 TAC Emission Factors for Gasoline Refueling Operations ICTF Rail Yard		
CAS	Chemical Name	Organic Fraction of VOC (by weight)
540841	2,2,4-trimethylpentane	0.0130
71432	benzene	0.0036
110827	cyclohexane	0.0103
100414	ethylbenzene	0.0012
78784	isopentane	0.3747
98828	Isopropylbenzene (cumene)	0.0001
108383	m-Xylene	0.0034
110543	n-Hexane	0.0155
95476	o-Xylene	0.0013
106423	p-Xylene	0.0011
108883	toluene	0.0171

Notes:
a. The organic fraction information is from CARB's speciation database. Data are from the "Headspace vapors 1996 SSD etoh 2.0% (MTBE phaseout)" option.
b. Emissions were calculated only for chemicals that were in both CARB's speciation database and the AB 2588 list.
c. The organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.9963

11. Sand Tower

Emission factors for the sand tower operations are from EPA's AP-42 document. The sand transfer system consists of two parts: pneumatic transfer and gravity transfer. The pneumatic transfer system is similar to those used to unload cement at concrete batch plants. The gravity feed system is similar to the sand and aggregate transfer operations at concrete batch plants. Therefore, emissions will be calculated using the AP-42 emission factors for concrete batch plants. As previously discussed, the system is equipped with a baghouse; therefore, emission factors for a controlled system were used. These emission factors are shown in Table 46.

Table 46 Emission Factors for Sand Tower Operations Dolores Rail Yard		
Pollutant	Emission Factors (lb/ton)	
	Pneumatic Transfer[a]	Gravity Transfer[b]
PM_{10}	0.00034	0.00099

Notes:
a. Emission factor from AP-42, Table 11.12-5, 6/06. Factor for controlled pneumatic cement unloading to elevated storage silo was used. The unit is equipped with a fabric filter.
b. Emission factor from AP-42, Table 11.12-5, 6/06. Factor for sand transfer was used.
c. There are no TAC emissions from this source.

12. Wastewater Treatment Plant

Emission factors for the WWTP are from the *Air Emission Inventory and Regulatory Analysis Report for Dolores Yard* (Trinity Consultants, December 2005). Emission rates were calculated by Trinity Consultants using EPA's WATER9 program. The emission rates are shown in Table 47.

Table 47 Emission Factors for the Wastewater Treatment Plant Dolores Rail Yard	
Pollutant	Emission Rate (grams/sec)
Benzene	5.10×10^{-7}
Bis (2-ethylhexyl) Phthalate	1.83×10^{-11}
Bromomethane	8.99×10^{-7}
Chloroform	6.30×10^{-7}
Ethylbenzene	3.04×10^{-6}
Methylene Chloride	1.04×10^{-5}
Toluene	3.50×10^{-6}
Xylene	6.20×10^{-6}
Total	$\mathbf{2.52 \times 10^{-5}}$

Notes:
a. Emission rates from *Air Emission Inventory and Regulatory Analysis for Dolores Yard*, Trinity Consultants, December 2005.

13. Steam Cleaners

Criteria pollutant emission factors for the propane-fueled heaters and the gasoline-fueled pump in the steam cleaners are from AP-42 Table 1.5-1 (10/96) and Table 3.3-1 (10/96), respectively.[26] The emission factors are shown in Table 48. Detailed emission calculations are shown in Appendix K.

Table 48
Criteria Pollutant Emission Factors for Steam Cleaners
Dolores Rail Yard

Emission Unit	Emission Factors				
	ROG	CO	NOx	PM_{10}	SOx[c]
Heater (lb/mgal)[a]	0.5	1.9	14.0	0.4	0.002
Pump (g/hp-hr)[b]	9.79	199.13	4.99	0.33	0.27

Notes:
a. Emission factors from AP-42, Table 1.5-1 (10/96).
b. Emission factors from AP-42, Table 3.3-1 (10/96).
c. Based on a propane sulfur content of 185 ppm and a density of 4.24 lb propane per gallon.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from the steam cleaning operations.[27] The SPECIATE database does not include a profile for propane-fueled boilers. Therefore, the speciation profile for natural gas-fired boilers was used to determine the TAC emissions from the steam cleaner heaters. All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC speciation profiles and emission rates for the steam cleaning operations are shown in Table 49. A copy of the relevant sections of the SPECIATE database is included in Appendix K.

[26] Available at *http://www.epa.gov/ttn/chief/ap42/*.
[27] Speciation profile number 3 was used to calculate TAC emissions from the heaters and profile number 665 was used to calculate the TAC emissions from the pump.

Table 49 TAC Emission Factors for Steam Cleaner Dolores Rail Yard			
		Organic Fraction of VOC (by weight)[c]	
CAS	Chemical Name	Heaters[a]	Pumps[b]
95636	1,2,4-trimethylbenzene	-	0.0140
106990	1,3-butadiene	-	0.0091
540841	2,2,4-trimethylpentane	-	0.0222
75070	acetaldehyde	-	0.0106
107028	acrolein (2-propenal)	-	0.0020
71432	benzene	0.0947	0.0368
4170303	crotonaldehyde	-	0.0014
110827	cyclohexane	0.0237	0.0050
100414	ethylbenzene	-	0.0167
74851	ethylene	-	0.0996
50000	formaldehyde	0.1895	0.0327
78795	isoprene	-	0.0016
98828	isopropylbenzene (cumene)	-	0.0006
67561	methyl alcohol	-	0.0038
78933	methyl ethyl ketone (mek)	-	0.0007
108383	m-xylene	-	0.0496
91203	Naphthalene	-	0.0014
110543	n-hexane	-	0.0146
95476	o-xylene	-	0.0173
115071	propylene	-	0.0546
100425	styrene	-	0.0014
108883	toluene	0.0474	0.0756

Notes:

a. Organic fraction information is from CARB's SPECIATE database. Data used are from the "External combustion boiler – natural gas" profile. SPECIATE does not include a profile for propane-fueled boilers. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.4222

b. Organic fraction information is from CARB's SPECIATE database. Data used are from the "Non-cat stabilized exhaust 1996 SSD 2.0% etoh (MTBE phaseout)" profile. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.9198

14. Natural Gas-Fired Heater

Criteria pollutant emission factors for the natural gas-fired heater were obtained from AP-42, Table 1.4-1 (7/98).[28] The emission factors are shown in Table 50. Detailed emission calculations are shown in Appendix L.

[28] Available at *http://www.epa.gov/ttn/chief/ap42/*.

Table 50 Emission Factors for Natural Gas-Fired Heater ICTF Rail Yard				
Emission Factors (lb/MMcf)[a]				
VOC	CO	NOx	PM_{10}	SOx
5.50	84.00	100.0	7.60	0.60

Notes:
a. Criteria pollutant emission factors from AP-42, Table 1.4-1, 7/98

CARB's speciation profile for natural gas-fired boilers was used to determine the fraction of each TAC in the total VOC emissions from the heater.[29] All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC speciation profiles and emission rates for the heater are shown in Table 51. A copy of the relevant sections of the SPECIATE database and detailed emission calculations are included in Appendix L.

Table 51 TAC Emission Factors for Natural Gas-Fired Heater ICTF Rail Yard		
CAS	Chemical Name[a]	Organic Fraction of VOC (by weight)[b]
71432	benzene	0.0947
110827	cyclohexane	0.0237
50000	formaldehyde	0.1895
108883	toluene	0.0474

Notes:
a. Organic fraction information is from CARB's SPECIATE database. Data used are from the "External combustion boiler – natural gas" profile.
b. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.4222.

15. <u>Propane-Fueled Welder</u>

Criteria pollutant emission factors for the propane-fueled welder were obtained from AP-42, Table 3.2-3 (7/00).[30] The emission factors are shown in Table 52.

[29] Speciation profile number 3 was used to calculate TAC emissions from this source.
[30] Available at *http://www.epa.gov/ttn/chief/ap42/*.

Table 52 Emission Factors for Propane-Fueled Welder Dolores Rail Yard				
Emission Factors (lb/MMBtu)[a]				
VOC	CO	NOx	PM_{10}	SOx
2.96×10^{-2}	3.51	2.27	9.50×10^{-3}	5.88×10^{-4}
Notes: a. Criteria pollutant emission factors from AP-42, Table 3.2-3, 7/00.				

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from the propane-fueled welder. The SPECIATE database does not include a profile for propane-fueled internal combustion engine. Therefore, the speciation profile for natural gas-fired reciprocating engines was used to determine the TAC emissions from the welder.[31] All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC speciation profiles and emission rates for the heater are shown in Table 53. A copy of the relevant section of the SPECIATE database is and detailed emission calculations are included in Appendix M.

[31] Speciation profile number 719 was used to calculate emissions from this source.

Table 53 TAC Emission Factors for Propane-Fueled Welder Dolores Rail Yard		
CAS	Chemical Name[a]	Organic Fraction of VOC (by weight)[b]
95636	1,2,4-trimethylbenzene	0.00001
75070	acetaldehyde	0.00003
71432	benzene	0.00010
110827	cyclohexane	0.00001
100414	ethylbenzene	0.00001
74851	ethylene	0.00058
50000	formaldehyde	0.00074
108383	m-xylene	0.00001
110543	n-hexane	0.00002
95476	o-xylene	0.00001
115071	propylene	0.00154
108883	toluene	0.00004
1330207	xylene	0.00002

Notes:
a. Organic fraction information is from CARB's SPECIATE database. Data used are from the "I.C.E. reciprocating – natural gas" profile.
b. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.0914.

16. Miscellaneous Gasoline Fueled Equipment

Criteria pollutant emission factors for the miscellaneous gasoline fueled equipment were obtained from AP-42, Table 3.3-1 (10.96).[32] The emission factors are shown in Table 54 below.

Table 54 Emission Factors for Miscellaneous Gasoline Fueled Equipment ICTF Rail Yard				
Emission Factors (g/bhp-hr)[a]				
VOC	CO	NOx	PM_{10}	SOx
9.79	199.13	4.99	0.33	0.27

Notes:
a. Criteria pollutant emission factors from AP-42, Table 3.3-1, 10/96.

[32] Available at *http://www.epa.gov/ttn/chief/ap42/*.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from each piece of equipment.[33] All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC speciation profiles and emission rates for the miscellaneous equipment are shown in Table 55. A copy of the relevant section of the SPECIATE database are included in Appendix N. Equipment specific calculations are also shown in Appendix N.

Table 55
TAC Emission Factors for Miscellaneous Gasoline Fueled Equipment
ICTF Rail Yard

CAS	Chemical Name[a]	Organic Fraction of VOC (by weight)[b]
95636	1,2,4-trimethylbenzene	0.0140
106990	1,3-butadiene	0.0091
540841	2,2,4-trimethylpentane	0.0222
75070	acetaldehyde	0.0106
107028	acrolein (2-propenal)	0.0020
71432	benzene	0.0368
4170303	crotonaldehyde	0.0014
110827	cyclohexane	0.0050
100414	ethylbenzene	0.0167
74851	ethylene	0.0996
50000	formaldehyde	0.0327
78795	isoprene	0.0016
98828	isopropylbenzene (cumene)	0.0006
67561	methyl alcohol	0.0038
78933	methyl ethyl ketone (mek)	0.0007
108383	m-xylene	0.0496
91203	naphthalene	0.0014
110543	n-hexane	0.0146
95476	o-xylene	0.0173
115071	propylene	0.0546
100425	styrene	0.0014
108883	toluene	0.0756

Notes:
a. Organic fraction information is from CARB's SPECIATE database. Data used are from the "Non-cat stabilized exhaust 1996 SSD 2.0% etoh (MTBE phaseout)" profile.
b. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.9198

[33] Speciation profile number 665 was used to calculate TAC emissions from this source.

17. Worker Vehicles

Fleet average criteria pollutant emission factor for traveling exhaust emissions from worker vehicles were calculated using the EMFAC2007 model with the BURDEN output option. Since the model year distribution is not known, the EMFAC2007 default distribution for gasoline-fueled passenger cars and light duty trucks operating in Los Angeles County was used. Idling emissions were assumed to be negligible. The criteria pollutant emission factors are shown in Table 56 below.

Table 56
Emission Factors for Worker Vehicles
Dolores and ICTF Rail Yards

Emission Factors (g/mi)[a]				
ROG	CO	NOx	PM_{10}	SOx
0.36	0.63	0.59	0.04	0.00

Notes:
a. Criteria pollutant emission factors (g/mi) from EMFAC 2007 using the BURDEN output option. The EMFAC default model year distribution for L.A. County was used.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from each yard truck.[34] All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC speciation profiles and emission rates for worker vehicles are shown in Table 57. A copy of the relevant section of the SPECIATE database and detailed calculations are included in Appendix O.

[34] Speciation profile number 2105 was used to calculate TAC emissions from this source.

Table 57 TAC Emission Factors for Worker Vehicles Dolores and ICTF Rail Yards		
CAS	Chemical Name[a]	Organic Fraction of VOC (by weight)[b]
95636	1,2,4-trimethylbenzene	0.0120
106990	1,3-butadiene	0.0068
540841	2,2,4-trimethylpentane	0.0288
75070	acetaldehyde	0.0035
107028	acrolein (2-propenal)	0.0017
71432	benzene	0.0309
4170303	crotonaldehyde	0.0004
110827	cyclohexane	0.0077
100414	ethylbenzene	0.0131
74851	ethylene	0.0794
50000	formaldehyde	0.0197
78795	isoprene	0.0018
98828	isopropylbenzene (cumene)	0.0001
67561	methyl alcohol	0.0015
78933	methyl ethyl ketone (mek)	0.0002
108383	m-xylene	0.0445
91203	naphthalene	0.0006
110543	n-hexane	0.0200
95476	o-xylene	0.0155
115071	propylene	0.0382
100425	styrene	0.0015
108883	toluene	0.0718

Notes:

a. Organic fraction information is from CARB's SPECIATE database. Data used are from the "Cat stabilized exhaust 2005 SSD etoh 2% O (MTBE phaseout)" profile.
b. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.8012.

18. Road Dust

Particulate matter emissions were calculated for paved roadways in both the ICTF and Dolores rail yards. Particulate emissions occur when loose material on road surfaces is resuspended as vehicles travel over a roadway. Emissions are based on the number of vehicles driving on the road, the length of the road, and the amount of loose material on the road surface.

A PM_{10} emission factor of 12.11 g/VMT was calculated using the following equation from AP-42, Section 13.2.1 (11/06)[35] and the variables listed in Table 58.

$$E = \left[k \left(\frac{sL}{2} \right)^{0.65} x \left(\frac{W}{3} \right)^{1.5} - C \right] \left(1 - \frac{P}{4N} \right)$$

Where,

E = PM_{10} emission factor (g/VMT)
k = particle size multiplier
sL= road surface silt loading (g/m^2)
W= average weight (tons) of the vehicles traveling on the road, and
C = emission factor for 1980's vehicle fleet exhaust, brake wear, and tire wear
P = number of "wet" days with at least 0.254 mm of precipitation during the averaging period
N = number of days in the averaging period

Table 58
Variable Used to Calculate PM_{10} Emission Factors for Roadway Emissions
ICTF and Dolores Rail Yards

Variable	Unit	Value	Reference
k	g/VMT	7.3	AP-42, Table 13.2-1.1, 11/06
sL	g/m^2	0.015	AP-42, Table 13.2.1-3, 11/06
W	tons	36.1	Trinity Report, Table 19-1
C	g/VMT	0.2119	AP-42, Table 13.2.1-2, 11/06
P	days	40	AP-42, Fig 13.2.1-2, 11/06
N	days	365	

Per UPRR staff, the paved roadways within the ICTF and Dolores rail yards are swept to remove loose material.[36] A control efficiency of 45%, based on street sweeping twice per week, was calculated using the methods outlined in the SCAQMD Staff Report for Rule 1186.[37] Detailed emission factor and control efficiency derivation and detailed emission calculations are in Appendix P.

[35] Available at *http://www.epa.gov/ttn/chief/ap42/*.
[36] Personal communication with Duffy Exon.
[37] Available at *http://www.aqmd.gov/rules/support.html*.

B. Emissions by Source Type

Emission calculations for each source type were based on the site-specific equipment inventory (shown in Part V of this report), equipment activity data (shown in Part VI of this report), and the source-specific emission factors shown in Part VII.A above.

1. Locomotives

Emissions from locomotive operations were based on the emission factors shown in Tables 26 through 32, the number of events, the number of locomotives per consist, duration, and duty cycle of different types of activity. Table 59 shows the duty cycles assumed for different types of activities.

Table 59
Locomotive Duty Cycles
Dolores and ICTF Rail Yards

Activity	Duty Cycle
Through Train Movement	EB: N4 – 100%; WB: N3- 100%
Movements within the Yard	N1 – 50%, N2- 50%
Yard Operations	EPA Switch Duty Cycle[a]

Notes:
a. EPA (1998) Regulatory Support Document

For locomotive models and tiers for which specific emission factors were not available, the emissions for the next lower tier were used, or the next higher tier if no lower tier data were available. Emission factors for the "average locomotive" for different types of activity were developed from the emission factors and the actual locomotive model and technology distributions for that activity. Separate distributions were developed for eight types of activity: through trains (including through power moves); intermodal arrival; intermodal departures; other trains; arriving power moves; departing power moves; east end Yard operations; and west end Yard operations. Table 60 shows the criteria pollutant and DPM emission estimates for the different types of activities.

Table 60 Summary of Emissions from Locomotives Dolores and ICTF Rail Yards						
Activity	Emissions (tpy)					
	HC	CO	NOx	PM10	DPM	SOx
Train Activity	3.32	5.52	50.08	1.23	1.23	2.93
Yard Operations	11.44	26.72	256.11	5.57	5.57	1.79
Alameda Corridor	2.36	5.65	53.39	1.39	1.39	3.13
Service Load Testing	0.97	2.73	25.13	0.59	0.59	0.46
Service Idling	3.13	4.58	19.46	0.65	0.65	3.03
Alameda Corridor – Offsite	0.70	1.67	15.76	0.41	0.41	0.93
Total	**21.92**	**46.87**	**419.93**	**9.84**	**9.84**	**12.27**

Notes:

a. See Table 1 for equipment specifications.
b. See Tables 8 and 9 for activity data.
c. See Table 26 though 32 for emission factors.
d. Emissions from Yard operations are based on five sets of switcher locomotives, with three sets operating 15 hrs/day each and two sets operating 23 hrs/day each, the EPA Switch Duty Cycle, and the emission factors shown in Table 16.
e. See Appendices A-3 and A-4 for detailed emission calculations. The calculations of sulfur adjustments are shown in Appendix A-7.
f. Alameda Corridor – Offsite includes emissions from locomotives operating with in 0.5 miles of the facilities.

The UPRR train data included only trains operating within Dolores/ICTF. Emissions for mainline (Alameda Corridor) through trains were calculated based on data for the gross tonnage of all freight trains[38] traversing the Alameda Corridor provided by the Alameda Corridor Transportation Authority[39]. The previously identified emission factors in grams per hour were converted to gram per gallon emission rates based on fuel consumption rate data collected concurrently with emissions testing of the different locomotive models. Emissions were then calculated for these mainline trains based on the gross tonnage, UPRR's estimated system-wide fuel consumption rate (expressed in gallons of fuel per 1,000 gross ton miles of freight), and the gram per gallon emission factor for the UPRR intermodal train locomotive model distribution.

2. HHD Diesel-Fueled Drayage Trucks

a. Onsite Operations

DPM emission estimates for the HHD Diesel-fueled drayage trucks operating within the Yard are based on the number of truck trips, the annual VMT within the Yard, and the amount of idling time. Table 61 shows the criteria pollutant and DPM emission estimates for the Diesel-fueled HHD drayage trucks operating within the Yard in 2005.

[38] The emission estimates for the Alameda Corridor include emissions from trains that are not owned and operated by UPRR. The CARB *Rail Yard Emission Inventory Methodology* (September, 2006) requires that the emissions inventory include emissions from locomotives traveling on rail lines that are adjacent to the rail yard.

[39] Locomotive emissions in the modeled section of the Alameda Corridor are calculated based on the total gross ton-miles of train traffic in the Corridor (as provided by ACTA) divided by the length of the corridor. Emissions of through trains passing through the Dolores Yard and returning to the Corridor are calculated separately, resulting in a small but undetermined amount of double counting of emissions.

Table 61 **Summary of Emissions from HHD Diesel-Fueled** **Drayage Trucks – Onsite Operations** **ICTF Rail Yard**						
Activity	Emissions (tpy)					
	ROG	CO	NOx	PM_{10}	DPM	SOx
Traveling Emissions	11.58	31.18	51.91	4.58	4.46	0.44
Idling Emissions	8.36	27.40	51.90	1.47	1.47	0.28
Total	**19.94**	**58.58**	**103.81**	**6.05**	**5.93**	**0.72**

Notes:
a. See Part V for equipment specifications.
b. See Tables 10 and 11 for activity data.
c. See Table 33 and 34 for emission factors.

b. Offsite Operations

Emission estimates for drayage trucks operating within 0.5 miles of the facility are based on the number of truck trips and the annual VMT on each travel route. Emissions from excess idling were not calculated for offsite drayage truck operations. Table 62 shows the criteria pollutant and DPM emission estimates for the Diesel-fueled HHD drayage trucks operating within 0.5 miles of the Yard in 2005.

Table 62 **Summary of Emissions from HHD Diesel-Fueled** **Drayage Trucks – Onsite Operations** **ICTF Rail Yard**						
Activity	Emissions (tpy)					
	ROG	CO	NOx	PM_{10}	DPM	SOx
Route A	0.88	3.39	9.91	0.56	0.53	0.07
Route B	1.23	4.73	13.84	0.78	0.74	0.10
Route C	0.47	1.83	5.36	0.30	0.29	0.04
Total	**2.58**	**9.95**	**29.11**	**1.64**	**1.56**	**0.21**

Notes:
a. See Part V for equipment specifications.
b. See Tables 10 and 11 for activity data.
c. See Table 33 and 34 for emission factors.

3. Cargo Handling Equipment

DPM emission estimates for the CHE are based on the number and type of equipment, the equipment model, and the hours of operation. Table 63 shows the criteria pollutant and DPM emission estimates for the Diesel-fueled cargo handling equipment operating at ICTF in 2005.

Table 63
Summary of Emissions from Cargo Handling Equipment
ICTF Rail Yard

Equipment Type[a]	Make/Model	Model Year	No of Units	Emissions (tpy)					
				ROG	CO	NOx	PM10	DPM	SOx
Forklift	Toyota 6FDU25	1997	1	0.02	0.08	0.18	0.01	0.01	0.00
RTG	Mi Jack 850R	1997	1	0.10	0.36	2.28	0.06	0.06	0.02
RTG	Mi Jack 1000R	1988	1	0.20	0.98	2.67	0.14	0.14	0.02
RTG	Mi Jack 1000R	1995	4	0.87	4.33	11.94	0.56	0.56	0.07
RTG	Mi Jack 1000RC	2002	2	0.08	0.68	3.12	0.07	0.07	0.04
RTG	Mi Jack 1200R	2005	1	0.03	0.38	1.56	0.04	0.04	0.02
Top Pick	Mi Jack PC-90	1972	1	0.04	0.20	0.51	0.03	0.03	0.00
Top Pick	Taylor Tay-950	1988	1	0.35	1.68	4.58	0.24	0.24	0.03
Top Pick	Taylor Tay-950	1989	1	0.35	1.66	4.54	0.23	0.23	0.03
Yard Hostler	Capacity TJ5000	1999	15	0.28	1.39	3.32	0.20	0.20	0.03
Yard Hostler	Capacity TJ5000	2005	58	2.41	55.60	86.46	2.80	2.80	1.21
Total			**86**	**4.71**	**67.35**	**121.16**	**4.38**	**4.38**	**1.46**

Notes:

a. See Table 2 for equipment specifications.
b. See Table 12 for activity data.
c. See Table 35 for emission factors.

4. Heavy Equipment

Emission estimates for the heavy equipment are based on the number and type of equipment, the equipment model, and the hours of operation. Table 64 shows the criteria pollutant and DPM emission estimates for the heavy equipment operating at the Dolores and ICTF Yards in 2005.

Table 64 Summary of Emissions from Heavy Equipment Dolores and ICTF Rail Yards										
				No	Emissions (tpy)					
Yard	Equipment Type	Make/Model	Model Year	of Units	ROG	CO	NOx	PM_{10}	DPM	SOx
ICTF	Crane	Grove RT600E	2004	1	0.03	0.25	0.41	0.02	0.02	0.00
ICTF	Forklift	Taylor 850	2005	2	0.16	2.07	3.19	0.10	0.10	0.04
ICTF	Forklift	Taylor 850	1998	1	0.49	1.36	3.19	0.23	0.23	0.02
ICTF	Manlift	Unknown	1985	1	0.14	0.28	0.20	0.03	0.03	0.00
Dolores	Forklift	Yale GP-060	ALL	2	0.04	7.62	2.38	0.02	NA	0.00
Total				**7**	**0.86**	**11.58**	**9.38**	**0.40**	**0.38**	**0.07**

Notes:
a. See Table 3 for equipment specifications.
b. See Table 13 for activity data.
c. See Table 36 for emission factors.

CARB's speciation profile database was used to determine the fraction of each TAC in the total ROG emissions from the propane-fueled forklifts. The database does not contain a profile for propane combusted in an internal combustion engine. Therefore, the speciation profile for natural gas-fired reciprocating engines was used. The database does not contain a profile for Diesel-fueled equipment; therefore, TAC emissions, other than DPM, were not calculated for this equipment. The TAC emissions for the propane-fueled forklifts are shown in Table 65.

Table 65 **TAC Emissions from Propane-Fueled Forklifts** **Dolores Rail Yard**		
CAS	Pollutant[a]	Emissions (tons/yr)
95636	1,2,4-trimethylbenzene	3.21×10^{-7}
75070	Acetaldehyde	9.63×10^{-7}
71432	Benzene	3.53×10^{-6}
110827	Cyclohexane	3.21×10^{-7}
100414	Ethylbenzene	3.21×10^{-7}
74851	Ethylene	2.02×10^{-5}
50000	Formaldehyde	2.60×10^{-5}
108383	m-xylene	3.21×10^{-7}
110543	n-hexane	6.42×10^{-7}
95476	o-xylene	3.21×10^{-7}
115071	Propylene	5.42×10^{-5}
108883	Toluene	1.28×10^{-6}
1330207	Xylene	6.42×10^{-7}
Total		$\mathbf{1.09 \times 10^{-4}}$

Notes:
a. Emissions were calculated for only those chemicals that were in both the CARB SPECIATE database and the AB 2588 list.
b. Organic fraction data are from CARB's SPECIATE database. Data are from profile #719 "I.C.E. reciprocating – natural gas." A speciation profile for propane was not included in the database.
c. Organic fraction is reported on a ROG basis using CARB's SPECIATE ROG/TOG ratio of 0.0914

5. <u>TRUs and Reefer Cars</u>

Emission estimates for the Diesel-fueled TRUs and reefer cars were based on the average number of units in the Yard and the hours of operation. Table 66 shows the criteria pollutant and DPM emission estimates from TRUs and reefer cars operating at ICTF in 2005.

Table 66 **Summary of Emissions from TRUs and Reefer Cars** **ICTF Rail Yard**						
Equipment Type	ROG	CO	NOx	PM_{10}	DPM	SOx
TRU	5.12	12.16	11.53	1.28	1.28	0.12
Railcar	0.94	2.17	1.95	0.23	0.23	0.02
Total	**6.06**	**14.33**	**13.47**	**1.51**	**1.51**	**0.14**

Notes:
a. See Part V for equipment specifications.
b. See Table 14 for activity data.
c. See Table 38 for emission factors

6. HHD Diesel-Fueled Delivery Trucks

Emission estimates for Diesel-fueled delivery trucks are based on the number of truck trips, the length of each trip, and the amount of time spent idling. The criteria pollutant and DPM emissions from delivery trucks calling at the ICTF and Dolores Yards in 2005 are summarized in Table 67.

Table 67
Summary of Emissions from HHD Diesel-Fueled Delivery Trucks
Dolores and ICTF Rail Yards

Operating Mode	Emission (tpy)					
	ROG	CO	NOx	PM_{10}	DPM	SOx
Traveling	0.00	0.01	0.02	0.00	0.001	0.00
Idling	0.01	0.03	0.06	0.00	0.002	0.00
Total	**0.01**	**0.04**	**0.08**	**0.00**	**0.00**	**0.00**

Notes:
a. See Part V for equipment specifications.
b. See Table 15 for activity data.
c. See Table 39 for emission factors.

7. Yard Trucks

Emissions from the gasoline fueled yard trucks were based on the age of the vehicle and the annual miles traveled. The criteria pollutant emissions from yard trucks are summarized in Table 68.

Table 68
Summary of Emissions from Gasoline-Fueled Yard Trucks
Dolores and ICTF Rail Yards

Yard	Equipment Type	Make/Model	Vehicle Class	Model Year	Emissions (tpy)				
					ROG	CO	NOx	PM_{10}	SOx
ICTF	SUV	Jeep Cherokee	LDT	2000	0.01	0.24	0.02	0.00	0.00
ICTF	Pickup Truck	Chevy Ext. Cab	LDT	2003	0.00	0.16	0.01	0.00	0.00
ICTF	SUV	Chevy Trailblazer	LDT	2003	0.00	0.16	0.01	0.00	0.00
ICTF	Pickup Truck	Chevy Ext. Cab	LDT	2004	0.00	0.12	0.01	0.00	0.00
ICTF	Van	Chevy Van	LHDT 1	2004	0.00	0.04	0.01	0.00	0.00
Dolores	Service Truck	Chevy C4500	MHD	2003	0.01	0.17	0.03	0.00	0.00
Dolores	Mgr Truck	Chevy Trailblazer	LDT	2004	0.00	0.10	0.01	0.00	0.00
Dolores	Mgr Truck	Chevy Blazer	LDT	2004	0.00	0.08	0.01	0.00	0.00
Dolores	Pickup Truck	Ford F-150	LDT	2005	0.00	0.02	0.00	0.00	0.00
Total					0.02	1.09	0.11	0.00	0.00

Notes:
a. See Table 4 for equipment specifications.
b. See Table 16 for activity data.
c. See Table 40 for emission factors.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from each yard truck.[40] The TAC emissions from yard trucks are summarized in Table 69.

Table 69
Summary of TAC Emissions from Gasoline-Fueled Yard Trucks
Dolores and ICTF Rail Yards

CAS	Chemical Name[a]	TAC Emissions (tons/yr) ICTF	Dolores	Total
95636	1,2,4-trimethylbenzene	2.49×10^{-4}	2.33×10^{-4}	4.82×10^{-4}
106990	1,3-butadiene	1.41×10^{-4}	1.32×10^{-4}	2.72×10^{-4}
540841	2,2,4-trimethylpentane	5.96×10^{-4}	5.58×10^{-4}	1.15×10^{-3}
75070	acetaldehyde	7.20×10^{-5}	6.74×10^{-5}	1.39×10^{-4}
107028	acrolein (2-propenal)	3.42×10^{-5}	3.20×10^{-5}	6.62×10^{-5}
71432	benzene	6.38×10^{-4}	5.97×10^{-4}	1.24×10^{-3}
4170303	crotonaldehyde	7.46×10^{-6}	6.98×10^{-6}	1.44×10^{-5}
110827	cyclohexane	1.59×10^{-4}	1.48×10^{-4}	3.07×10^{-4}
100414	ethylbenzene	2.71×10^{-4}	2.53×10^{-4}	5.24×10^{-4}
74851	ethylene	1.64×10^{-3}	1.54×10^{-3}	3.18×10^{-3}
50000	formaldehyde	4.08×10^{-4}	3.81×10^{-4}	7.89×10^{-4}
78795	isoprene	3.66×10^{-5}	3.42×10^{-5}	7.08×10^{-5}
98828	isopropylbenzene (cumene)	2.49×10^{-6}	2.33×10^{-6}	4.81×10^{-6}
67561	methyl alcohol	3.15×10^{-5}	2.95×10^{-5}	6.11×10^{-5}
78933	methyl ethyl ketone (mek)	4.71×10^{-6}	4.41×10^{-6}	9.12×10^{-6}
108383	m-xylene	9.20×10^{-4}	8.61×10^{-4}	1.78×10^{-3}
91203	naphthalene	1.22×10^{-5}	1.14×10^{-5}	2.36×10^{-5}
110543	n-hexane	4.13×10^{-4}	3.86×10^{-4}	7.99×10^{-4}
95476	o-xylene	3.20×10^{-4}	2.99×10^{-4}	6.19×10^{-4}
115071	propylene	7.90×10^{-4}	7.40×10^{-4}	1.53×10^{-3}
100425	styrene	3.17×10^{-5}	2.97×10^{-5}	6.14×10^{-5}
108883	toluene	1.49×10^{-3}	1.39×10^{-3}	2.88×10^{-3}
Total		**8.26×10^{-3}**	**7.73×10^{-3}**	**1.60×10^{-2}**

Notes:
a. See Table 4 for equipment description.
b. See Table 16 for activity data.
c. See Table 41 for emission factors

[40] Speciation profile number 2105 was used to calculate TAC emissions from this source.

8. Diesel-Fueled IC Engines

Emissions from the Diesel-fueled IC engines are based on the rated capacity of the engine and the annual hours of operation. The criteria pollutant and DPM emissions are summarized in Table 70.

Table 70
Summary of Emissions from Diesel-Fueled IC Engines
ICTF Rail Yard

Unit	Emissions (tons/yr)					
	ROG	CO	NOx	PM_{10}	DPM	SOx
Emergency Generator	0.01	0.02	0.08	0.01	0.01	0.01
Air Compressor	0.06	0.16	0.76	0.05	0.05	0.05
Total	**0.07**	**0.18**	**0.84**	**0.06**	**0.06**	**0.06**

Notes:
a. See Part V for equipment specifications
b. See Table 17 for activity data.
c. See Table 42 for emission factors.

9. Tanks

VOC emissions from the storage tanks were calculated using EPA's TANKS program. The VOC emissions from each storage tank are shown in Table 71.

Table 71 **Summary of VOC Emissions from Storage Tanks** **Dolores and ICTF Rail Yards**					
Yard	Tank No.	Tank Location	Material Stored	Tank Capacity (gallons)	VOC Emissions (tpy)
ICTF	TNKD-9901	Crane Maintenance	Offroad Diesel	20,000	0.004
ICTF	TBA-1	Crane Maintenance	CARB Diesel	1,000	0.001
ICTF	TBA-2	Crane Maintenance	Gasoline	2,000	0.71
ICTF	TBA-3	Tractor Maintenance	SAE 15W-40 Motor Oil	500	0.0002
ICTF	TBA-4	Crane Maintenance	Used Oil	300	neg.
ICTF	TBA-5	Crane Maintenance	Motor Oil	243	neg.
ICTF	TBA-6	Crane Maintenance	Hydraulic Oil	300	neg.
ICTF	TBA-7	Tractor Maintenance	Auto. Transmission Fluid	243	neg.
ICTF	TBA-8	Tractor Maintenance	SAE 20W-50 Motor Oil	202	neg.
ICTF	TBA-9	Tractor Maintenance	Used Motor Oil	300	neg.
ICTF	TBA-10	Tractor Maintenance	Used Motor Oil	300	neg.
ICTF	TBA-11	Tractor Maintenance	Hydraulic Oil	240	neg.
Dolores	TNKD-0069	Tank Farm	Diesel	160,000	0.10
Dolores	TNKD-0068	Tank Farm	Diesel	160,000	0.10
Dolores	TNKO-0002	Tank Farm	Recovered Oil	10,000	0.002
Dolores	TNKO-0003	Tank Farm	Drain Oil	12,000	0.002
Dolores	TNKO-0004	Tank Farm	Journal Box Oil	8,000	0.001
Dolores	TNKO-0001	Tank Farm	Lube Oil	12,000	0.004
Dolores	TNKO-0184	Service Track	Recovered Oil	6,000	0.002
Dolores	TNKS-0005	Tank Farm	Stormwater	25,000	neg.
Dolores	TNKS-0006	Tank Farm	Stormwater	25,000	neg.
Dolores	TNKS-0007	Tank Farm	Stormwater	25,000	neg.
Dolores	TNKS-0008	Tank Farm	Stormwater	25,000	neg.
Dolores	TNKS-0010	Tank Farm	Soap	8,000	NA
Dolores	NA	WWTP	Sludge	1,000	neg.
Total					**0.93**

Notes:
a. Emission calculations performed using the USEPA TANKS 4.0.9d program.
b. Emissions from small (the TANKS program requires a minimum shell length of 5 feet for horizontal tanks and a minimum shell height of 5 feet for vertical tanks) oil tanks, stormwater tanks, and the sludge tank were assumed to be negligible.
c. The VOC emissions for oil tanks were estimated by modeling the liquid contents as Diesel fuel, resulting in conservative estimates

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions. The TAC emissions for the gasoline storage tank at ICTF are shown in

Table 72. As previously discussed, there are no TAC emissions from the Diesel fuel and oil storage tanks.

Table 72 TAC Emissions from Gasoline Storage Tank ICTF Rail Yard		
CAS	Chemical Name	Emissions (tpy)
540841	2,2,4-trimethylpentane	9.27×10^{-3}
71432	Benzene	2.58×10^{-3}
110827	Cyclohexane	7.36×10^{-3}
100414	Ethylbenzene	8.45×10^{-4}
78784	Isopentane	2.67×10^{-1}
98828	Isopropylbenzene (cumene)	7.88×10^{-5}
108383	m-Xylene	2.46×10^{-3}
110543	n-Hexane	1.10×10^{-2}
95476	o-Xylene	9.17×10^{-4}
106423	p-Xylene	7.66×10^{-4}
108883	Toluene	1.22×10^{-2}
Total		$\mathbf{3.15 \times 10^{-1}}$

Notes:
a. See Table 4 for equipment specifications.
b. See Table 13 for activity data.
c. See Table 20 for emission factors.

10. Refueling Operations

Refueling operations occur at the crane maintenance area of ICTF and at the locomotive shop at the Dolores Yard. Refueling emissions are based on the type of fuel, annual fuel throughput, and VOC emission factors from SCAQMD. VOC emissions from refueling operations are summarized in Table 73.

Table 73 Summary of VOC Emissions from Refueling Operations Dolores and ICTF Rail Yards				
Yard	Tank No.	Tank Location	Material Stored	VOC Emissions (tons/yr)
ICTF	TNKD-9901	Crane Maintenance	Offroad Diesel	0.002
ICTF	TBA-1	Crane Maintenance	CARB Diesel	0.001
ICTF	TBA-2	Crane Maintenance	Gasoline	0.078
Dolores	TNKD-0069	Tank Farm	Diesel	0.147
Dolores	TNKD-0068	Tank Farm	Diesel	0.147
Total				**0.375**

Notes:
a. See Part V for equipment description.
b. See Table 19 for activity data.
c. See Table 44 for emission factors.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions. The TAC emissions from the gasoline refueling operations at ICTF are shown in Table 74. As previously discussed, there are no TAC emissions from the Diesel fuel refueling operations.

Table 74 Summary of TAC Emissions from Gasoline Refueling Operations ICTF Rail Yard		
CAS	Chemical Name	Emissions (tons/yr)
540841	2,2,4-trimethylpentane	1.02×10^{-3}
71432	benzene	2.82×10^{-4}
110827	cyclohexane	8.06×10^{-4}
100414	ethylbenzene	9.25×10^{-5}
78784	isopentane	2.93×10^{-2}
98828	Isopropylbenzene (cumene)	8.63×10^{-6}
108383	m-Xylene	2.69×10^{-4}
110543	n-Hexane	1.21×10^{-3}
95476	o-Xylene	1.00×10^{-4}
106423	p-Xylene	8.39×10^{-5}
108883	toluene	1.33×10^{-3}
Total		$\mathbf{3.45 \times 10^{-2}}$

Notes:
a. See Part V for description of operations.
b. See Table 19 for activity data.
c. See Table 45 for emission factors.

11. Sand Tower

Emissions from the sand tower are based on the annual sand throughput and PM_{10} emission factors from AP-42. As previously discussed, there are no TAC emissions from the sand tower operations. PM_{10} emission estimates from the sand tower are shown in Table 75.

Table 75
PM_{10} Emission Factors and Emission Rates for Sand Tower Operations
Dolores Rail Yard

Pollutant	Sand Throughput (tons/yr)[a]	Emissions (tons/yr)		
		Pneumatic Transfer	Gravity Transfer	Total
PM_{10}	3,120	0.001	0.002	0.002

Notes:
a. See Part V for equipment description.
b. See Part VI for activity data.
c. See Table 46 for emission factors.

12. Wastewater Treatment Plant

TAC emission estimates for the WWTP are based on emission rates from the *Air Emission Inventory and Regulatory Analysis Report for Dolores Yard* (Trinity Consultants, December 2005) and the annual wastewater flow rate. Table 76 shows the TAC emissions from Dolores WWTP during 2005.

Table 76 TAC Emissions from the Wastewater Treatment Plant Dolores Rail Yard	
Pollutant	Emissions (tpy)
Benzene	2.37×10^{-5}
Bis (2-ethylhexyl) Phthalate	8.52×10^{-10}
Bromomethane	4.18×10^{-5}
Chloroform	2.93×10^{-5}
Ethylbenzene	1.41×10^{-4}
Methylene Chloride	4.84×10^{-4}
Toluene	1.63×10^{-4}
Xylene	2.89×10^{-4}
Total	**1.17×10^{-3}**

Notes:
a. See Part V for equipment description.
b. See Part VI for activity data.
c. See Table 47 for emission factors.

13. Steam Cleaners

Emissions from steam cleaners are based on the hours of operation, the fuel type and rated capacity of the heater, and the fuel type and rated capacity of the pump. The criteria pollutant emissions from steam cleaners are summarized in Table 77.

Table 77 Summary of Emissions from Steam Cleaners Dolores Rail Yard					
Emission Unit	Emission(tpy)				
	ROG	CO	NOx	PM_{10}	SOx
Heaters	0.00	0.02	0.11	0.00	0.00
Pumps	0.12	2.41	0.06	0.00	0.00
Total	**0.12**	**2.43**	**0.17**	**0.00**	**0.00**

Notes:
a. See Table 6 for equipment specifications.
b. See Table 20 for activity data.
c. See Table 48 for emission factors.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions. The TAC emissions from steam cleaners are shown in Table 78.

Table 78 Summary of TAC Emissions from Steam Cleaners Dolores Rail Yard			
CAS	Chemical Name	Emissions (tpy)	
		Heater	Pump
95636	1,2,4-trimethylbenzene	-	1.67×10^{-3}
106990	1,3-butadiene	-	1.08×10^{-3}
540841	2,2,4-trimethylpentane	-	2.63×10^{-3}
75070	acetaldehyde	-	1.26×10^{-3}
107028	acrolein (2-propenal)	-	2.38×10^{-4}
71432	benzene	3.64×10^{-4}	4.37×10^{-3}
4170303	crotonaldehyde	-	1.72×10^{-4}
110827	cyclohexane	9.11×10^{-5}	5.95×10^{-4}
100414	ethylbenzene	-	1.98×10^{-3}
74851	ethylene	-	1.18×10^{-2}
50000	formaldehyde	7.28×10^{-4}	3.88×10^{-3}
78795	isoprene	-	1.85×10^{-4}
98828	isopropylbenzene (cumene)	-	6.58×10^{-5}
67561	methyl alcohol	-	4.53×10^{-4}
78933	methyl ethyl ketone (mek)	-	7.88×10^{-5}
108383	m-xylene	-	5.89×10^{-3}
91203	Naphthalene	-	1.72×10^{-4}
110543	n-hexane	-	1.73×10^{-3}
95476	o-xylene	-	2.05×10^{-3}
115071	propylene	-	6.48×10^{-3}
100425	styrene	-	1.72×10^{-4}
108883	toluene	1.82×10^{-4}	8.98×10^{-3}
Total		$\mathbf{1.37 \times 10^{-3}}$	$\mathbf{5.60 \times 10^{-2}}$

Notes:
a. See Table 6 for equipment specifications.
b. See Table 20 for activity data.
c. See Table 49 for emission factors.

14. Natural Gas-Fired Heater

Emissions from the heater are based on the equipment's rated capacity, fuel type, and hours of operation. Criteria pollutant emissions from the heater are summarized in Table 79.

Table 79 Summary of Emissions from the Natural Gas-Fired Heater ICTF Rail Yard					
Equipment Type	Emissions (tons/yr)				
	VOC	CO	NOx	PM_{10}	SOx
Heater	0.00	0.07	0.08	0.01	0.00

Notes:
a. See Part V for equipment description
b. See Table 21 for activity data.
c. See Table 50 for emission factors.

CARB's speciation profile for natural gas-fired boilers was used to determine the fraction of each TAC in the total VOC emissions from the heater. The TAC emissions from the heater are shown in Table 80.

Table 80 Summary of TAC Emissions from the Natural Gas-Fired Heater ICTF Rail Yard		
CAS	Chemical Name	Emissions (tons/yr)
71432	benzene	4.34×10^{-4}
110827	cyclohexane	1.08×10^{-4}
50000	formaldehyde	8.67×10^{-4}
108883	toluene	2.17×10^{-4}
Total		$\mathbf{1.63 \times 10^{-3}}$

Notes:
a. See Part V for equipment specifications
b. See Table 21 for activity data.
c. See Table 51 for emission factors.

15. Propane-Fueled Welder

Emissions from the welder are based on the fuel type, rated capacity, and hours of operation for the unit. Criteria pollutant emissions from the welder are summarized in Table 81.

Table 81 Summary of Emissions from the Propane-Fueled Welder Dolores Rail Yard					
Equipment Type	Emissions (tons/yr)				
	VOC	CO	NOx	PM_{10}	SOx
Welder	0.002	0.221	0.143	0.001	0.000

Notes:
a. See Part V for equipment description.
b. See Table 22 for activity data.
c. See Table 52 for emission factors.

CARB's speciation profile for natural gas-fired reciprocating engines was used to determine the fraction of each TAC in the total VOC emissions from the welder. The TAC emissions from the welder are shown in Table 82.

Table 82 Summary of TAC Emissions from the Propane-Fueled Welder Dolores Rail Yard		
CAS	Chemical Name	Emissions (tons/yr)
95636	1,2,4-trimethylbenzene	1.70×10^{-8}
75070	acetaldehyde	5.11×10^{-8}
71432	benzene	1.87×10^{-7}
110827	cyclohexane	1.70×10^{-8}
100414	ethylbenzene	1.70×10^{-8}
74851	ethylene	1.07×10^{-6}
50000	formaldehyde	1.38×10^{-6}
108383	m-xylene	1.70×10^{-8}
110543	n-hexane	3.41×10^{-8}
95476	o-xylene	1.70×10^{-8}
115071	propylene	2.88×10^{-6}
108883	toluene	6.82×10^{-8}
1330207	xylene	3.41×10^{-8}
Total		$\mathbf{5.80 \times 10^{-6}}$

Notes:
a. See Part V for equipment specifications.
b. See Table 22 for activity data.
c. See Table 53 for emission factors.

16. Miscellaneous Gasoline Fueled Equipment

Emissions from the portable equipment are based on the fuel type, rated capacity, and hours of operation of each unit. The criteria pollutant emissions from the portable gasoline-fueled equipment are summarized in Table 83. Equipment specific emission estimates are shown in Appendix N.

Table 83
Summary of Emissions from Gasoline-Fueled Equipment
Dolores Rail Yard

Equipment Type	Emissions (tons/yr)				
	VOC	CO	NOx	PM_{10}	SOx
Misc. Gasoline-Fueled	1.89	38.41	0.96	0.06	0.05

Notes:
a. See Table 7 for equipment specifications.
b. See Table 23 for activity data.
c. See Table 54 for emission factors.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from the gasoline-fueled equipment. The TAC emissions from the miscellaneous gasoline-fueled equipment are summarized in Table 84. Equipment specific emission estimates are shown in Appendix N.

Table 84 Summary of TAC Emissions from Gasoline-Fueled Equipment ICTF Rail Yard		
CAS	Chemical Name	Emissions (tons/yr)
95636	1,2,4-trimethylbenzene	2.65×10^{-2}
106990	1,3-butadiene	1.71×10^{-2}
540841	2,2,4-trimethylpentane	4.19×10^{-2}
75070	acetaldehyde	2.00×10^{-2}
107028	acrolein (2-propenal)	3.78×10^{-3}
71432	benzene	6.95×10^{-2}
4170303	crotonaldehyde	2.73×10^{-3}
110827	cyclohexane	9.47×10^{-3}
100414	ethylbenzene	3.16×10^{-2}
74851	ethylene	1.88×10^{-1}
50000	formaldehyde	6.17×10^{-2}
78795	isoprene	2.94×10^{-3}
98828	isopropylbenzene (cumene)	1.05×10^{-3}
67561	methyl alcohol	7.21×10^{-3}
78933	methyl ethyl ketone (mek)	1.25×10^{-3}
108383	m-xylene	9.37×10^{-2}
91203	naphthalene	2.73×10^{-3}
110543	n-hexane	2.76×10^{-2}
95476	o-xylene	3.26×10^{-2}
115071	propylene	1.03×10^{-1}
100425	styrene	2.73×10^{-3}
108883	toluene	1.43×10^{-1}
Total		**8.90×10^{-1}**

Notes:
a. See Table 7 for equipment description.
b. See Table 23 for activity data.
c. See Table 57 for emission factors.

17. Worker Vehicles

Emissions from worker vehicles are based on the number of vehicle trips per day, the length of each trip, and fleet average emission factors from the EMFAC2007 model. Criteria pollutant emissions from worker vehicles are summarized in Table 85.

Table 85 Summary of Emissions from Worker Vehicles Dolores and ICTF Rail Yards					
Yard	Emissions (tons/yr)				
	ROG	CO	NOx	PM_{10}	SOx
ICTF	0.15	0.27	0.25	0.02	0.00
Dolores	0.01	0.01	0.01	0.00	0.00
Total	**0.16**	**0.28**	**0.26**	**0.02**	**0.00**

Notes:
a. See Part V for equipment specifications.
b. See Table 24 for activity data.
c. See Table 56 for emission factors.

CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions. The TAC emissions from the worker vehicles are summarized in Table 86.

Table 86 **Summary of TAC Emissions from Worker Vehicles** **Dolores and ICTF Rail Yards**				
CAS	Chemical Name	Emissions (tons/yr)		
		ICTF	Dolores	Total
95636	1,2,4-trimethylbenzene	1.81×10^{-3}	7.79×10^{-5}	1.89×10^{-3}
106990	1,3-butadiene	1.03×10^{-3}	4.41×10^{-5}	1.07×10^{-3}
540841	2,2,4-trimethylpentane	4.34×10^{-3}	1.87×10^{-4}	4.53×10^{-3}
75070	acetaldehyde	5.25×10^{-4}	2.26×10^{-5}	5.48×10^{-4}
107028	acrolein (2-propenal)	2.49×10^{-4}	1.07×10^{-5}	2.60×10^{-4}
71432	benzene	4.65×10^{-3}	2.00×10^{-4}	4.85×10^{-3}
4170303	crotonaldehyde	5.44×10^{-5}	2.34×10^{-6}	5.67×10^{-5}
110827	cyclohexane	1.16×10^{-3}	4.96×10^{-5}	1.21×10^{-3}
100414	ethylbenzene	1.97×10^{-3}	8.48×10^{-5}	2.06×10^{-3}
74851	ethylene	1.20×10^{-2}	5.14×10^{-4}	1.25×10^{-2}
50000	formaldehyde	2.97×10^{-3}	1.28×10^{-4}	3.10×10^{-3}
78795	isoprene	2.67×10^{-4}	1.14×10^{-5}	2.78×10^{-4}
98828	isopropylbenzene (cumene)	1.81×10^{-5}	7.78×10^{-7}	1.89×10^{-5}
67561	methyl alcohol	2.30×10^{-4}	9.88×10^{-6}	2.40×10^{-4}
78933	methyl ethyl ketone (mek)	3.44×10^{-5}	1.48×10^{-6}	3.58×10^{-5}
108383	m-xylene	6.70×10^{-3}	2.88×10^{-4}	6.99×10^{-3}
91203	naphthalene	8.87×10^{-5}	3.81×10^{-6}	9.25×10^{-5}
110543	n-hexane	3.01×10^{-3}	1.29×10^{-4}	3.14×10^{-3}
95476	o-xylene	2.33×10^{-3}	1.00×10^{-4}	2.43×10^{-3}
115071	propylene	5.76×10^{-3}	2.47×10^{-4}	6.01×10^{-3}
100425	styrene	2.31×10^{-4}	9.93×10^{-6}	2.41×10^{-4}
108883	toluene	1.08×10^{-2}	4.65×10^{-4}	1.13×10^{-2}
Total		**6.02×10^{-2}**	**2.59×10^{-3}**	**6.28×10^{-2}**

Notes:

a. See Part V for equipment specifications.
b. See Table 24 for activity data.
c. See Table 57 for emission factors.

18. Road Dust

Particulate matter emissions were calculated for paved roadways in both the ICTF and Dolores rail yards. Particulate emissions occur when loose material on road surfaces is resuspended as vehicles travel over a roadway. Emissions are based on the number of vehicles driving on the road, the length of the road, and the amount of loose material on the road surface. The PM_{10} emissions from paved roadways are shown in Table 87.

Table 87 Summary of Emissions from Roadways Dolores and ICTF Rail Yards		
Yard	Vehicle Type	PM_{10} Emissions (tons/yr)
ICTF	Drayage Trucks	12.06
ICTF	Delivery Trucks	0.00
ICTF	Yard Truck	2.68
ICTF	Worker Vehicles	2.81
Dolores	Delivery Trucks	0.00
Dolores	Yard Truck	0.87
Dolores	Worker Vehicles	0.12
Total		**18.54**

Notes:
a. See Part V for source description.
b. See Table 25 for activity data.
c. See Table 58 for emission factors.

C. Facility Total Emissions

Facility-wide criteria pollutant and DPM emissions for onsite operations are shown in Table 88. Facility-wide TAC emissions, excluding DPM, for onsite operations are shown in Table 89. The criteria pollutant and DPM emissions from offsite operations, within 0.5 miles of the facility, of locomotives and drayage trucks are summarized in Table 90.

Table 88 Facility-Wide Criteria Pollutant and DPM Emissions – Onsite Operations Dolores and ICTF Rail Yards						
Source Group	Emissions (tons/yr)					
	ROG	CO	NOx	PM_{10}	DPM	SOx
Locomotives	18.86	39.55	350.77	8.04	8.04	8.21
Drayage Trucks	19.94	58.58	103.81	6.05	5.93	0.72
Cargo Handling Equipment	4.71	67.35	121.16	4.38	4.38	1.46
Heavy Equipment	0.86	11.58	9.38	0.40	0.38	0.07
TRUs and Reefer Cars[a]	6.06	14.33	13.47	1.51	1.51	0.14
Delivery Trucks	0.01	0.04	0.08	0.00	0.00	0.00
Yard Trucks	0.02	1.09	0.11	0.00	NA	0.00
IC Engines	0.07	0.18	0.84	0.06	0.06	0.06
Tanks	0.93	NA	NA	NA	NA	NA
Refueling	0.38	NA	NA	NA	NA	NA
Sand Tower	NA	NA	NA	0.00	NA	NA
WWTP	0.00	NA	NA	NA	NA	NA
Steam Cleaners	0.12	2.43	0.17	0.00	NA	0.00
Heater	0.00	0.07	0.08	0.01	NA	0.00
Propane Welder	0.00	0.22	0.14	0.00	NA	0.00
Miscellaneous Equipment	1.89	38.41	0.96	0.06	NA	0.05
Worker Vehicles	0.16	0.28	0.26	0.02	NA	0.00
Road Dust	NA	NA	NA	18.54	NA	NA
Total	**53.99**	**234.11**	**601.23**	**39.07**	**20.30**	**10.73**

Table 89
Facility-Wide TAC Emissions – Onsite Operations
Dolores and ICTF Rail Yards

CAS	Chemical	Emissions (tpy)										
		Yard Trucks	Propane Forklifts	Gasoline Tank	Refueling	WWTP	Heater	Worker Vehicles	Steam Cleaners	Misc. Equip.	Propane Welder	Total
95636	1,2,4-trimethylbenzene	4.82×10^{-4}	3.21×10^{-7}	-	-	-	-	1.89×10^{-3}	1.67×10^{-3}	2.65×10^{-2}	1.70×10^{-8}	3.06×10^{-2}
106990	1,3-butadiene	2.72×10^{-4}	-	-	-	-	-	1.07×10^{-3}	1.08×10^{-3}	1.71×10^{-2}	-	1.95×10^{-2}
540841	2,2,4-trimethylpentane	1.15×10^{-3}	-	9.27×10^{-3}	1.02×10^{-3}	-	-	4.53×10^{-3}	2.63×10^{-3}	4.19×10^{-2}	-	6.05×10^{-2}
75070	acetaldehyde	1.39×10^{-4}	9.63×10^{-7}	-	-	-	-	5.48×10^{-4}	1.26×10^{-3}	2.00×10^{-2}	5.11×10^{-8}	2.20×10^{-2}
107028	acrolein (2-propenal)	6.62×10^{-5}	-	-	-	-	-	2.60×10^{-4}	2.38×10^{-4}	3.78×10^{-3}	-	4.34×10^{-3}
71432	benzene	1.24×10^{-3}	3.53×10^{-6}	2.58×10^{-3}	2.82×10^{-4}	2.37×10^{-5}	4.34×10^{-4}	4.85×10^{-4}	4.73×10^{-3}	6.95×10^{-2}	1.87×10^{-7}	8.36×10^{-2}
	bis(2-ethylhexyl) Phthalate	-	-	-	-	8.52×10^{-10}	-	-	-	-	-	8.52×10^{-10}
	bromomethane	-	-	-	-	4.18×10^{-5}	-	-	-	-	-	4.18×10^{-5}
67663	chloroform	-	-	-	-	2.93×10^{-5}	-	-	-	-	-	2.93×10^{-5}
4170303	crotonaldehyde	1.44×10^{-5}	-	-	-	-	-	5.67×10^{-5}	1.72×10^{-4}	2.73×10^{-3}	-	2.97×10^{-3}
110827	cyclohexane	3.07×10^{-4}	3.21×10^{-7}	7.36×10^{-3}	8.06×10^{-4}	-	1.08×10^{-4}	1.21×10^{-3}	6.86×10^{-4}	9.47×10^{-3}	1.70×10^{-8}	1.99×10^{-2}
100414	ethylbenzene	5.24×10^{-4}	3.21×10^{-7}	8.45×10^{-4}	9.25×10^{-5}	1.41×10^{-4}	-	2.06×10^{-3}	1.98×10^{-3}	3.16×10^{-2}	1.70×10^{-8}	3.72×10^{-2}
74851	ethylene	3.18×10^{-3}	2.02×10^{-5}	-	-	-	-	1.25×10^{-2}	1.18×10^{-2}	1.88×10^{-1}	1.07×10^{-6}	2.16×10^{-1}
50000	formaldehyde	7.89×10^{-4}	2.60×10^{-5}	-	-	-	8.67×10^{-4}	3.10×10^{-3}	4.61×10^{-3}	6.17×10^{-2}	1.38×10^{-6}	7.11×10^{-2}
78784	isopentane	-	-	2.67×10^{-1}	2.93×10^{-2}	-	-	-	-	-	-	2.97×10^{-1}
78795	isoprene	7.08×10^{-5}	-	-	-	-	-	2.78×10^{-4}	1.85×10^{-4}	2.94×10^{-3}	-	3.47×10^{-3}
98828	isopropylbenzene (cumene)	4.81×10^{-6}	-	7.88×10^{-5}	8.63×10^{-6}	-	-	1.89×10^{-5}	6.58×10^{-5}	1.05×10^{-3}	-	1.22×10^{-3}
67561	methyl alcohol	6.11×10^{-5}	-	-	-	-	-	2.40×10^{-4}	4.53×10^{-4}	7.21×10^{-3}	-	7.96×10^{-3}
78933	methyl ethyl ketone	9.12×10^{-6}	-	-	-	-	-	3.58×10^{-5}	7.88×10^{-5}	1.25×10^{-3}	-	1.38×10^{-3}
	methylene chloride	-	-	-	-	4.84×10^{-4}	-	-	-	-	-	4.84×10^{-4}
108383	m-xylene	1.78×10^{-3}	3.21×10^{-7}	2.46×10^{-3}	2.69×10^{-4}	-	-	6.99×10^{-3}	5.89×10^{-3}	9.37×10^{-2}	1.70×10^{-8}	1.11×10^{-1}
91203	naphthalene	2.36×10^{-5}	-	-	-	-	-	9.25×10^{-5}	1.72×10^{-4}	2.73×10^{-3}	-	3.02×10^{-3}
110543	n-hexane	7.99×10^{-4}	6.42×10^{-7}	1.10×10^{-2}	1.21×10^{-3}	-	-	3.14×10^{-3}	1.73×10^{-3}	2.76×10^{-2}	3.41×10^{-8}	4.55×10^{-2}
95476	o-xylene	6.19×10^{-4}	3.21×10^{-7}	9.17×10^{-4}	1.00×10^{-4}	-	-	2.43×10^{-3}	2.05×10^{-3}	3.26×10^{-2}	1.70×10^{-8}	3.87×10^{-2}
106423	p-xylene	-	-	7.66×10^{-4}	8.39×10^{-5}	-	-	-	-	-	-	8.50×10^{-4}
115071	propylene	1.53×10^{-3}	5.42×10^{-5}	-	-	-	-	6.01×10^{-3}	6.48×10^{-3}	1.03×10^{-1}	2.88×10^{-6}	1.17×10^{-1}
100425	styrene	6.14×10^{-5}	-	-	-	-	-	2.41×10^{-4}	1.72×10^{-4}	2.73×10^{-3}	-	3.21×10^{-3}
108883	toluene	2.88×10^{-3}	1.28×10^{-6}	1.22×10^{-2}	1.33×10^{-3}	1.63×10^{-4}	2.17×10^{-4}	1.13×10^{-2}	9.16×10^{-3}	1.43×10^{-1}	6.82×10^{-8}	1.80×10^{-1}
1330207	xylene (total)	-	6.42×10^{-7}	-	-	2.89×10^{-4}	-	-	-	-	3.41×10^{-8}	2.89×10^{-4}

Table 90
Emissions from Locomotives and Drayage Trucks – Offsite Operations
Dolores and ICTF Rail Yards

Source	Emissions (tons/yr)					
	ROG	CO	NOx	PM_{10}	DPM	SOx
Locomotives[a]	3.06	7.32	69.15	1.80	1.80	4.06
Drayage Trucks[b]	2.58	9.95	29.11	1.64	1.56	0.21
Total	**5.64**	**17.27**	**98.26**	**3.44**	**3.36**	**4.27**

Notes:
a. Includes locomotive emissions from the section of the Alameda corridor immediately adjacent to the Dolores Yard plus emissions from locomotive operations on the Alameda corridor within 0.5 miles from the Yard.
b. Includes emissions from drayage truck travel within 0.5 miles of the Yard.

PART VIII. RISK SCREENING CALCULATIONS

As previously discussed, at the request of the Ports of Los Angeles and Long Beach in the context of the ICTF Modernization Project, emission sources that would have been excluded and exempt or de minimis, per the UPRR Protocol, were included in the inventory and air dispersion modeling analysis. Therefore, a risk screening analysis to determine de minimis risk sources was not performed for this report.

PART IX. <u>AIR DISPERSION MODELING</u>

An air dispersion modeling analysis was conducted for the Dolores and ICTF Yards. The Yards are physically separate facilities, but due to their close proximity to one another, they were treated as one facility for the emission inventory and dispersion modeling analysis. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations near the Yards. Air dispersion modeling was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006). Each aspect of the modeling is further described below.

A. <u>Model Selection and Preparation</u>

1. <u>Modeled Sources and Source Treatment</u>

As discussed previously, all emission sources that were included in the inventory, including the offsite locomotive and drayage truck emissions, were also included in the dispersion modeling analysis. Emissions from mobile sources, low-level cargo handling equipment, heavy equipment, and moving locomotives were simulated as a series of volume sources along their corresponding travel routes and work areas. Idling and load testing of locomotives and elevated cargo handling equipment (RTGs) were simulated as a series of point sources within the areas where these events occur. The elevation for each source was interpolated from a 50 m grid of USGS terrain elevations. Table 91 shows the sources that were included in the modeling analysis and treatment used for each source. Assumptions used to spatially allocate emissions from locomotive operations within the Yard are included in Appendix A-4. Assumptions used to spatially allocate emissions from non-locomotive sources are contained in Appendix Q. Figures 4 through 7 show the location of each source.

Table 91 Source Treatment for Air Dispersion Modeling – ICTF and Dolores Rail Yard 2005 Baseline Year	
Source[a,b]	Source Treatment
Locomotives (idling)	Point
Locomotives (traveling)	Volume
Drayage Trucks (idling)	Volume
Drayage Trucks (traveling)	Volume
Cargo Handling Equipment (low level)	Volume
Cargo Handling Equipment (RTGs)	Point
Heavy Equipment (idling)	Volume
Heavy Equipment (traveling)	Volume
TRUs and reefer cars	Volume
Delivery Trucks (idling and traveling)	Volume
Yard Trucks	Volume
Diesel-Fueled Emergency Generator	Volume
Diesel-Fueled Air Compressor	Volume
Storage Tanks	Point
Refueling	Point
WWTP	Volume
Steam Cleaners	Volume
Heater	Volume
Propane-Fueled Welder	Volume
Miscellaneous Gasoline-Fueled Equipment	Volume
Worker Vehicles	Volume

Notes:
a. See Figures 4 through 7 for source locations.
b. There are no TAC emissions from the sand tower or in road dust. Therefore, these sources were not included in the dispersion modeling analysis.

2. Model Selection

Selection of air dispersion models depends on many factors, including the type of emissions source (point, line, or volume) and type of terrain surrounding the emission source. The USEPA-approved guideline air dispersion model, AERMOD, was selected for this project. AERMOD is recommended by EPA as the preferred air dispersion model, and is the recommended model in the CARB's *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006).

AERMOD is a steady-state,[41] multiple-source, Gaussian dispersion model designed for use with emission sources situated in terrain where ground elevations can exceed the release heights of the emission sources (i.e., complex terrain).[42] AERMOD was used with surface meteorological data from the St. Peter and Paul School in Wilmington, cloud cover from Long Beach Daugherty Field, and upper air data from the Miramar Marine Corps Air Station. AERMOD used these data to calculate the appropriate dispersion coefficients.

[41] The term "steady-state" means that the model assumes no spatial variability in meteorological parameters over a one-hour time period.

[42] Federal Register, November 9, 2005; Volume 70, Number 216, Pages 68218-68261.

Figure 4
Consist Idling, RTG Operations, and Gasoline Storage Tank

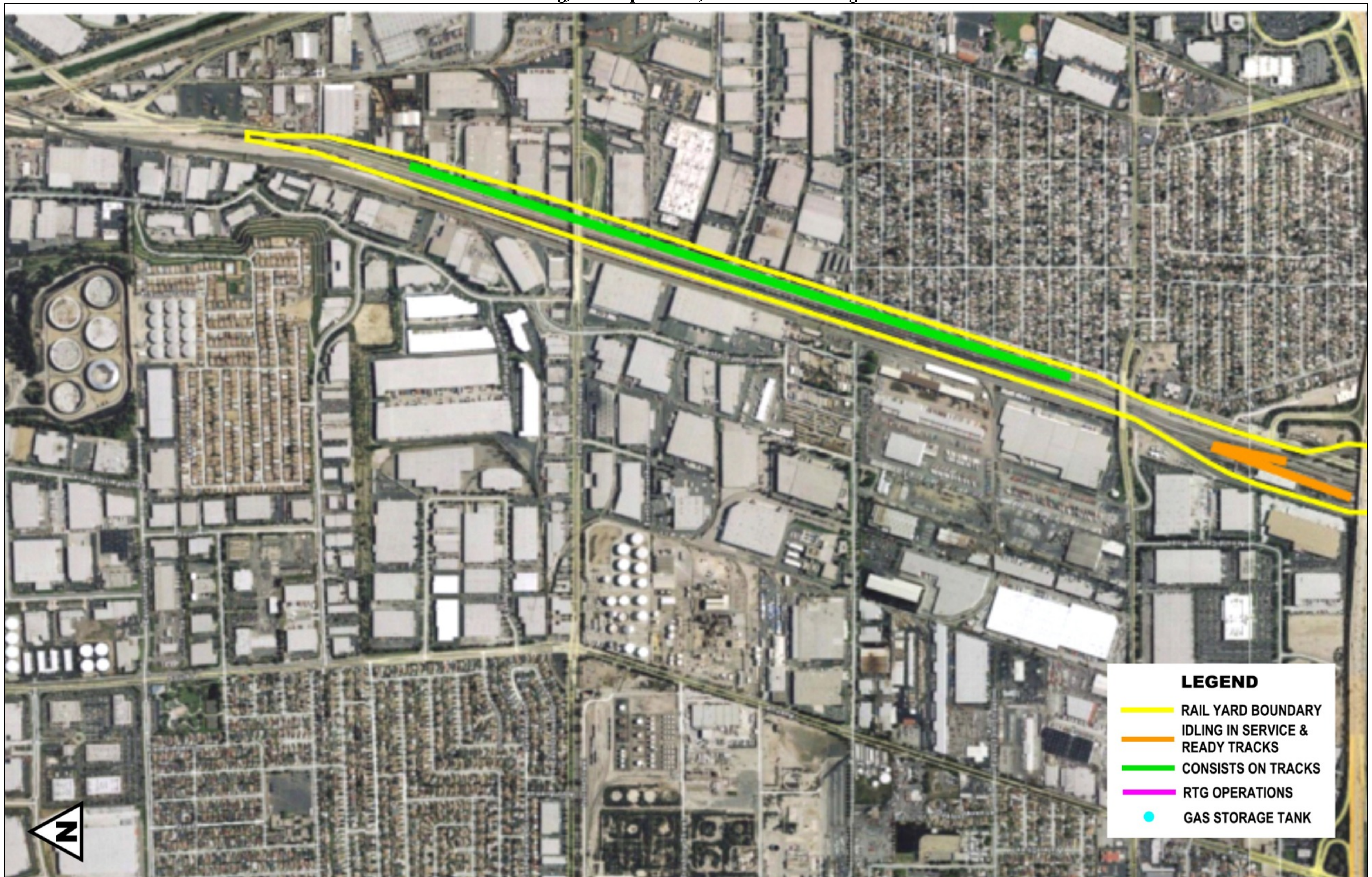


Figure 4
Consist Idling, RTG Operations, and Gasoline Storage Tank (continued)

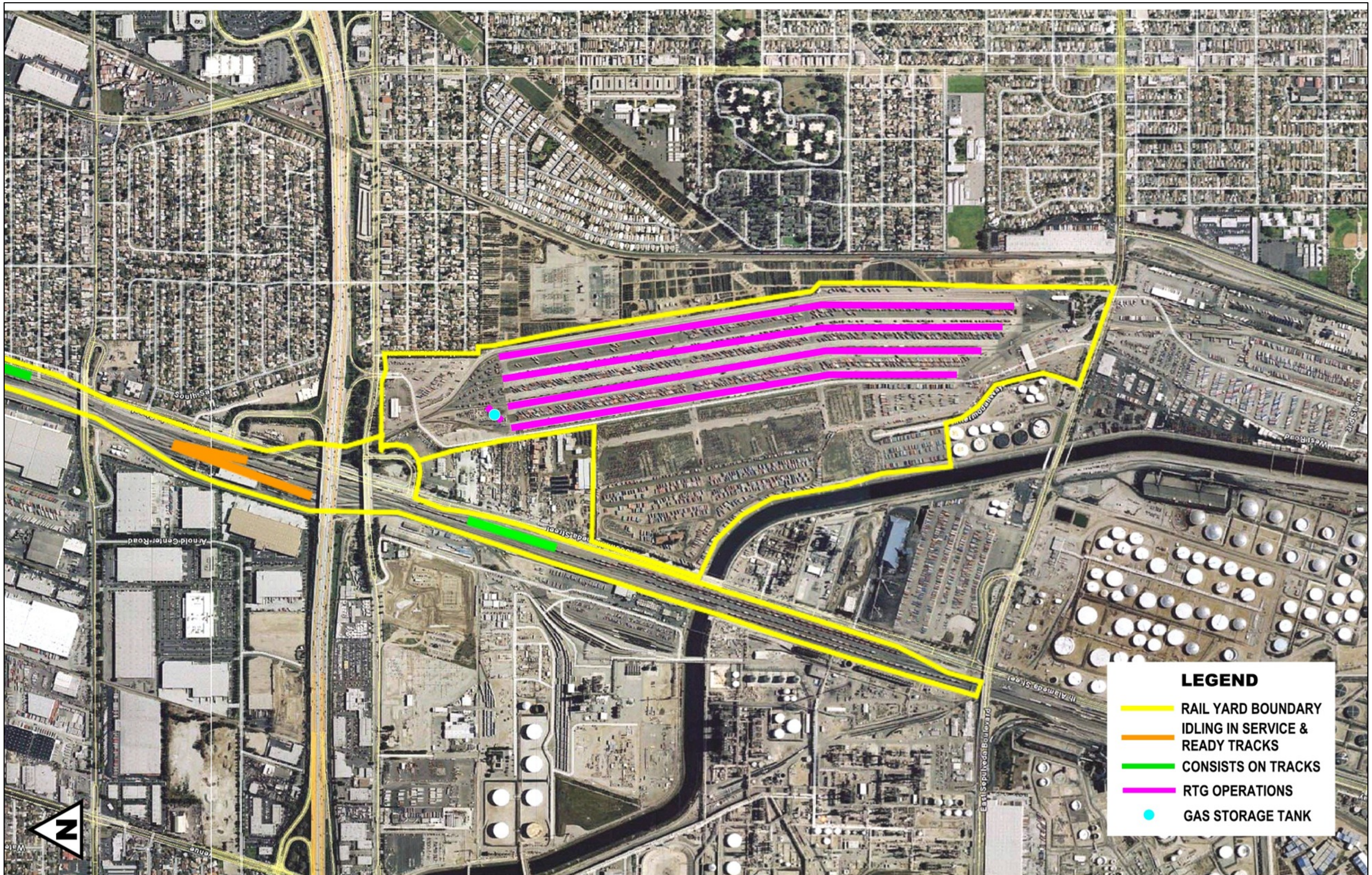


Figure 5
Diesel Trucks, Low-Level Cargo Handling Equipment and Heavy Equipment

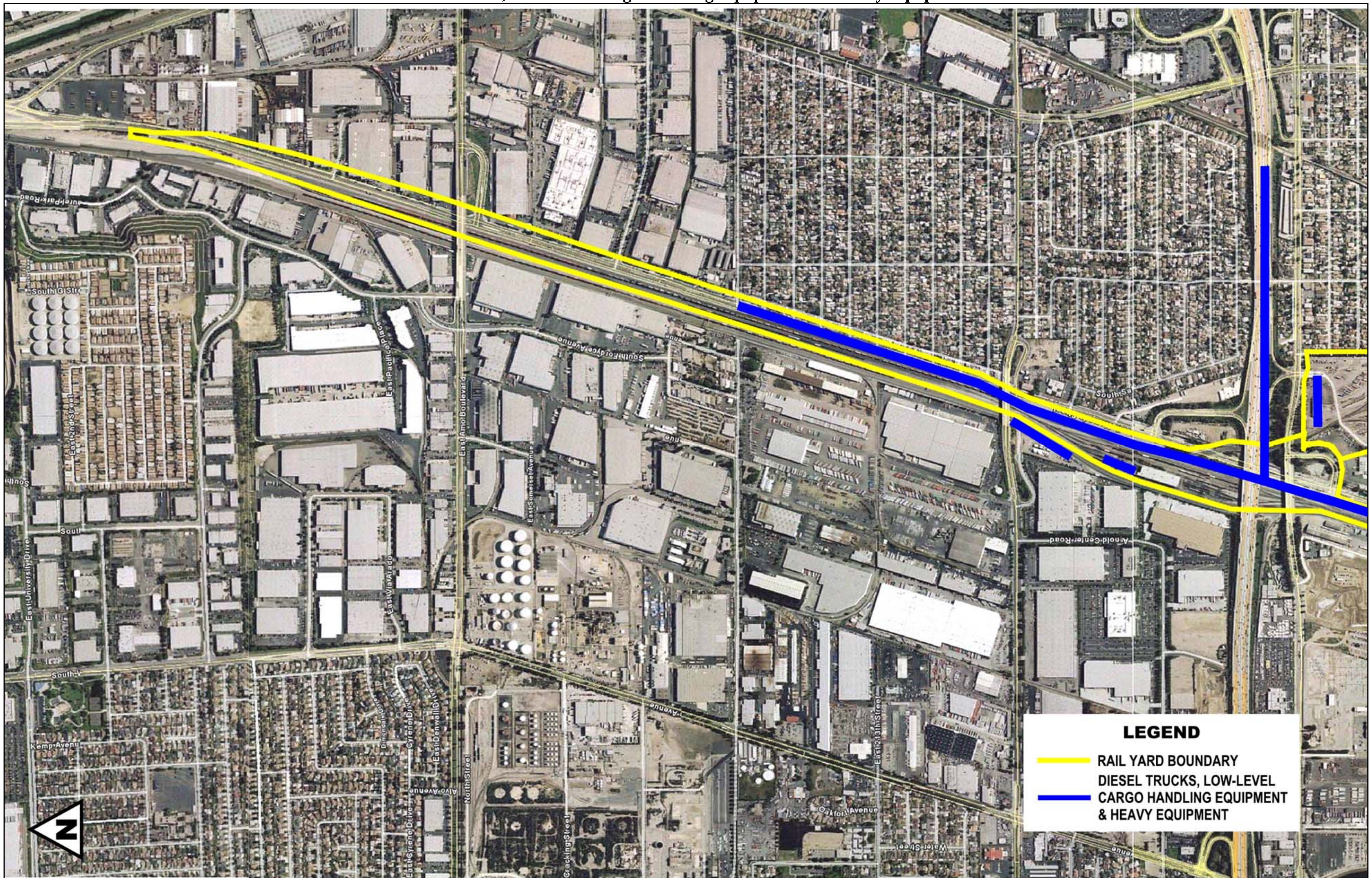


Figure 5
Diesel Trucks, Low-Level Cargo Handling Equipment and Heavy Equipment (continued)

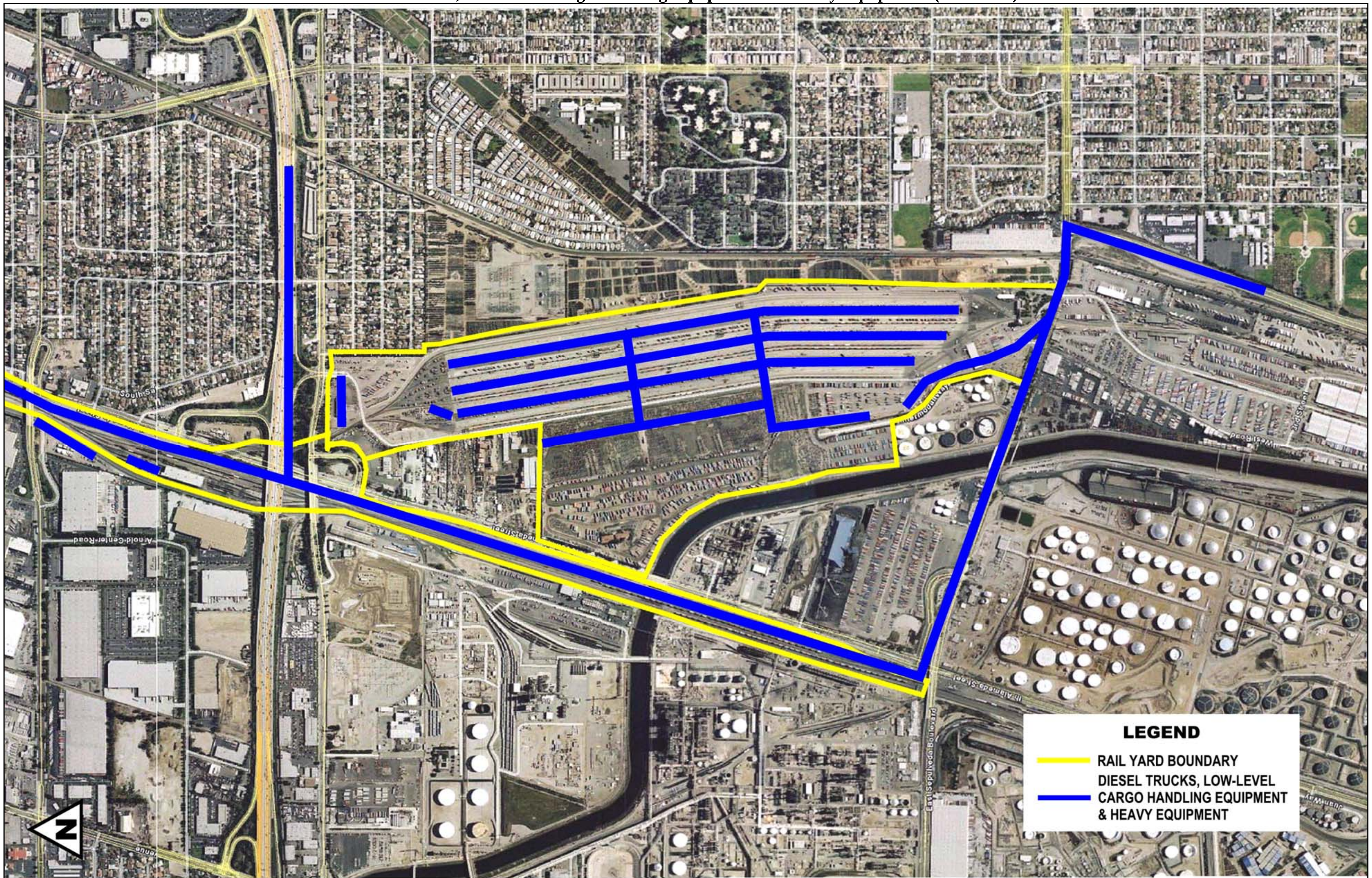


Figure 6
Yard Switching Operations

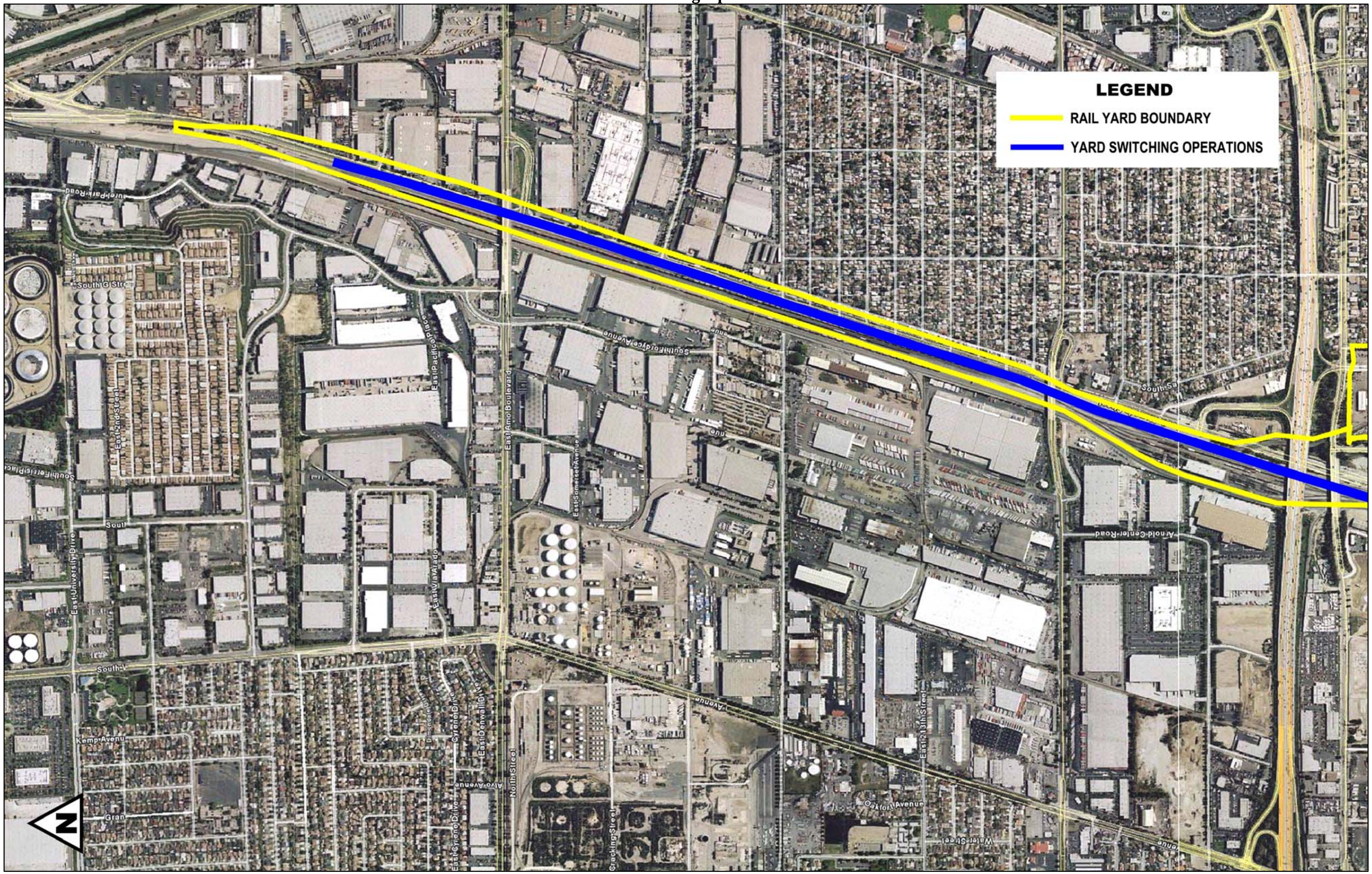


Figure 6
Yard Switching Operations (continued)

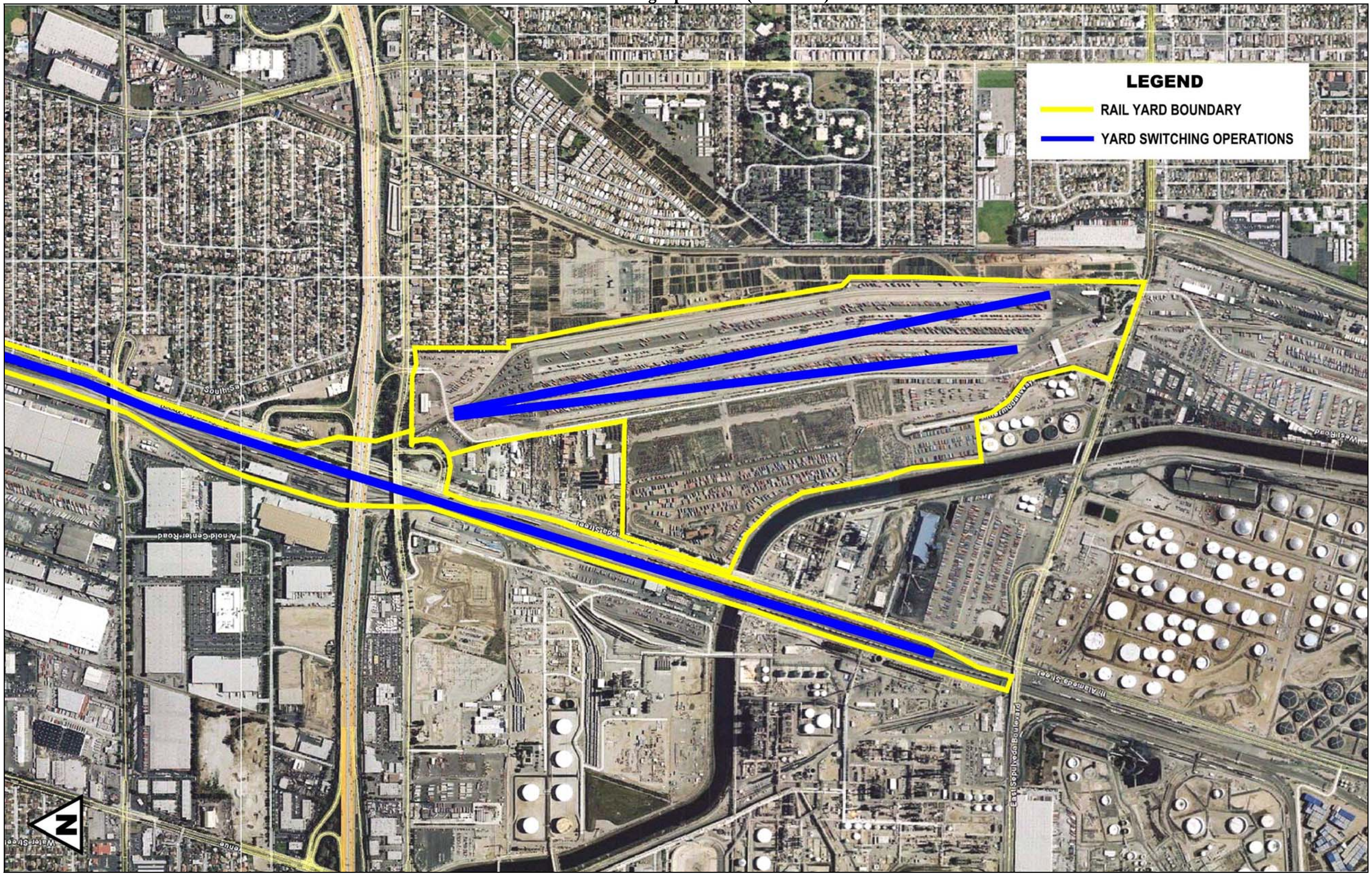


Figure 7
Consist Movement and Load Testing

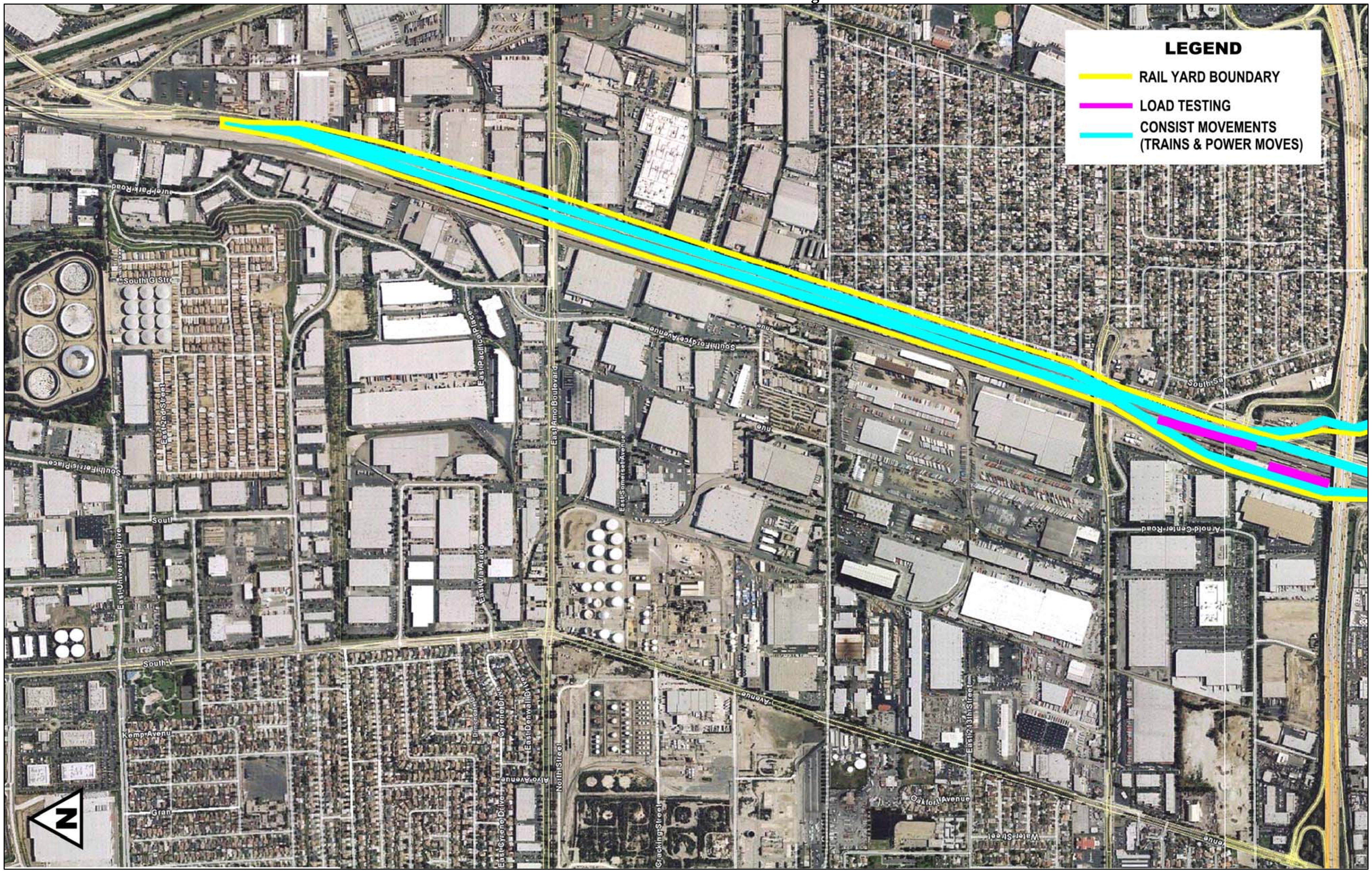
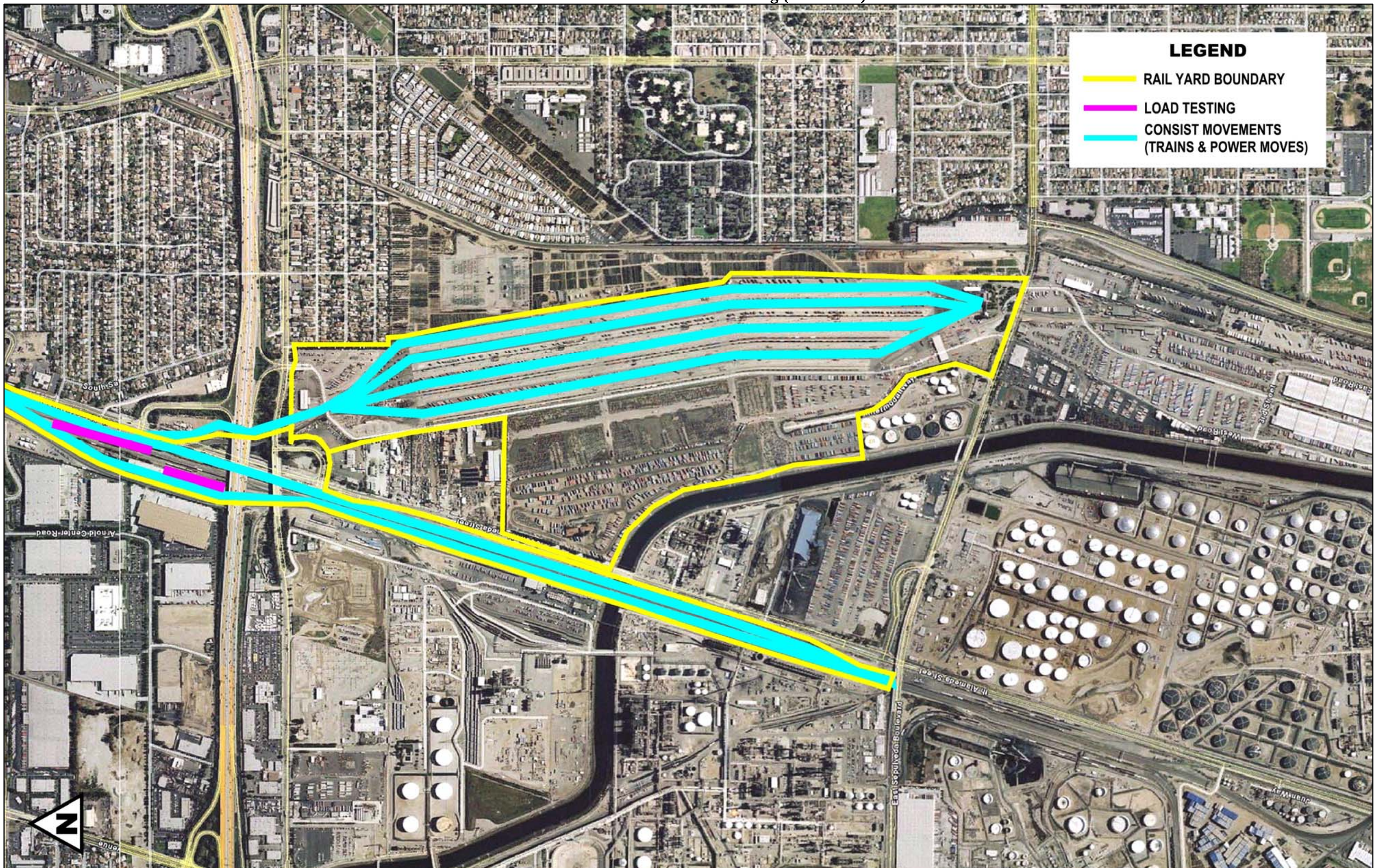


Figure 7
Consist Movement and Load Testing (continued)



Standard AERMOD control parameters were used, including stack-tip downwash, non-screening mode, non-flat terrain, and sequential meteorological data check. Following USEPA guidance, the stack-tip downwash option adjusted the effective stack height downward following the methods of Briggs (1972) for stack exit velocities less than 1.5 times the wind speed at stack top.

Two AERMET preprocessors (Stages 1 and 2, and Stage 3) were used by ENVIRON [43] to prepare meteorological data for use in AERMOD. Albedo, surface roughness, and Bowen ratio[44] were estimated in multiple wind direction sectors surrounding the Yard.

As suggested by USEPA (2000), for purposes of determining albedo and Bowen ratio the surface characteristics were specified in sectors no smaller than a 30-degree arc. Specifying surface characteristics in narrower sectors becomes less meaningful because of expected wind direction variability during an hour, as well as the encroachment of characteristics from the adjacent sectors with a one-hour travel time. Use of weighted-average[45] characteristics by surface area within a 30-degree (or wider) sector made it possible to have a unique portion of the surface significantly influence the properties of the sector that it occupies. The length of the upwind fetch for defining the nature of the turbulent characteristics of the atmosphere in each sector surrounding the source location was 3 kilometers as recommended by Irwin (1978) and USEPA's *Guideline on Air Quality Models*.[46]

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[43] Because of the relative proximity of the ICTF to BNSF's Watson/Wilmington rail yard, the same Wilmington meteorological data are being used in the air dispersion modeling conducted for both rail yards under the 2005 CARB MOU. A detailed description of the methodology used to develop the meteorological data are available in the following document: ENVIRON. *Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards,* July 25, 2006.

[44] The albedo of a specified surface is the ratio of the radiative flux reflected from the surface to the radiative flux incident on the surface. Flux is the amount of energy per unit time incident upon or crossing a unit area of a defined flat plane. For example, the albedo for snow and ice varies from 80% to 85% and the albedo for bare ground from 10% to 20%. Bowen ratio is the ratio of heat energy used for sensible heating (conduction and convection) of the air above a specified surface to the heat energy used for latent heating (evaporation of water or sublimation of snow) at the surface. The Bowen ratio ranges from 0.1 for the ocean surface to more than 2.0 for deserts; negative values are also possible.

[45] Weighting was based on wind direction frequency, as determined from a wind rose.

[46] USEPA (1986), and published as Appendix W to 40 CFR Part 51 (as revised).

3. Modeling Inputs

Modeling was based on the annual average emissions for each source as discussed in Part V.A.1 above. Diurnal and/or seasonal activity scalars were applied to locomotive activities. The following profiles were used in the modeling. See Appendix A-4 for the profiles used and Appendix R for a description of the methods used to develop them.

- A seasonal/diurnal activity profile was calculated for locomotive idling based on the number of arrivals and departures in each hour of the day and the number of arriving and departing trains in each season. Each hourly factor was based on the number of arrivals and departures in that hour and the average number of departures in that hour and the following hour. This approach captures the idling times for consists prior to departure. These factors were applied to consist idling for arriving and departing trains.
- A seasonal/diurnal activity profile was calculated for in-yard locomotive movements of road power using the same approach as for idling. In this case, however, only the number of arriving and departing trains in a single hour was used for that hour's factor.
- A seasonal profile was used for switching operations based on the same seasonal profile developed for train activity. No diurnal profile was used as yard switching operations continue throughout the day.
- A seasonal profile was applied to locomotive service and load test emissions based on monthly service release data.

The volume source release heights and vertical dispersion parameters (σ_z) were those used by CARB for the Truck Stop Scenario in Appendix VII of the Diesel Risk Reduction Plan for mobile vehicles and equipment other than locomotives. For locomotives, the release height and σ_z values used were those developed by CARB for daytime and nighttime locomotive movements in the Roseville Risk Assessment modeling. Stack parameters used to create the AERMOD input file for locomotive operations are shown in Table 92. Table 93 summarizes the modeling inputs used to create the AERMOD input file for each non-locomotive source at the Yard.

Table 92
Locomotive Modeling Inputs
Dolores and ICTF Rail Yards

Source	Point/Idling Source Parameters				Volume Source Parameters		
	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Temp (° K)	σ_z (m)	σ_y[e] (m)	Release Height (m)
Locomotives (idling and load tests)[a]							
Road power at all yards-SD7x[b]	4.6	0.625	3.1	364	-	-	-
Load tests – N1[c]	4.6	0.625	8.0	420	-	-	-
Load tests – N8[c]	4.6	0.625	36.6	589	-	-	-
Yard locomotives	4.6	0.305	7.5	342	-	-	-
Locomotives (traveling)[d]							
Day[e]	-	-	-	-	2.6	20-50	5.6
Night[e]	-	-	-	-	6.79	20-50	14.6

Notes:

a. Stack parameters for stationary locomotives were taken from the CARB Roseville modeling analysis.
b. Idling road power stack parameters are those of the most prevalent locomotive model (SD-7x).
c. Load test stack parameters are those of the most prevalent locomotive model (SD-7x).
d. All locomotive movements for road power and Yard locomotives while working are the day and night volume source parameters for moving locomotives from the CARB Roseville modeling analysis.
e. Lateral dispersion coefficient (σ_y) for moving locomotive volume sources was set to values between 20 and 50 m, depending on the spacing of sources in different areas of the Yard and proximity to Yard boundaries.

Table 93
Non-Locomotive Modeling Inputs
Dolores and ICTF Rail Yards

Source	Point/Idling Source Parameters				Volume Source Parameters		
	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Temp (° K)	σ_z (m)	σ_y[c] (m)	Release Height (m)
HHD Diesel-Fueled Trucks (Drayage and Delivery)	-	-	-	-	1.39	20-50	4.15
Cranes[a]	12.5	0.13	20	644.3	-	-	-
RTGs[a]	12.5	0.13	20	644.3	-	-	-
Top Picks[b]	-	-	-	-	1.39	20-50	4.15
Forklifts[b]	-	-	-	-	1.39	20-50	4.15
Manlift[b]	-	-	-	-	1.39	20-50	4.15
Yard Hostlers[b]	-	-	-	-	1.39	20-50	4.15
TRUs and Reefer Cars	-	-	-	-	1.39	20-50	4.15
Yard Trucks	-	-	-	-	1.39	50	4.15
Diesel-Fueled IC Engines	-	-	-	-	1.39	20-50	1.829
Storage Tanks	2.438	0.152	0.001	293.15	-	-	-
Refueling Operations	-	-	-	-	1.39	20	4.15
WWTP	-	-	-	-	2.6	11.63	5.6
Steam Cleaners	-	-	-	-	1.39	20	1.829
Heater	-	-	-	-	1.39	20	4.15
Propane –Fueled Welder	-	-	-	-	1.39	20	1.829
Miscellaneous Gasoline-Fueled Equipment	-	-	-	-	1.39	20-50	1.829
Worker Vehicles	-	-	-	-	1.39	20-50	4.15

Notes:
a. Stack parameters from equipment manufacturers.
b. Low level sources treated as volume sources using the release height and vertical dispersion parameter (σ_z) from the CARB Diesel Risk Reduction Plan (Sept. 13, 2000), Appendix VII, Table 2 (Truck stop scenario).
c. Low level source lateral dispersion parameter (σ_y) set to a value between 20 and 50 meters based on spacing between sources and proximity to the Yard boundary.

4. Meteorological Data Selection

The Yard does not monitor meteorological variables on site. Surface data from the St. Peter and Paul School monitoring station in Wilmington, and cloud cover data from the Long Beach Daugherty Field station were used for this project.[47] The upper air data used in the modeling were obtained from Miramar Marine Corps Air Station.

Because rail yards, and therefore emissions from locomotives, tend to be aligned linearly along the main track routes, the directions of prevailing surface winds were important to achieve representativeness of model predictions in the near field. For longer transport distances (e.g., 1 to 10 km), surface winds were still the primary consideration, with atmospheric stability also playing an important role. Due to the relatively low release heights and limited plume rise of rail yard sources, modeled concentrations are relatively insensitive to mixing heights, temperatures, and vertical temperature and wind profiles

Based on an evaluation of available meteorological data,[48] including the above criteria for representativeness, wind speed and direction and temperature data from St. Peter and Paul School in Wilmington, cloud cover data from the Long Beach Daugherty Field station, and upper air data from Miramar Marine Corps Air Station were processed in AERMET, the meteorological preprocessor for AERMOD.

As the only one-year sequence of satisfactory surface data available, twelve months from July 1, 2005 through June 30, 2006, of meteorological data from St. Peter and Paul School were processed with AERMET. It is not expected that year-to-year variability would cause significant differences in the modeled air quality impacts. This conclusion is based on modeling sensitivity analyses that were carried out using five years of meteorological data for the Stockton area. The five annual average concentration patterns were compared with one another and with the average predictions for the full five year period. Differences between these were found to be negligible in terms of spatial concentration patterns, locations of highest concentrations, and absolute concentrations. A similar result would be expected for meteorological conditions at

[47] ENVIRON. *Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards*, Report 06-12910J, July 25, 2006.
[48] Ibid.

ICTF. At coastal locations such as ICTF, air flow patterns over the course of a year are expected to be at least as consistent as an inland location such as Stockton.

5. Model Domain and Receptor Grids

A domain size of 20 km by 20 km and coarse receptor grid of 500 m x 500 m was used for the modeling analysis. A fine grid of 50 m x 50 m surrounding the Yard was used for modeling within 300 m of the fence line. A medium-fine grid of 100 m x 100 m was used for receptors between 300 and 600 m of the fence line around the fine grid network, and a medium grid of 200 m x 200 m was used for receptor distances between 600 and 1000 m.

All receptors were identified by UTM coordinates. United States Geological Survey (USGS) 7.5 Minute digital elevation model (DEM) data were used to identify terrain heights at each receptor. Figures 8 and 9 show the outline of the Yard along with the coarse and fine receptor grids.

Sensitive receptors, consisting of hospitals, schools, day-care centers, and elder care facilities, within a 1-mile radius of the Yard, were identified. Table 94 lists the address, elevations, and UTM coordinates for each sensitive receptor. Figure 10 shows the outline of the Yard and the location of each sensitive receptor identified in Table 94.

Table 94 Sensitive Receptor Locations Dolores and ICTF Rail Yards				
Receptor	Address	Elevation (m)	UTM-E (m)	UTM-N (m)
Birney Elementary School	710 W. Spring St., Long Beach, CA 90806	6.1	388723	3741906
Broadacres Elementary School	19424 South Broadacres Ave., Carson, CA 90746	27.1	385487	3746625
Colin L Powell Academy for Success	150 Victoria St., Long Beach, CA 90805	15.2	388674	3747490
Daniel Webster Elementary School	1755 W 32nd Way, Long Beach, CA 90810	7.9	387237	3742482
Del Amo Elementary School	21228 Water St., Carson, CA 90745	7.9	385285	3744613
Dominguez Elementary School	21250 Santa Fe Ave., Carson, CA 90810	10.7	387547	3744455
Elizabeth Hudson Elementary School	2335 Webster Ave, Long Beach, CA 90810	5.5	386913	3740724
James Garfield Elementary School	2240 Baltic Ave, Long Beach, CA 90810	5.2	387694	3740521
John Muir Elementary School	3038 Delta Ave, Long Beach, CA 90810	7.0	387916	3741941
Juan Rodriguez Cabrillo High School	2001 Santa Fe Ave, Long Beach, CA 90810	4.3	387013	3740052
Mary Bethune School	2101 San Gabriel Avenue, Long Beach, CA 90810	3.7	386731	3739865
Savannah Academy	2152 W Hill St, Long Beach, CA 90810	4.9	387079	3740317
St. Lucy School	2320 Cota Ave, Long Beach, CA 90810	5.5	387396	3740537
Sutter Elementary School	5075 Daisy Ave., Long Beach, CA 90805	12.2	388889	3746000
William Logan Stephens Middle School	1830 W Columbia St, Long Beach, CA 90810	6.4	387086	3741654
First Baptist Preschool and Daycare	2679 E Carson St, Carson, CA 90810	10.1	387219	3744170
Sanders Teeny Tiny Preschool	3211 Santa Fe Ave, Long Beach, CA 90810	7.9	387501	3742404
Little Greenwood Daycare	22114 S Carlerik Ave, Long Beach, CA 90810	10.1	387307	3743616
Blessing's Child Care	1422 E Bach St, Carson, CA 90745	7.3	384552	3743731
Santa Fe Convalescent	3294 Santa Fe Ave, Long Beach, CA 90810	7.9	387523	3742527

Notes:
d. UTM Coordinates are in Zone 11, NAD 83.

Figure 8
Coarse Modeling Grid
Dolores and ICTF Rail Yards

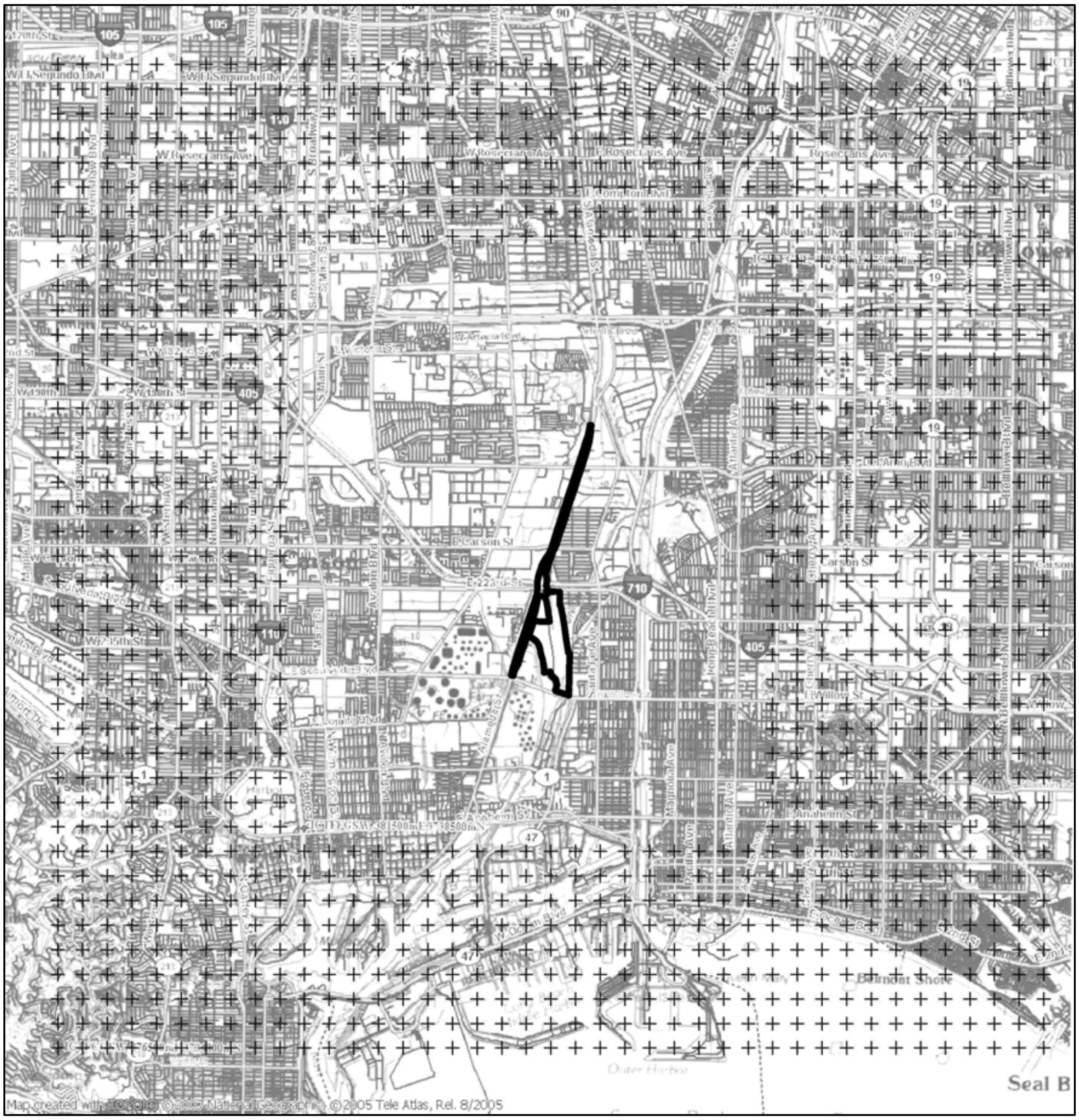


Figure 9
Fine Modeling Grid
Dolores and ICTF Rail Yards

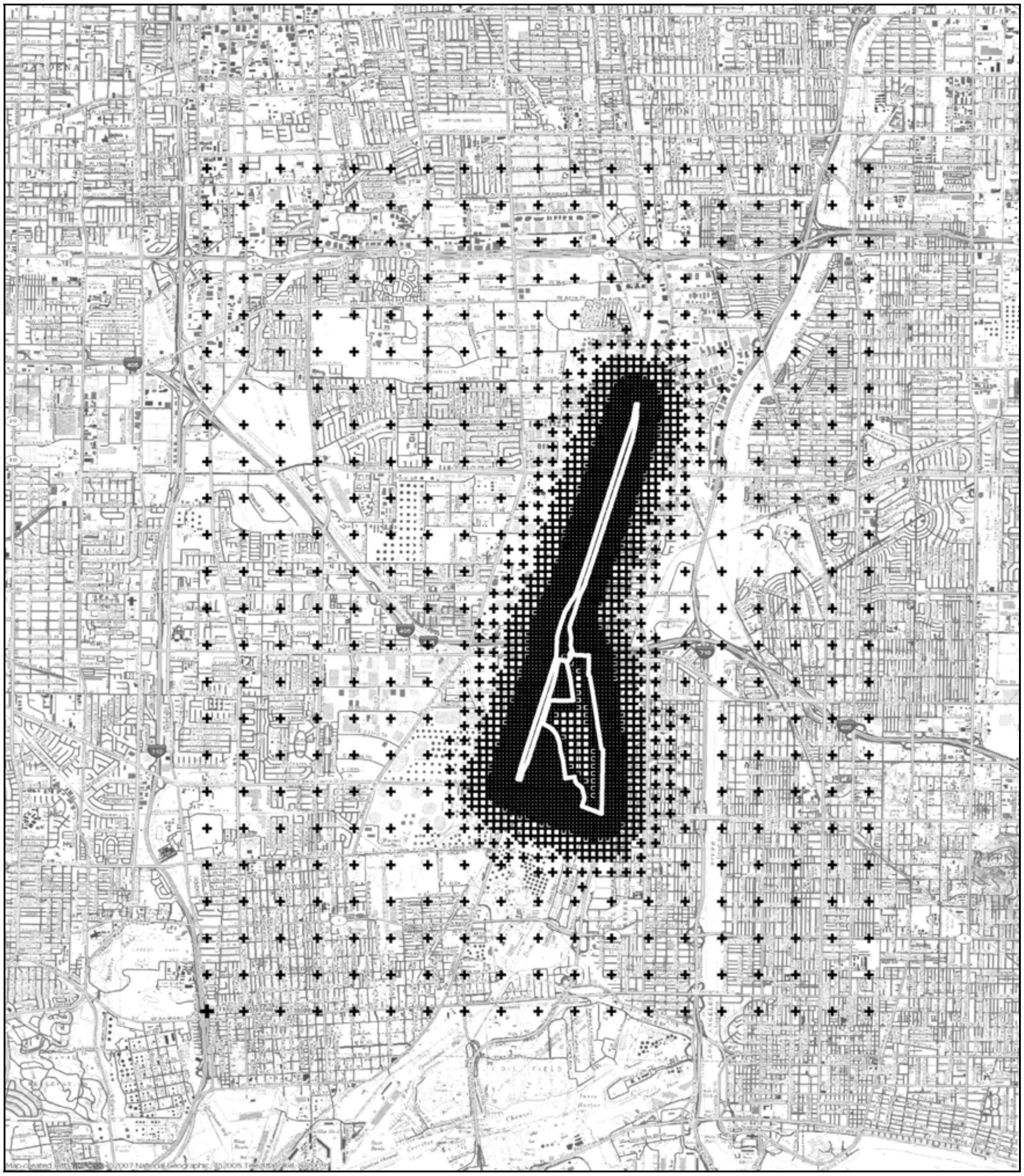
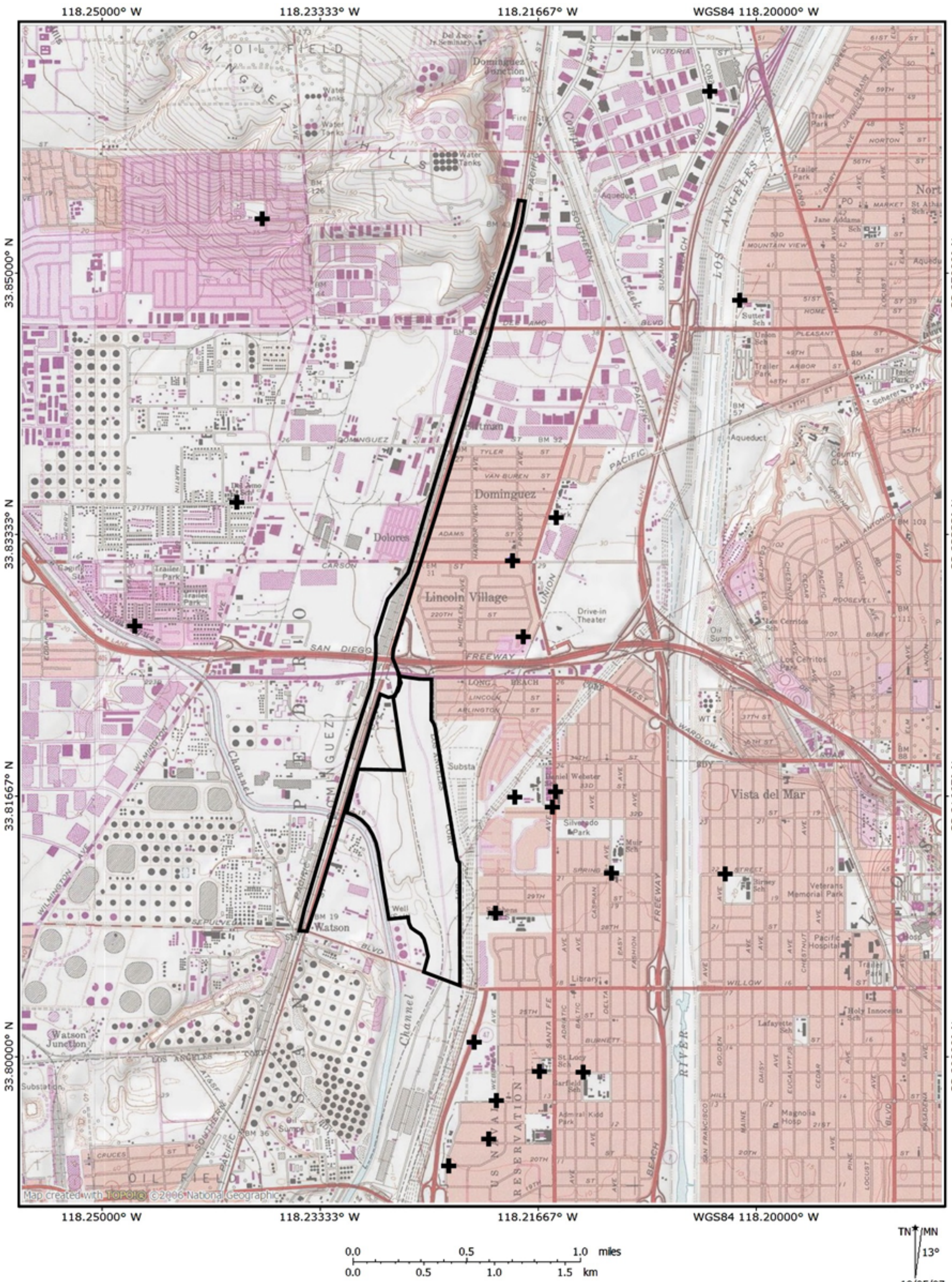


Figure 10
Sensitive Receptors
Dolores and ICTF Rail Yards



6. Dispersion Coefficients

Dispersion coefficients are used in air dispersion models to reflect the land use over which the pollutants are transported. The area surrounding the nearby BNSF Watson/Wilmington Rail Yard was divided into sectors to characterize the albedo, surface roughness and Bowen ratio[49]. These parameters were provided along with the meteorological data to the AERMET software. The resulting meteorological input file allowed AERMOD to select appropriate dispersion coefficients during its simulation of air dispersion. AERMOD also provides an urban input option to use the overall size of the Standard Metropolitan Statistical Area that contains the emission source (i.e., the Yard) in accounting for the urban heat island effect on the nocturnal convective boundary layer height. If the option is not selected, AERMOD defaults to rural dispersion coefficients. If the urban option is selected, but no surface roughness is specified (not to be confused with the surface roughness parameters already specified for sectors around the meteorological monitoring station and input to AERMET), AERMOD assigns a default "urban" surface roughness of 1 meter. For Dolores/ICTF, AERMOD was run with the urban option. If Dolores/ICTF were located further inland, based on CARB and USEPA guidance,[50] namely "*For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source,*" the population of the Los Angeles Standard Metropolitan Statistical Area (SMSA) would have been considered appropriate for determining the urban heat island effect on the nocturnal convective boundary layer height. Due to the proximity of San Pedro Bay, however, a lower population was selected to avoid overestimation of the urban heat island effect. The population of this SMSA is approximately 14,000,000, so in this case, a population of one half this value, 7,000,000 was used. The surface roughness that characterizes this area was set to the URBANOPT default of 1 m. See Appendix S for additional discussion of this issue.

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[49] As previously discussed, a meteorological data set, prepared by ENVIRON, for the BNSF Watson/Wilmington Yard was used for this project. The albedo, surface roughness, and Bowen ratio were characterized for the area surrounding the Watson/Wilmington Yard. The albedo, surface roughness, and Bowen ratio for the ICTF will be similar to those calculated for Watson/Wilmington Yard, due to the close proximity of Yards. Therefore, the parameters for the Watson/Wilmington Yard were used for this project.

[50] AERMOD Implementation Guide**,** September 27, 2005, *http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide.pdf*

7. Building Downwash

Building downwash effects were considered for the Yards. Stack-tip downwash adjusted the effective stack height downward following the methods of Briggs (1972) when the stack exit velocity was less than 1.5 times the wind speed at stack top. The locomotives are the only structures in the Yards of sufficiently large size and close enough proximity to the modeled emission sources (i.e., their own stacks) to be entered into the Building Profile Input Program (BPIP) with one set of dimensions for a "standard" locomotive (24.2 m. long x 4.0 m. wide x 4.6 m. high).

B. Modeling Results

The AERMOD input and output files have been provided to CARB in an electronic format.

C. Demographic Data

Demographic data files have been provided to CARB in an electronic format. See Appendix T for a description of the data.

PART X. REFERENCES

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APPENDIX A

LOCOMOTIVE DATA

APPENDIX A-1

LOCOMOTIVE MODEL, TIER, AND AUTO-START/STOP TECHNOLOGY FREQUENCY BY TRAIN TYPE

CONFIDENTIAL BUSINESS INFORMATION/TRADE SECRET

Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

Through IM Trains

EB arr 74

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	27	0	12	2	0	0	19	25	0	2
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	1	0	0
Tier 0	No	0	0	0	0	1	38	0	0	3	9	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	9	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	41	0	0	0	1	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	16	0	0	0	43	0	0

EB dep 74

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	26	0	13	2	0	0	19	25	0	1
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	1	0	0
Tier 0	No	0	0	0	0	1	38	0	0	3	9	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	9	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	40	0	0	0	1	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	16	0	0	0	43	0	0

WB arr 215

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	26	2	19	1	1	0	32	41	0	6
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	1	0	0
Tier 0	No	0	0	0	0	5	121	0	0	3	15	6	0
Tier 0	Yes	0	0	0	0	1	1	0	0	0	1	0	0
Tier 1	No	0	0	0	0	0	20	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	104	0	0	0	5	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	41	0	0	0	175	0	0

CONFIDENTIAL BUSINESS INFORMATION/TRADE SECRET

Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB dep	215												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	0	0	26	2	19	1	1	0	32	40	0	6
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	1	0	0
Tier 0	**No**	0	0	0	0	4	115	0	0	3	15	6	0
Tier 0	**Yes**	0	0	0	0	1	1	0	0	0	1	0	0
Tier 1	**No**	0	0	0	0	0	20	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	103	0	0	0	5	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	40	0	0	0	169	0	0

Arriving IM Trains

EB arr	0												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

EB dep	0												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB arr 3557

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	1	8	858	73	494	41	11	5	817	702	4	112
Pre Tier 0	Yes	0	2	1	0	0	0	0	0	0	62	0	0
Tier 0	No	0	0	24	1	106	2267	1	0	134	234	6	0
Tier 0	Yes	0	2	0	0	6	7	0	0	0	29	0	0
Tier 1	No	0	0	0	0	0	432	0	0	0	1	0	0
Tier 1	Yes	0	0	0	0	0	1777	0	0	0	54	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	382	0	0	0	819	0	0

WB dep 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

Departing IM Trains

EB arr 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

EB dep 2045

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	685	64	281	35	12	4	697	533	3	98
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	49	0	0
Tier 0	No	0	0	14	2	69	1601	0	0	100	193	6	0
Tier 0	Yes	0	0	0	0	2	5	0	0	0	15	0	0
Tier 1	No	0	0	0	0	0	298	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	1199	0	0	0	20	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	193	0	0	0	502	0	0

WB arr 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

WB dep 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

Through Non-IM Trains

EB arr 403

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	190	126	4	4	0	5	0	3	8	0	4
Pre Tier 0	Yes	0	202	32	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	1	0	1	7	0	0	0	6	0	0
Tier 0	Yes	5	9	0	0	1	0	0	0	0	2	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	6	0	0	0	3	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	5	0	0

EB dep 403

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	190	126	4	5	0	5	0	3	8	0	4
Pre Tier 0	Yes	0	202	32	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	1	0	1	7	0	0	0	6	0	0
Tier 0	Yes	5	9	0	0	1	0	0	0	0	2	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	6	0	0	0	3	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	5	0	0

WB arr 101

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	20	2	17	2	1	0	32	20	0	1
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	1	0	0
Tier 0	No	0	0	0	0	6	62	0	0	6	11	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	12	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	44	0	0	0	5	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	2	0	0	0	16	0	0

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Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB dep 101

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	1	20	2	17	2	1	0	32	19	0	1
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	1	0	0
Tier 0	No	0	0	0	0	6	61	0	0	6	11	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	12	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	44	0	0	0	5	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	2	0	0	0	16	0	0

Non-IM Arriving Trains

EB arr 865

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	5	465	311	2	7	0	0	0	14	6	0	6
Pre Tier 0	Yes	0	263	64	0	0	0	0	0	0	0	0	0
Tier 0	No	0	26	0	0	1	27	0	0	3	4	0	0
Tier 0	Yes	108	180	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	1	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	18	0	0	0	1	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	3	0	0

EB dep 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB arr	2145												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	2	509	934	43	775	9	46	2	219	198	0	33
Pre Tier 0	**Yes**	0	289	70	0	1	0	0	0	0	8	0	0
Tier 0	**No**	0	20	15	0	183	374	1	0	37	112	48	0
Tier 0	**Yes**	166	245	0	0	6	1	0	0	0	40	0	0
Tier 1	**No**	0	0	0	0	0	73	0	0	0	3	0	0
Tier 1	**Yes**	0	0	0	0	0	275	0	0	0	129	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	19	0	0	0	42	0	0

WB dep	0												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

Non-IM Departing Trains

EB arr	0												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

EB dep 1824

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	3	519	803	13	869	11	44	1	107	127	0	21
Pre Tier 0	**Yes**	0	281	73	0	0	0	0	0	0	5	0	0
Tier 0	**No**	0	20	12	0	213	260	0	0	18	91	50	0
Tier 0	**Yes**	153	254	0	0	5	2	0	0	0	30	0	0
Tier 1	**No**	0	0	0	0	0	58	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	203	0	0	0	114	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	25	0	0	0	62	0	0

WB arr 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

WB dep 865

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	6	469	316	3	6	2	0	0	16	9	0	6
Pre Tier 0	**Yes**	0	269	69	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	28	0	0	1	44	0	0	2	7	0	0
Tier 0	**Yes**	107	181	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	3	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	34	0	0	0	1	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	3	0	0	0	7	0	0

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Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

Power Moves Through

EB arr 17

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	14	2	8	0	0	0	1	2	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	1	8	1	0	0	3	1	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	1	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	3	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	5	0	0

EB dep 17

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	13	2	8	0	0	0	1	2	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	6	1	0	0	3	1	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	3	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	5	0	0

WB arr 7

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	4	0	0	0	1	4	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	3	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	2	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	2	0	0

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Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB dep	7												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	0	0	0	0	4	0	0	0	1	4	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	0	3	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	2	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	2	0	0

Power Moves Arriving

EB arr	0												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

EB dep	0												
Technology	**ZTR/AESS**	**Switch**	**GP3x**	**GP4x**	**GP50**	**GP60**	**SD7x**	**SD90**	**Dash7**	**Dash8**	**Dash9**	**C60A**	**Unknown**
Pre Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

CONFIDENTIAL BUSINESS INFORMATION/TRADE SECRET

Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB arr 237

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	2	135	9	76	4	7	1	82	73	0	12
Pre Tier 0	Yes	0	2	0	0	0	0	0	0	0	5	0	0
Tier 0	No	0	0	6	0	12	174	1	0	19	26	0	0
Tier 0	Yes	1	1	0	0	1	3	0	0	0	3	0	0
Tier 1	No	0	0	0	0	0	24	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	144	0	0	0	14	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	26	0	0	0	51	0	0

WB dep 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

Power Moves Departing

EB arr 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix A-1

Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

EB dep 424

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	9	201	16	174	4	8	2	113	83	3	22
Pre Tier 0	Yes	0	5	6	0	1	0	0	0	0	8	0	0
Tier 0	No	0	1	9	0	31	242	2	0	23	52	2	0
Tier 0	Yes	2	2	0	0	1	1	0	0	0	22	0	0
Tier 1	No	0	0	0	0	0	42	0	0	0	4	0	0
Tier 1	Yes	0	0	0	0	0	193	0	0	0	84	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	28	0	0	0	86	0	0

WB arr 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

WB dep 0

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX A-2

LOCOMOTIVE MODEL DISTRIBUTION
BY TRAIN TYPE GROUPS

CONFIDENTIAL BUSINESS INFORMATION/TRADE SECRET

Appendix A2
Locomotive Model Distribution by Train Type Groups

All Intermodal Trains and Power Moves

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	**No**	0.00005	0.00099	0.10115	0.00863	0.05551	0.00452	0.00203	0.00062	0.09158	0.07604	0.00052
Pre Tier 0	**Yes**	0.00000	0.00047	0.00036	0.00000	0.00005	0.00000	0.00000	0.00000	0.00000	0.00655	0.00000
Tier 0	**No**	0.00000	0.00005	0.00275	0.00016	0.01169	0.23151	0.00026	0.00000	0.01466	0.02765	0.00109
Tier 0	**Yes**	0.00016	0.00026	0.00000	0.00000	0.00057	0.00088	0.00000	0.00000	0.00000	0.00364	0.00000
Tier 1	**No**	0.00000	0.00000	0.00000	0.00000	0.00000	0.04293	0.00000	0.00000	0.00000	0.00026	0.00000
Tier 1	**Yes**	0.00000	0.00000	0.00000	0.00000	0.00000	0.18000	0.00000	0.00000	0.00000	0.00925	0.00000
Tier 2	**No**	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 2	**Yes**	0.00000	0.00000	0.00000	0.00000	0.00000	0.03566	0.00000	0.00000	0.00000	0.08748	0.00000

WB Departing and EB Arriving Freight Trains

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	**No**	0.00296	0.30280	0.20286	0.00242	0.00458	0.00054	0.00135	0.00000	0.00889	0.00620	0.00000
Pre Tier 0	**Yes**	0.00000	0.19774	0.04445	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 0	**No**	0.00000	0.01455	0.00027	0.00000	0.00081	0.02101	0.00000	0.00000	0.00135	0.00458	0.00000
Tier 0	**Yes**	0.05927	0.09968	0.00000	0.00000	0.00027	0.00000	0.00000	0.00000	0.00000	0.00054	0.00000
Tier 1	**No**	0.00000	0.00000	0.00000	0.00000	0.00000	0.00108	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 1	**Yes**	0.00000	0.00000	0.00000	0.00000	0.00000	0.01562	0.00000	0.00000	0.00000	0.00135	0.00000
Tier 2	**No**	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 2	**Yes**	0.00000	0.00000	0.00000	0.00000	0.00000	0.00081	0.00000	0.00000	0.00000	0.00404	0.00000

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Appendix A2
Locomotive Model Distribution by Train Type Groups

EB Departing and WB Arriving Freight Trains

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.00052	0.10732	0.18342	0.00605	0.17340	0.00230	0.00950	0.00031	0.03737	0.03602	0.00000
Pre Tier 0	Yes	0.00000	0.05951	0.01493	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00146	0.00000
Tier 0	No	0.00000	0.00418	0.00282	0.00000	0.04197	0.07266	0.00010	0.00000	0.00637	0.02234	0.01023
Tier 0	Yes	0.03330	0.05209	0.00000	0.00000	0.00115	0.00031	0.00000	0.00000	0.00000	0.00731	0.00000
Tier 1	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.01493	0.00000	0.00000	0.00000	0.00031	0.00000
Tier 1	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.05449	0.00000	0.00000	0.00000	0.02589	0.00000
Tier 2	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 2	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.00480	0.00000	0.00000	0.00000	0.01253	0.00000

Yard Switching

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0	1	0	0	0	0	0	0	0	0	0
Pre Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0
Tier 0	No	0	0	0	0	0	0	0	0	0	0	0
Tier 0	Yes	0	0	0	0	0	0	0	0	0	0	0
Tier 1	No	0	0	0	0	0	0	0	0	0	0	0
Tier 1	Yes	0	0	0	0	0	0	0	0	0	0	0
Tier 2	No	0	0	0	0	0	0	0	0	0	0	0
Tier 2	Yes	0	0	0	0	0	0	0	0	0	0	0

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Appendix A2
Locomotive Model Distribution by Train Type Groups

Locomotives Services

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.00000	0.00544	0.13099	0.01379	0.03507	0.00556	0.00411	0.00085	0.10256	0.07886	0.00024
Pre Tier 0	Yes	0.00000	0.00895	0.00460	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00581	0.00000
Tier 0	No	0.00000	0.00024	0.00339	0.00024	0.00955	0.21601	0.00036	0.00000	0.02008	0.03157	0.00411
Tier 0	Yes	0.00169	0.00218	0.00000	0.00000	0.00060	0.00109	0.00000	0.00000	0.00000	0.00266	0.00000
Tier 1	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.03205	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 1	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.17816	0.00000	0.00000	0.00000	0.00556	0.00000
Tier 2	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00012	0.00000
Tier 2	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.03084	0.00000	0.00000	0.00000	0.06265	0.00000

Locomotives Load Tested

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.00000	0.00715	0.12470	0.01033	0.03813	0.00794	0.00556	0.00079	0.13503	0.07943	0.00000
Pre Tier 0	Yes	0.00000	0.01033	0.00715	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00635	0.00000
Tier 0	No	0.00000	0.00000	0.00397	0.00079	0.01191	0.20492	0.00079	0.00000	0.02621	0.03574	0.00397
Tier 0	Yes	0.00000	0.00318	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00238	0.00000
Tier 1	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.02303	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 1	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.16362	0.00000	0.00000	0.00000	0.00635	0.00000
Tier 2	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 2	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.03098	0.00000	0.00000	0.00000	0.04925	0.00000

APPENDIX A-3

SAMPLE CALCULATIONS

Appendix A-3
Sample Calculations

Activity Types

Description	Activity Code	Number of Events/Year	Locomotives per Consist	Number of Setouts	Emission Factor Group	Locomotives per Consist Working	Fraction of Calif. Fuel
EB Intermodal Through	1	74	3.365	22	1	3.365	0.90
WB Intermodal Through	3	215	2.916	166	1	2.916	0.50
EB Intermodal Terminating	5	0	0.000	0	1	0.000	0.90
WB Intermodal Terminating	6	3557	2.663	0	1	2.663	0.00
EB Intermodal Originating	7	2045	3.267	35	1	3.267	0.90
WB Intermodal Originating	8	0	0.000	0	1	0.000	0.90
EB Other Through	9	403	1.548	384	2	1.548	0.90
WB Other Through	11	101	2.574	79	3	2.574	0.90
EB Other Terminating	13	865	1.751	0	2	1.751	0.90
WB Other Terminating	14	2145	2.297	0	3	2.297	0.00
EB Other Originating	15	1824	2.438	75	3	2.438	0.90
WB Other originating	16	865	1.837	1	2	1.837	0.90
EB Power Moves Through	17	17	2.941	2	1	1.500	0.90
WB Power Moves Through	19	7	2.286	0	1	1.500	0.90
EB Power Moves Terminating	21	393	3.074	0	1	1.500	0.00
WB Power Moves Terminating	22	624	3.857	0	1	1.500	0.90
EB Power Moves Originating	23	424	3.495	3	1	1.500	0.90
WB Power Moves Originating	24	1604	3.324	0	1	1.500	0.90

Note: Alameda Corridor through train activity calculated separately from ACTA gross ton-mile data for UPRR and BNSF, UPRR's system-wide fuel consumption (gallons per ton-mile), and gram per gallon emission factors for the Dolores/ICTF intermodal locomotive fleet fleet in 2005.

CONFIDENTIAL BUSINESS INFORMATION/TRADE SECRET

Appendix A-3
Sample Calculations

Emission Factors Weighted by Model/Tier/ZTR Fractions - DPM g/hr per Locomotive

Consist Groups	Group ID	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
California Fuel (221 ppm S)												
Intermodal Trains and Power Moves	1	20.58	29.05	54.30	48.10	99.01	222.45	281.58	355.98	550.94	636.84	732.27
Other Train EB Thru, EB Terminating, WB Originating	2	23.36	39.21	71.64	33.10	112.71	184.39	202.35	252.16	407.34	473.22	608.32
Other Train WB Thru, WB, Terminating, EB Originating	3	29.08	37.79	71.00	41.97	111.59	213.57	245.02	312.94	487.25	572.18	709.44
Yard Switching	4	38.00	38.00	72.00	31.00	110.00	174.13	187.48	230.17	369.15	423.51	555.15
47-State Fuel (2639 ppm S)												
Intermodal Trains and Power Moves	1	20.58	29.05	54.30	48.10	99.01	242.28	312.84	401.09	617.44	715.12	827.80
Other Train EB Thru, EB Terminating, WB Originating	2	23.36	39.21	71.64	33.10	112.71	195.87	225.31	286.88	453.66	513.91	661.64
Other Train WB Thru, WB, Terminating, EB Originating	3	29.08	37.79	71.00	41.97	111.59	229.50	272.52	354.17	544.51	631.92	785.75
Yard Switching	4	N/A -- Hump and trim sets operate on 100% California Fuel										

Note: Idle-NonZTR is the average per-locomotive idle emission rate for the fraction of locomotives not equipped with ZTR/Auto start-stop technology

Locomotive Model Distributions
Intermodal Trains and Power Moves

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	**No**	0.0001	0.0010	0.1012	0.0086	0.0555	0.0045	0.0020	0.0006	0.0916	0.0760	0.0005
Pre Tier 0	**Yes**	0.0000	0.0005	0.0004	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0066	0.0000
Tier 0	**No**	0.0000	0.0001	0.0028	0.0002	0.0117	0.2315	0.0003	0.0000	0.0147	0.0277	0.0011
Tier 0	**Yes**	0.0002	0.0003	0.0000	0.0000	0.0006	0.0009	0.0000	0.0000	0.0000	0.0036	0.0000
Tier 1	**No**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0429	0.0000	0.0000	0.0000	0.0003	0.0000
Tier 1	**Yes**	0.0000	0.0000	0.0000	0.0000	0.0000	0.1800	0.0000	0.0000	0.0000	0.0093	0.0000
Tier 2	**No**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	**Yes**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0357	0.0000	0.0000	0.0000	0.0875	0.0000

Appendix A-3
Sample Calculations

Other Train EB Thru, EB Terminating, WB Originating

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0030	0.3028	0.2029	0.0024	0.0046	0.0005	0.0014	0.0000	0.0089	0.0062	0.0000
Pre Tier 0	Yes	0.0000	0.1977	0.0445	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	No	0.0000	0.0146	0.0003	0.0000	0.0008	0.0210	0.0000	0.0000	0.0014	0.0046	0.0000
Tier 0	Yes	0.0593	0.0997	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0156	0.0000	0.0000	0.0000	0.0014	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0040	0.0000

Other Train WB Thru, WB, Terminating, EB Originating

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0005	0.1073	0.1834	0.0061	0.1734	0.0023	0.0095	0.0003	0.0374	0.0360	0.0000
Pre Tier 0	Yes	0.0000	0.0595	0.0149	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0015	0.0000
Tier 0	No	0.0000	0.0042	0.0028	0.0000	0.0420	0.0727	0.0001	0.0000	0.0064	0.0223	0.0102
Tier 0	Yes	0.0333	0.0521	0.0000	0.0000	0.0012	0.0003	0.0000	0.0000	0.0000	0.0073	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0149	0.0000	0.0000	0.0000	0.0003	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0545	0.0000	0.0000	0.0000	0.0259	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0048	0.0000	0.0000	0.0000	0.0125	0.0000

Yard Switching

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Appendix A-3
Sample Calculations

Track Segment	Segment Number	Length (mi)	
North End Inlet Lead	1	0.195189	NendIn
Through Track 1	2	0.124009	ML1
Through Track 2	3	0.283696	ML2
Through Track 3	4	0.303405	ML3
Through Track 4	5	0.243976	ML4
Through Track 5	6	0.440504	ML5
Through Track 6	7	0.080956	ML6
Through Track 7	8	0.097993	ML7
Through Track 8	9	0.200691	ML8
Through Track 9	10	0.148838	ML9
Through Track 10	11	0.181881	ML10
Through Track 11	12	0.966906	ML11
Through Track 12	13	0.121125	ML12
Through Track ICTF Lead	14	0.049832	ML2IM
ICTF Inlet 1	15	0.07547	IMin1
ICTF Inlet 2	16	0.017837	IMin2
ICTF Inlet 3	17	0.058636	IMin3
ICTF Inlet 4	18	0.040822	IMin4
ICTF Inlet 5	19	0.099582	IMin5
West IM Track Inlet	20	0.175734	IMWin
West IM Track North	21	0.575068	IMWN
West IM Track South	22	0.25826	IMWS
#2 IM Track Inlet	23	0.17154	IM2in
#2 IM Track North	24	0.583713	IM2N
#2 IM Track South	25	0.310285	IM2S
#3 IM Track Inlet	26	0.177971	IM3in
#3 IM Track North	27	0.584395	IM3N
#3 IM Track South	28	0.367938	IM3S
East IM Track Inlet	29	0.196489	IMEin
East IM Track North	30	0.59928	IMEN
East IM Track South	31	0.361993	IMES
West IM Track South Lead	32	0.236448	IMWSin
#2 IM Track South Lead	33	0.165715	IM2Sin
#3 IM Track South Lead	34	0.107509	IM3Sin
East IM Track South Lead	35	0.115646	IMESin
900 Track North Inlet	36	0.093907	900Nin
900 Track North End	37	0.256369	900N20
900 Track Center	38	0.769108	900ctr
900 Track South End	39	0.256369	900S20
900 Track to Service South Inlet	40	0.549954	9002SvcSsplt
Service South Inlet to South Service	41	0.092052	SvcSplt2SvcS
Service South Inlet to Service North Inlet	42	0.27463	SvcSSplt2NSplt
Service North Inlet to Ready Track	43	0.143631	SvcNSplt2Rdy
Ready Track to 900 Track	44	0.416487	Rdy2900
Ready Track to Through Track 6	45	0.316654	Rdy2ML6
Ready Track to 300 Track	46	0.424593	Rdy2300
Ready Track to Through Track 11	47	0.314496	Rdy2ML11

Appendix A-3
Sample Calculations

Track Segment	Segment Number	Length (mi)	
Through Track 10 to 300 Track	48	0.110429	ML102300
300 Track North End	49	0.167208	300N20
300 Track Center	50	0.501623	300ctr
300 Track South End	51	0.167208	300S20
300 Track South Lead	52	0.109795	300Sin
Adjacent Alameda Corridor 1	53	0.139525	AC1
Adjacent Alameda Corridor 2	54	0.467126	AC2
Adjacent Alameda Corridor 3	55	1.034728	AC3
Adjacent Alameda Corridor 4	56	0.114405	AC4
Adjacent Alameda Corridor 5	57	0.144254	AC5
Adjacent Alameda Corridor 6	58	0.215233	AC6
Adjacent Alameda Corridor 7	59	0.158101	AC7
Adjacent Alameda Corridor 8	60	0.029687	AC8
Adjacent Alameda Corridor 9	61	1.085783	AC9
Service South Inlet to 300 Track	62	0.296304	SvxSSplt2300
900 Track to Through Track 8	63	0.197766	9002ML8
Yard Switching - 900 Track	64	1.69741	YdOps900
Yard Switching - 300 Track N End	65	0.424593	YdOps3N
Yard Switching - IM Tracks 1	66	1.062441	YdOpsIM1
Yard Switching - IM Tracks 2	67	1.129003	YdOpsIM2
Yard Switching - 300 Track S End	68	0.836038	YdsOps3S

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
EB Intermodal Through	1	1	15	1	0.000	0.000	1.000
"	1	2	15	1	0.000	0.000	1.000
"	1	3	15	1	0.000	0.000	1.000
"	1	4	15	1	0.000	0.000	1.000
"	1	5	15	1	0.000	0.000	1.000
"	1	6	15	1	0.000	0.000	1.000
"	1	7	15	1	0.000	0.000	1.000
"	1	8	10	2	0.000	0.000	1.000
"	1	9	10	2	0.000	0.000	1.000
"	1	10	10	2	0.000	0.000	1.000
"	1	11	10	2	0.000	0.000	1.000
"	1	12	10	2	0.000	0.000	1.000
"	1	13	10	2	0.000	0.000	1.000
"	-1	38	0	2	0.000	0.500	0.000
WB Intermodal Through	3	1	15	1	0.000	0.000	1.000
"	3	2	15	1	0.000	0.000	1.000
"	3	3	15	1	0.000	0.000	1.000
"	3	4	15	1	0.000	0.000	1.000
"	3	5	15	1	0.000	0.000	1.000
"	3	6	15	1	0.000	0.000	1.000
"	3	7	15	1	0.000	0.000	1.000
"	3	8	10	2	0.000	0.000	1.000
"	3	9	10	2	0.000	0.000	1.000
"	3	10	10	2	0.000	0.000	1.000
"	3	11	10	2	0.000	0.000	1.000
"	3	12	10	2	0.000	0.000	1.000
"	3	13	10	2	0.000	0.000	1.000
"	-3	38	0	2	0.000	0.500	0.000
EB Intermodal Terminating	5	52	10	2	0.000	0.000	1.000
"	5	51	10	2	0.000	0.000	1.000
"	5	50	10	2	0.000	0.000	1.000
"	5	-49	10	2	0.000	0.000	1.000
"	5	-62	10	2	0.000	0.000	1.000
"	5	-41	10	2	0.000	0.000	1.000
WB Intermodal Terminating	6	1	10	2	0.000	0.000	1.000
"	6	2	10	2	0.000	0.000	1.000
"	6	3	10	2	0.000	0.000	1.000
"	6	4	10	2	0.000	0.000	1.000
"	6	5	10	2	0.000	0.000	1.000
"	6	6	10	2	0.000	0.000	1.000
"	6	7	10	2	0.000	0.000	1.000
"	6	8	10	2	0.000	0.000	1.000
"	6	9	10	2	0.000	0.000	1.000
"	-6	38	0	2	0.000	0.500	0.000
"	6	14	10	2	0.000	0.000	0.200
"	6	15	10	2	0.000	0.000	0.200
"	6	16	10	2	0.000	0.000	0.200
"	6	17	10	2	0.000	0.000	0.200
"	6	18	10	2	0.000	0.000	0.200
"	6	19	10	2	0.000	0.000	0.200
"	6	20	10	2	0.000	0.000	0.050
"	6	21	10	2	0.000	0.000	0.050
"	6	22	10	2	0.000	0.000	0.050

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	6	23	10	2	0.000	0.000	0.050
"	6	24	10	2	0.000	0.000	0.050
"	6	25	10	2	0.000	0.000	0.050
"	6	26	10	2	0.000	0.000	0.050
"	6	27	10	2	0.000	0.000	0.050
"	6	28	10	2	0.000	0.000	0.050
"	6	29	10	2	0.000	0.000	0.050
"	6	30	10	2	0.000	0.000	0.050
"	6	31	10	2	0.000	0.000	0.050
"	6	-32	10	2	0.000	0.000	0.050
"	6	-33	10	2	0.000	0.000	0.050
"	6	-34	10	2	0.000	0.000	0.050
"	6	-35	10	2	0.000	0.000	0.050
"	6	-20	10	2	0.000	0.000	0.050
"	6	-21	10	2	0.000	0.000	0.050
"	6	-22	10	2	0.000	0.000	0.050
"	6	-23	10	2	0.000	0.000	0.050
"	6	-24	10	2	0.000	0.000	0.050
"	6	-25	10	2	0.000	0.000	0.050
"	6	-26	10	2	0.000	0.000	0.050
"	6	-27	10	2	0.000	0.000	0.050
"	6	-28	10	2	0.000	0.000	0.050
"	6	-29	10	2	0.000	0.000	0.050
"	6	-30	10	2	0.000	0.000	0.050
"	6	-31	10	2	0.000	0.000	0.050
"	6	-32	10	2	0.000	0.000	0.050
"	6	-33	10	2	0.000	0.000	0.050
"	6	-34	10	2	0.000	0.000	0.050
"	6	-35	10	2	0.000	0.000	0.050
"	6	-19	10	2	0.000	0.000	0.200
"	6	-18	10	2	0.000	0.000	0.200
"	6	-17	10	2	0.000	0.000	0.200
"	6	-16	10	2	0.000	0.000	0.200
"	6	-15	10	2	0.000	0.000	0.200
"	6	-14	10	2	0.000	0.000	0.200
"	6	-9	10	2	0.000	0.000	0.200
"	6	-8	10	2	0.000	0.000	0.200
"	6	-40	10	2	0.000	0.000	0.200
"	6	-41	10	2	0.000	0.000	0.200
"	6	10	10	2	0.000	0.000	0.800
"	6	48	10	2	0.000	0.000	0.800
"	6	49	10	2	0.000	0.000	0.800
"	6	50	10	2	0.000	0.000	0.800
"	6	51	10	2	0.000	0.000	0.800
"	6	-52	10	2	0.000	0.000	0.800
"	6	-52	10	2	0.000	0.000	0.800
"	6	-51	10	2	0.000	0.000	0.800
"	6	-50	10	2	0.000	0.000	0.800
"	6	-49	10	2	0.000	0.000	0.800
"	6	-62	10	2	0.000	0.000	0.800
"	6	-41	10	2	0.000	0.000	0.800
EB Intermodal Originating	7	-46	10	2	0.000	0.000	0.200
"	7	49	10	2	0.000	0.500	0.200

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	7	48	10	2	0.000	0.000	0.200
"	7	10	10	2	0.000	0.000	0.200
"	7	9	10	2	0.000	0.000	0.200
"	7	8	10	2	0.000	0.000	0.200
"	7	7	15	1	0.000	0.000	0.200
"	7	6	15	1	0.000	0.000	0.200
"	7	5	15	1	0.000	0.000	0.200
"	7	4	15	1	0.000	0.000	0.200
"	7	3	15	1	0.000	0.000	0.200
"	7	2	15	1	0.000	0.000	0.200
"	7	1	15	1	0.000	0.000	0.200
"	7	-44	10	2	0.000	0.000	0.800
"	7	-39	10	2	0.000	0.000	0.800
"	7	-38	10	2	0.000	0.000	0.800
"	7	37	10	2	0.000	0.500	0.800
"	7	36	10	2	0.000	0.000	0.800
"	7	1	10	2	0.000	0.000	0.800
"	-7	38	10	2	0.000	0.500	0.000
WB Intermodal Originating	8	-41	10	2	0.000	0.000	1.000
"	8	-62	10	2	0.000	0.000	1.000
"	8	-49	10	2	0.000	0.000	1.000
"	8	-50	10	2	0.000	0.000	1.000
"	8	51	10	2	0.000	0.500	1.000
"	8	52	10	2	0.000	0.000	1.000
EB Other Through	9	1	15	1	0.000	0.000	1.000
"	9	2	15	1	0.000	0.000	1.000
"	9	3	15	1	0.000	0.000	1.000
"	9	4	15	1	0.000	0.000	1.000
"	9	5	15	1	0.000	0.000	1.000
"	9	6	15	1	0.000	0.000	1.000
"	9	7	15	1	0.000	0.000	1.000
"	9	8	10	2	0.000	0.000	1.000
"	9	9	10	2	0.000	0.000	1.000
"	9	10	10	2	0.000	0.000	1.000
"	9	11	10	2	0.000	0.000	1.000
"	9	12	10	2	0.000	0.000	1.000
"	9	13	10	2	0.000	0.000	1.000
"	-9	38	0	2	0.000	0.500	0.000
WB Other Through	11	1	15	1	0.000	0.000	1.000
"	11	2	15	1	0.000	0.000	1.000
"	11	3	15	1	0.000	0.000	1.000
"	11	4	15	1	0.000	0.000	1.000
"	11	5	15	1	0.000	0.000	1.000
"	11	6	15	1	0.000	0.000	1.000
"	11	7	15	1	0.000	0.000	1.000
"	11	8	10	2	0.000	0.000	1.000
"	11	9	10	2	0.000	0.000	1.000
"	11	10	10	2	0.000	0.000	1.000
"	11	11	10	2	0.000	0.000	1.000
"	11	12	10	2	0.000	0.000	1.000
"	11	13	10	2	0.000	0.000	1.000
"	-11	38	0	2	0.000	0.500	0.000
EB Other Terminating	13	13	10	2	0.000	0.000	0.500

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	13	12	10	2	0.000	0.000	0.500
"	13	11	10	2	0.000	0.000	0.500
"	13	10	10	2	0.000	0.000	0.500
"	13	9	10	2	0.000	0.000	0.500
"	13	63	10	2	0.000	0.000	0.500
"	13	39	10	2	0.000	0.000	0.500
"	13	38	10	2	0.000	0.000	0.500
"	13	-37	10	2	0.000	0.000	0.500
"	13	-37	10	2	0.000	0.000	0.500
"	13	-38	10	2	0.000	0.000	0.500
"	13	-39	10	2	0.000	0.000	0.500
"	13	-40	10	2	0.000	0.000	0.500
"	13	-41	10	2	0.000	0.000	0.500
"	13	52	10	2	0.000	0.000	0.500
"	13	51	10	2	0.000	0.000	0.500
"	13	50	10	2	0.000	0.000	0.500
"	13	-49	10	2	0.000	0.000	0.500
"	13	-62	10	2	0.000	0.000	0.500
"	13	-41	10	2	0.000	0.000	0.500
WB Other Terminating	14	1	15	1	0.000	0.000	0.500
"	14	2	15	1	0.000	0.000	0.500
"	14	3	15	1	0.000	0.000	0.500
"	14	4	15	1	0.000	0.000	0.500
"	14	5	15	1	0.000	0.000	0.500
"	14	6	15	1	0.000	0.000	0.500
"	14	7	15	1	0.000	0.000	0.500
"	14	8	10	2	0.000	0.000	0.500
"	14	9	10	2	0.000	0.000	0.500
"	14	10	10	2	0.000	0.000	0.500
"	14	11	10	2	0.000	0.000	0.500
"	14	48	10	2	0.000	0.000	0.500
"	14	49	10	2	0.000	0.000	0.500
"	14	50	10	2	0.000	0.000	0.500
"	14	-51	10	2	0.000	0.000	0.500
"	14	-52	10	2	0.000	0.000	0.500
"	14	-52	10	2	0.000	0.000	0.500
"	14	-51	10	2	0.000	0.000	0.500
"	14	-50	10	2	0.000	0.000	0.500
"	14	-49	10	2	0.000	0.000	0.500
"	14	-62	10	2	0.000	0.000	0.500
"	14	-41	10	2	0.000	0.000	0.500
"	14	1	10	2	0.000	0.000	0.500
"	14	36	10	2	0.000	0.000	0.500
"	14	37	10	2	0.000	0.000	0.500
"	14	38	10	2	0.000	0.000	0.500
"	14	-39	10	2	0.000	0.000	0.500
"	14	-40	10	2	0.000	0.000	0.500
"	14	-41	10	2	0.000	0.000	0.500
EB Other Originating	15	-44	10	2	0.000	0.000	1.000
"	15	-39	10	2	0.000	0.000	1.000
"	15	-38	10	2	0.000	0.000	1.000
"	15	37	10	2	0.000	0.500	1.000
"	15	1	10	2	0.000	0.000	1.000

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	-15	38	10	2	0.000	0.500	0.000
WB Other originating	16	-44	10	2	0.000	0.000	1.000
"	16	-39	10	2	0.000	0.000	1.000
"	16	39	10	2	0.000	0.500	1.000
"	16	63	10	2	0.000	0.000	1.000
"	16	9	10	2	0.000	0.000	1.000
"	16	10	10	2	0.000	0.000	1.000
"	16	11	10	2	0.000	0.000	1.000
"	16	12	10	2	0.000	0.000	1.000
"	16	13	10	2	0.000	0.000	1.000
EB Power Moves Through	17	1	15	1	0.000	0.000	1.000
"	17	2	15	1	0.000	0.000	1.000
"	17	3	15	1	0.000	0.000	1.000
"	17	4	15	1	0.000	0.000	1.000
"	17	5	15	1	0.000	0.000	1.000
"	17	6	15	1	0.000	0.000	1.000
"	17	7	15	1	0.000	0.000	1.000
"	17	8	10	2	0.000	0.000	1.000
"	17	9	10	2	0.000	0.000	1.000
"	17	10	10	2	0.000	0.000	1.000
"	17	11	10	2	0.000	0.000	1.000
"	17	12	10	2	0.000	0.000	1.000
"	17	13	10	2	0.000	0.000	1.000
"	-17	38	0	2	0.000	0.500	0.000
WB Power Moves Through	19	1	15	1	0.000	0.000	1.000
"	19	2	15	1	0.000	0.000	1.000
"	19	3	15	1	0.000	0.000	1.000
"	19	4	15	1	0.000	0.000	1.000
"	19	5	15	1	0.000	0.000	1.000
"	19	6	15	1	0.000	0.000	1.000
"	19	7	15	1	0.000	0.000	1.000
"	19	8	10	2	0.000	0.000	1.000
"	19	9	10	2	0.000	0.000	1.000
"	19	10	10	2	0.000	0.000	1.000
"	19	11	10	2	0.000	0.000	1.000
"	19	12	10	2	0.000	0.000	1.000
"	19	13	10	2	0.000	0.000	1.000
EB Power Moves Terminating	21	-52	10	2	0.000	0.000	1.000
"	21	-51	10	2	0.000	0.000	1.000
"	21	-50	10	2	0.000	0.000	1.000
"	21	-49	10	2	0.000	0.000	1.000
"	21	-62	10	2	0.000	0.000	1.000
"	21	-41	10	2	0.000	0.000	1.000
WB Power Moves Terminating	22	-1	15	1	0.000	0.000	1.000

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	22	-2	15	1	0.000	0.000	1.000
"	22	-3	15	1	0.000	0.000	1.000
"	22	-4	15	1	0.000	0.000	1.000
"	22	-5	15	1	0.000	0.000	1.000
"	22	-6	15	1	0.000	0.000	1.000
"	22	-7	15	1	0.000	0.000	1.000
"	22	-45	10	2	0.000	0.000	1.000
"	22	-41	10	2	0.000	0.000	1.000
"	22	-41	10	2	0.000	0.000	1.000
EB Power Moves Originating	23	-45	10	2	0.000	0.000	1.000
"	23	-7	15	1	0.000	0.000	1.000
"	23	-6	15	1	0.000	0.000	1.000
"	23	-5	15	1	0.000	0.000	1.000
"	23	-4	15	1	0.000	0.000	1.000
"	23	-3	15	1	0.000	0.000	1.000
"	23	-2	15	1	0.000	0.000	1.000
"	23	-1	15	1	0.000	0.000	1.000
WB Power Moves Originating	24	-47	10	2	0.000	0.000	1.000
"	24	-12	10	2	0.000	0.000	1.000
"	24	-13	10	2	0.000	0.000	1.000

Notes

(1) Segment numbers listed as negative values are in-yard power moves from arriving trains to service or from service to departing trains
(2) Non-ZTR Idling is the duration of an idle event when units without ZTR continue to idle after ZTR-equipped units have shut down
(3) Idling All is the duration of idling during which all locomotives continue to idle
(4) Fraction of Segment Moving is the fraction of the length of the segment over which the movement occurs or the fraction of events moving on this route.
(5) Intermodal terminating trains are assumed to be distributed between the 300 Track (80%) and the four intermodal tracks in ICTF (20%)
(6) 80% of departing intermodal trains are assumed to depart from the 900 Track, and the other 20% from the 300 Track
(7) 50% of other trains arriving or departing are assumed to use the 900 Track, and the other 50% use the 300 Track
(8) Negative activity code values indicate an activity and segment where setout idling occurs

Appendix A-3
Sample Calculations

Yard Operations	**Activity Code**	**Segment Number**	**Duty Cycle Number**	**Non-ZTR Idle Time (hrs)**	**ZTR Idle Time (hrs)**	**Working Time or Fraction (hrs)**
ICTF Yard Switchers - Top End	25	64	3	0	0	8.262714
"	25	66	3	0	0	5.171789
"	25	67	3	0	0	5.495802
"	25	68	3	0	0	4.069694
ICTF Yard Switchers - Bottom End	26	65	3	0	0	7.746634
"	26	68	3	0	0	15.25337
Dolores Yard Switchers	27	64	3	0	0	8.607437
"	27	65	3	0	0	2.15308
"	27	68	3	0	0	4.239483

Duty Cycles (Percent of Time by Notch)	**Duty Cycle Number**	**Idle**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Through Track North End	1	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
In Yard Movement	2	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Yard Switching	3	59.8%	0.0%	12.4%	12.3%	5.8%	3.6%	3.6%	1.5%	0.2%	0.8%

Appendix A-3
Sample Calculations

Emission Factors Weighted by Model/Tier/ZTR Fractions - DPM g/hr per Locomotive

Locomotive Model Group	Group ID	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
California Fuel (221 ppm S)												
Service	1	21.96	30.45	57.39	47.9	100.03	220.03	275.96	350.59	540.4	623.27	722.81
LoadTest	2	23.16	31.29	62.18	49.49	101.9	220.72	274.35	348.2	528.2	608.47	710.52
47-State Fuel (2639 ppm S)												
Service	1	21.96	30.45	57.39	47.9	100.03	239.56	306.61	395.05	605.63	699.85	816.91
LoadTest	2	23.16	31.29	62.18	49.49	101.9	240.94	304.75	391.96	592.43	686.25	806.85

Note: Idle-NonZTR is the average per-locomotive idle emission rate for the fraction of locomotives not equipped with ZTR/Auto start-stop technology

Service and Shop Activity

			Duration of Activity per Locomotive (minutes)											
Activity	**Number of Locomotives**	**Fraction of Calif. Fuel**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Service - Inbound	8294	0.00	0	30	0	0	0	0	0	0	0	0	0
In Service	8294	0.00	0	60	0	0	0	0	0	0	0	0	0
Service - Post Service	8294	0.90	15	30	0	0	0	0	0	0	0	0	0
Pre-Shop Idling	2815	0.90	0	30	0	0	0	0	0	0	0	0	0
Pre-Maintenance Load Test	281	0.90	0	2	0	0	0	0	0	0	0	0	8
Post-Maintenance Load Test	281	0.90	0	10	0	10	0	0	0	0	0	0	10
Quarterly Maintenance Load Test	430	0.90	0	2	0	0	0	0	0	0	0	0	8
Unscheduled Mtc Diagnostic Test	6	0.90	0	10	0	0	0	0	0	0	0	0	10
Unscheduled Mtc Post Test	777	0.90	0	15	0	0	0	0	0	0	0	0	45

Appendix A-3
Sample Calculations

Locomotive Model Distributions
Locomotives Serviced

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0054	0.1310	0.0138	0.0351	0.0056	0.0041	0.0009	0.1026	0.0789	0.0002
Pre Tier 0	Yes	0.0000	0.0090	0.0046	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0058	0.0000
Tier 0	No	0.0000	0.0002	0.0034	0.0002	0.0096	0.2160	0.0004	0.0000	0.0201	0.0316	0.0041
Tier 0	Yes	0.0017	0.0022	0.0000	0.0000	0.0006	0.0011	0.0000	0.0000	0.0000	0.0027	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0321	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1782	0.0000	0.0000	0.0000	0.0056	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0308	0.0000	0.0000	0.0000	0.0627	0.0000

Locomotives Load Tested

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0072	0.1247	0.0103	0.0381	0.0079	0.0056	0.0008	0.1350	0.0794	0.0000
Pre Tier 0	Yes	0.0000	0.0103	0.0072	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0064	0.0000
Tier 0	No	0.0000	0.0000	0.0040	0.0008	0.0119	0.2049	0.0008	0.0000	0.0262	0.0357	0.0040
Tier 0	Yes	0.0000	0.0032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0230	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1636	0.0000	0.0000	0.0000	0.0064	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0310	0.0000	0.0000	0.0000	0.0493	0.0000

Appendix A-3
Sample Calculations

Example 1 -- EB Departing Intermodal Trains

Parameter	Value
Activity Code	7
Number of Events	2045
Locomotives per Consist on Train	3.267
Number of Setouts	35
Locomotives per Consist Working During Power Moves	1.5
Emission Factor Group	1
Fraction of California Fuel	0.90

Route Followed	Activity Code	Segment Number	Length (miles)	Speed (mph)	Duty Cycle	Power Move	Non-ZTR Idle (hrs)	ZTR Idle (hrs)	Fraction of Segment Moving	Locomotive Hours Moving (Duty Cycle 1)	Locomotive Hours Moving (Duty Cycle 2)	Locomotive Hours NonZTR Idle	Locomotive Hours ZTR Idle
Ready Track to 300 Track	7	-46	0.424593	10	2	Y	0	0	0.2	0.00	56.73	0.00	0.00
300 Track North End	7	49	0.167208	10	2	N	0	0.5	0.2	0.00	22.34	0.00	3340.51
Through Track 10 to 300 Track	7	48	0.110429	10	2	N	0	0	0.2	0.00	14.76	0.00	0.00
Through Track 9	7	10	0.148838	10	2	N	0	0	0.2	0.00	19.89	0.00	0.00
Through Track 8	7	9	0.200691	10	2	N	0	0	0.2	0.00	26.82	0.00	0.00
Through Track 7	7	8	0.097993	10	2	N	0	0	0.2	0.00	13.09	0.00	0.00
Through Track 6	7	7	0.080956	15	1	N	0	0	0.2	7.21	0.00	0.00	0.00
Through Track 5	7	6	0.440504	15	1	N	0	0	0.2	39.24	0.00	0.00	0.00
Through Track 4	7	5	0.243976	15	1	N	0	0	0.2	21.73	0.00	0.00	0.00
Through Track 3	7	4	0.303405	15	1	N	0	0	0.2	27.03	0.00	0.00	0.00
Through Track 2	7	3	0.283696	15	1	N	0	0	0.2	25.27	0.00	0.00	0.00
Through Track 1	7	2	0.124009	15	1	N	0	0	0.2	11.05	0.00	0.00	0.00
North End Inlet Lead	7	1	0.195189	15	1	N	0	0	0.2	17.39	0.00	0.00	0.00
Ready Track to 900 Track	7	-44	0.416487	10	2	Y	0	0	0.8	0.00	222.60	0.00	0.00
900 Track South End	7	-39	0.256369	10	2	Y	0	0	0.8	0.00	137.02	0.00	0.00
900 Track Center	7	-38	0.769108	10	2	Y	0	0	0.8	0.00	411.07	0.00	0.00
900 Track North End	7	37	0.256369	10	2	N	0	0.5	0.8	0.00	137.02	0.00	3340.51
900 Track North Inlet	7	36	0.093907	10	2	N	0	0	0.8	0.00	50.19	0.00	0.00
North End Inlet Lead	7	1	0.195189	10	2	N	0	0	0.8	0.00	104.32	0.00	0.00
900 Track Center - Setouts	-7	38	0.769108	10	2	N	0	0.5	0	0.00	0.00	0.00	57.17
Total										*148.92*	*1215.87*	*0.00*	*6738.19*

Emission Factors	Group ID	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
Departing IM Trains - CA Fuel	1	20.6	29.1	54.3	48.1	99.0	222.5	281.6	356.0	550.9	636.8	732.3
Departing IM Trains - 47-State Fuel	1	20.6	29.1	54.3	48.1	99.0	242.3	312.8	401.1	617.4	715.1	827.8
CA Fuel Fraction Adjusted Rates		*20.6*	*29.1*	*54.3*	*48.1*	*99.0*	*224.4*	*284.7*	*360.5*	*557.6*	*644.7*	*741.8*

Appendix A-3
Sample Calculations

	Duty Cycle											
Duty Cycle Moving	1	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Weighted g/hr emissions	1	0.00	0.00	0.00	0.00	0.00	224.43	0.00	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	24.05	49.51	0.00	0.00	0.00	0.00	0.00	0.00

	Moving (Duty Cycle 1)	Moving (Duty Cycle 2)	Idle-NonZTR	Idle-All
Emission Rate (g/hr)	224.43	73.56	20.58	29.05
Locomotive Hours	148.92	1215.87	0.00	6738.19
Total Emissions (g/yr)	**33422**	**89434**	**0**	**195744**

Example 2 -- Quarterly Maintenance Load Testing

Number of Quarterly Maintenance Load Tests	430
Fraction of Calif. Fuel	0.9

Emission Factors (g/hr)	**Group ID**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Load Test - CA Fuel	2	23.16	31.29	62.18	49.49	101.90	220.72	274.35	348.20	528.20	608.47	710.52
Load Test - 47-State Fuel	2	23.16	31.29	62.18	49.49	101.9	240.94	304.75	391.96	592.43	686.25	806.85
CA Fuel Fraction Adjusted Rates		*23.16*	*31.29*	*62.18*	*49.49*	*101.90*	*222.74*	*277.39*	*352.58*	*534.62*	*616.25*	*720.15*

							Duration (minutes)					
Activity	**Number of Locomotives**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Quarterly Maintenance Load Test	430	0	2	0	0	0	0	0	0	0	0	8
Emissions (g)												
Notch-Specific		0.0	448.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41288.8

Total Emissions (g/yr)	**41737**

APPENDIX A-4

METHODOLOGY FOR ESTIMATING LOCOMOTIVE EMISSIONS AND GENERATING AERMOD EMISSION INPUTS

Appendix A-4

Methodology for Estimating Locomotive Emissions and Generating AERMOD Emission Inputs

Overview

This appendix describes the general procedures followed for developing locomotive emission inventories for the Union Pacific Railroad (UPRR) rail yards under the Memorandum of Understanding with the California Air Resources Board. It also describes the procedure by which the emission inputs are prepared for both locomotive and non-locomotive sources are used in AERMOD dispersion modeling.

EMISSION CALCULATIONS

This section describes the details of the development of activity inputs, emission factors, and emission estimates for locomotive operations. Separate procedures are followed for estimating activity associated with locomotives on trains, locomotive consist movements within a yard, service and shop activity (if occurring at a specific yard), and yard switching operations within a yard. Emission factors are developed for each of the types of locomotive activity based on the model and technology distribution of locomotives involved in each activity. Emission estimates are then developed for the activities and specific areas of a yard in which each activity occurs. The data used to calculate these emissions are included in the Appendix A-3 Excel workbook, which includes a "Sample Calculations" worksheet showing the linkages between the various activities, emission factors, and operating characteristics data.

Train Activity

Train activity data for emissions calculations include a number of separate components:

- The number of trains arriving, departing, or passing through a yard, broken down by type of train;
- The average composition of working locomotives in each consist[1], including the fraction of locomotives of different models, emissions technology tier, and automatic idling control equipment[2];
- The identification of routes followed for different types of train activities; and

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[1] The term "consist" refers to the group of locomotives (typically between one and four) that provide power for a specific train.

[2] Two types of automatic idling control equipment are in use, known as ZTR SmartStart (typically retrofit equipment on low horsepower units) and AESS (typically factory installed on newer high horsepower units). Both are programmed to automatically shut off the engines of parked idling locomotives after a specified period of time, and to restart the unit if any of a number of operating parameters (battery state, air pressure, coolant temperature, etc.) reach specified thresholds.

- Identification of the speeds and throttle settings for different types of train activities in different locations.

The primary source of information for estimating train activity is a database identifying the arrival and departure of locomotives at a specific yard. This database identifies locomotives by their ID numbers and models, the status on the train (working or not working), and the specific train to which they are connected. From these data, the total numbers of trains of different types are identified based on train symbols, train dates, train origination and termination indicators, and dates and times of arrival and departure. For each type of train and activity, the average number of locomotives per consist is calculated along with the distribution of locomotive models, emission technology tiers, and automatic idling control equipment. A separate database of UPRR locomotives is consulted based on locomotive ID to determine the tier and date of any retrofits of automatic idling controls to complete the development of these model distributions. The activity data so derived are shown on the "Activities" worksheet in the Appendix A-3 Excel workbook, and the model and technology distributions are shown on the "Consist Emissions" worksheet.

The types of trains to be identified can vary from yard to yard. For all yards, through trains (which bypass the yard itself on mainline tracks adjacent to the yard) are identified. Depending on the yard, trains entering or departing from the yard can be of several types, including:

- Intermodal trains;
- Automobile trains;
- "Manifest" or freight trains;
- Local trains; and
- Power moves.

Power moves are trains consisting only of locomotives that are either arriving at the yard to be serviced or used for departing trains, or departing from the yard to be serviced at another location or used for trains departing from another location. The routes followed by each type of train on arrival and departure are identified in consultation with UPRR yard personnel, along with estimates of average speeds and duty cycles (fraction of time spent at different throttle settings) for different areas.

Specific track subsections are identified by UTM coordinates digitized from georeferenced aerial photographs. The segments identified and their lengths are shown on the "Track Segments" worksheet of Appendix A-3. For each train type, direction, and route, a listing of track segments, segment lengths, and duty cycles is developed. Duty cycles are shown on the "Consist Emissions" worksheet of Appendix A-3, and the segment speeds, duty cycles, idling durations are shown on the "Movements and Yard Operations" worksheet. This listing, along with the number of locomotives per consist and number of trains of each type, allows the number of locomotive hours in each duty cycle to be calculated for each section of track. For arriving and departing trains, estimates of the duration of idling were developed in consultation with UPRR personnel.

These idling periods were divided into two parts: the assumed amount of time that all locomotives in a consist would idle on arrival or departure, and the amount of time that only locomotives not equipped with automatic idle controls would idle. Idling periods were assigned to a segment of the arrival or departure track one fifth of the length of the track at the appropriate end.

Service and Shop Activity

If there is a service track and/or shop at a yard, locomotives (including both road power from trains as well as yard switchers) undergo a variety of activities at these locations. If present at a yard, details of the service and shop activity, model distributions, and emission factors are shown on the “Service and Shop” worksheet of Appendix A-3. Specific locomotive activities involve idling while awaiting or undergoing routine service (cleaning, refueling, oiling, sanding, and other minor maintenance), movement and idling between service and maintenance areas, and stationary load testing associated with specific types of maintenance events. A database of service events at individual yards identifies the number of service events during the year, the locomotive ID and model, and the nature of servicing performed. Routine servicing involves periods of idling prior to and during service, and additional idling prior to movement of consists to departing trains in the yard. Estimates of the duration of idling associated with servicing are developed in consultation with UPRR personnel. As was done for trains, these idling periods were separated into two parts: the average total duration of idling by all locomotives, and the average duration of additional idling by locomotives not equipped with automatic idling controls.

The database also specifically identifies load test events and the type of maintenance with which the load testing is associated. These types include planned maintenance at different intervals (e.g., quarterly, semiannual) as well as unscheduled maintenance that may involve both diagnostic load testing prior to maintenance and post-maintenance load testing. The duration of load test events in each throttle setting depends on the equipment available and types of maintenance performed at the yard. Estimates of these durations, as well as the identification of load testing activity by type of load test and the time and duration of any additional idling and movements, are developed in consultation with UPRR personnel.

A total number of events (servicing and load testing by location and type) are developed from these data, as are locomotive model and technology distributions for all locomotives serviced and for those specific locomotives undergoing load testing (if applicable). From these event counts and durations, the total number of hours of locomotive idling and higher throttle setting operation in different portions of the service areas are calculated for each of the two model distributions.

Yard Switcher Activity

In each yard, there are routine jobs assigned to individual switchers or sets of switchers. These activities are generally not tracked from hour to hour, but they occur routinely within yard boundaries during specified work shifts. Similarly, the specific yard switcher locomotive IDs assigned to these jobs are not routinely tracked, but these yard jobs are generally assigned to a specific model of low horsepower locomotive. From the assigned yard switcher jobs and shifts, and in consultation with UPRR personnel, an estimate of the hours per day of switcher operation in a yard are developed, along with the specific times of day when these activities occur (time of day assignments were made only if operation was less than 24 hour per day). Duty cycles for switching operation are also developed in consultation with local UPRR personnel. Depending on the type of activity and type of trains being handled in a yard, duty cycle estimates may vary. In the absence of more detailed information, the USEPA switcher duty cycle is assumed to be representative of each switcher's operation[3]. The total number of locomotive hours of operation for each model are calculated and assigned to the areas in which the units work. In some cases, yard jobs are assigned to specific areas within the yard and specific models of locomotives. In these cases, the switcher activities are assigned specifically to these areas of the yard.

Emission Factor Development

The locomotive model and technology group distributions derived in the development of activity data are grouped by type or types of activity with consideration for the level and nature of the activity. For example, a single distribution is used for through trains of all types, including power moves, while consist model distributions for different types of trains within a yard may be treated as separate distributions if they are handled in different areas of a yard. As shown in Part VII of this report, model-group-specific emission factors by throttle setting were developed based on emission test data and sulfur content adjustment factors. From these emission factors and the locomotive model and technology distributions for different types of trains and activities, weighted average emission factors are calculated for the "average" locomotive for that train type or activity on a gram per hour basis. For each train type or activity, two separate idle emission rates are calculated. The first is the straight weighted average emission rate for all locomotives, while the second is the weighted average only for the fraction of locomotives without automatic idle controls. Mathematically,

$$\overline{Q}(l) = \sum_{i=1}^{11} \sum_{j=1}^{4} \sum_{k=1}^{2} F(i, j, k) \cdot Q(i, j, l)$$

for *l* corresponding to idle through N8, and

$$\overline{Q}(l^*) = \sum_{i=1}^{11} \sum_{j=1}^{4} F(i, j, 1) \cdot Q(i, j, l^*)$$

[3] USEPA (1998). Locomotive Emission Standards -- Regulatory Support Document. (Available at *www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf*).

for idling emission rate during periods when only locomotives without automatic idle controls are idling

where

$\overline{\overline{Q}}(l)$ = weighted average emission factor for throttle setting l

$Q(i,j,l)$ = the base g/hr emission factor of a particular model group/technology class and throttle setting

$F(i,j,k)$ = the fraction of locomotives of a particular model group/technology class

i = model group index (Switcher, GP-3x, etc.)

j = technology tier index (pre-Tier 0, Tier 0, Tier 1, Tier 2)

k = automatic idle control status index (with or without)

l = throttle setting (idle, N1, . . ., N8)

l^* = index for idle throttle of locomotives without automatic idle controls.

Thus, for each defined locomotive model distribution, gram per hour emission factors are generated for each throttle setting.

Emission Calculations – Locomotive Movements

From the train activity analysis, the following data are available for each segment of track: track length of segment $L(i)$; speed $V(i)$; movement duty cycle $\boldsymbol{D}(i)$ (a vector of fractions of time spent in each throttle setting); number of trains of each type $N(j)$; and number of working locomotives per consist for each train type $C(j)$. For each type of train j, there is a set of throttle-specific emission factors $Q_j(l)$ for the "average" locomotive used on that train type. If a particular type of train or consist movement can follow multiple paths within the yard, the activity is allocated to sequences of track segments representing each such path. Total annual emissions $q_{tot}(i)$ for each segment are then calculated as

$$q_{tot}(i) = \frac{L(i)}{V(i)} \cdot \sum_j N(j) \cdot C(j) \sum_l D(i,l) \cdot Q_j(l) .$$

Emission Calculations – Locomotive Idling

Locomotive idling is calculated in a similar manner for road power and locomotives in service. For each train type and for service events, activity data provide a number of annual events $N(i)$, duration of idling by locomotives with ($T_{all}(i)$) and without ($T_{nZTR}(i)$) automatic idle control, and gram per hour emission rates for the "average" locomotive $Q_{all}(i)$, and the "average" locomotive excluding those with automatic idle controls $Q_{nZTR}(i)$. Total annual emissions are calculated as

$$q_{idle} = \sum_i N(i) \cdot C(i) \cdot (T_{all}(i) \cdot Q_{all}(i) + T_{nZTR}(i) \cdot Q_{nZTR}(i)) .$$

If a particular type of activity occurs at multiple locations within the yard (e.g., on multiple arrival or departure tracks), then the idling time is allocated to different segments of track as appropriate so that segment-specific emissions are obtained.

Emission Calculations – Load Testing

Load testing emissions are calculated separately for each throttle setting (idle, N1, and N8) using the weighted average emission factors for the load-tested units, the number of load tests of different types, and the duration of testing in each throttle setting for each type of test.

Emission Calculations – Yard Switcher Operations

Activity data provide the number and model group information for yard switchers, and the number of operating hours per day. Model-group-specific emission factors are multiplied by the duty cycle to generate weighted average gram per hour emissions for idling and for combined emissions from operation in notch 1 through notch 8. Emissions are calculated directly from the number of units, hours per day working, and duty cycle weighted emission factors for both idle and non-idle throttle settings during work shifts.

AERMOD EMISSION INPUT PREPARATION

Emissions from both locomotives and from other emission sources in a yard are allocated to multiple individual point or volume sources in AERMOD inputs. In addition to each type of activity's emission rates, the locations of emissions, the release parameters, and other inputs (e.g., building downwash parameters, temporal variation in emissions, etc.) are required by AERMOD. Emission inputs are prepared sequentially for different types of activities and the areas within which they occur. The source elevation for each point or volume source is interpolated from a high-resolution terrain file.

Locomotive Movements

For each type of locomotive movement, emissions calculated for each track segment are uniformly allocated to a series of evenly spaced volume sources along that track segment. The maximum spacing between sources is specified and the number of sources to be used for each segment is calculated from the segment length. The raw emission rate value in the AERMOD inputs (g/sec) is based directly on the annual emission total for the segment divided by the number of sources on that segment. For locomotive movements, separate day and night release parameters are needed. Therefore, each source is duplicated (but with a different source ID and parameters) in the AERMOD inputs, with temporal profile inputs (EMISFACT HROFDY) that use day time parameters from 0600-1800 and night time parameters for 1800-0600.

Locomotive Idling and Load Testing

Locomotive idling and load testing emissions are allocated to track segments in the same manner as locomotive movements, but as point, rather than volume, sources. Each source location may have up to three separate sources identified, with different stack parameters used for idle, notch 1, and notch 8. Building downwash inputs are assigned from a pre-prepared set of records for a typical locomotive's dimensions and the orientation of the track segment on which the emissions occur.

Yard Switcher Operations

Yard switcher operations are allocated to areas within the yard based on the estimated time spent working in each area. As for locomotive movements, yard switcher emissions for a specific area are allocated uniformly to a number of volume sources on defined segments. Day and night operations are handled similarly to train and consist movements, with EMISFACT HROFDY records used to switch day and night volume source release parameters. Depending on their magnitude and distance from yard boundaries, the "working idling" emissions for yard switching may be added to the non-idle emissions from volume sources, or treated as a series of point sources, using stack parameters for the specific model group being used. If treated as point sources, building downwash inputs are prepared as for other locomotive idling and load testing.

APPENDIX A-5

PRINCIPLE LOCOMOTIVE ROUTES

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Appendix A-5
Through Train Routes

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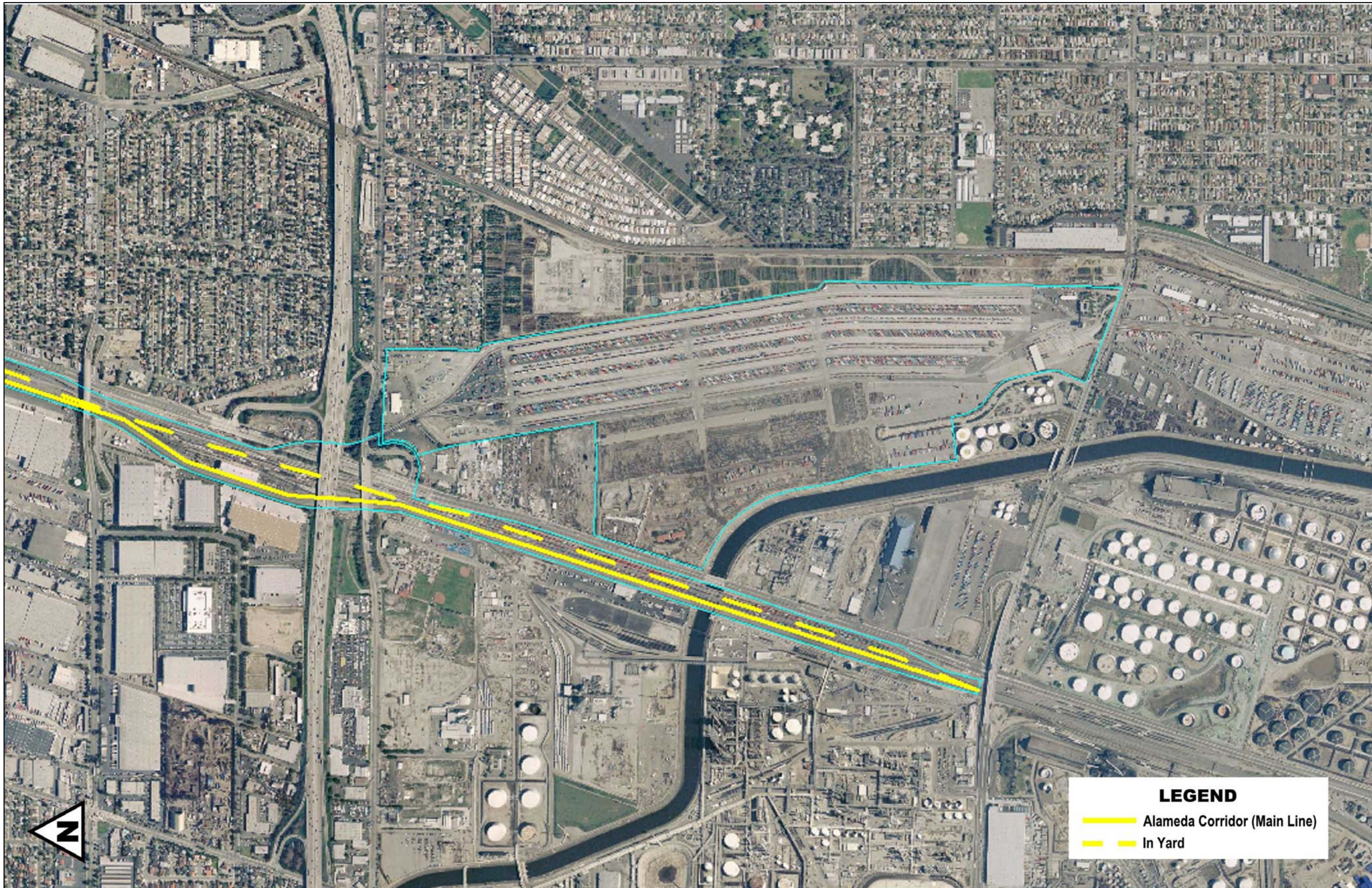
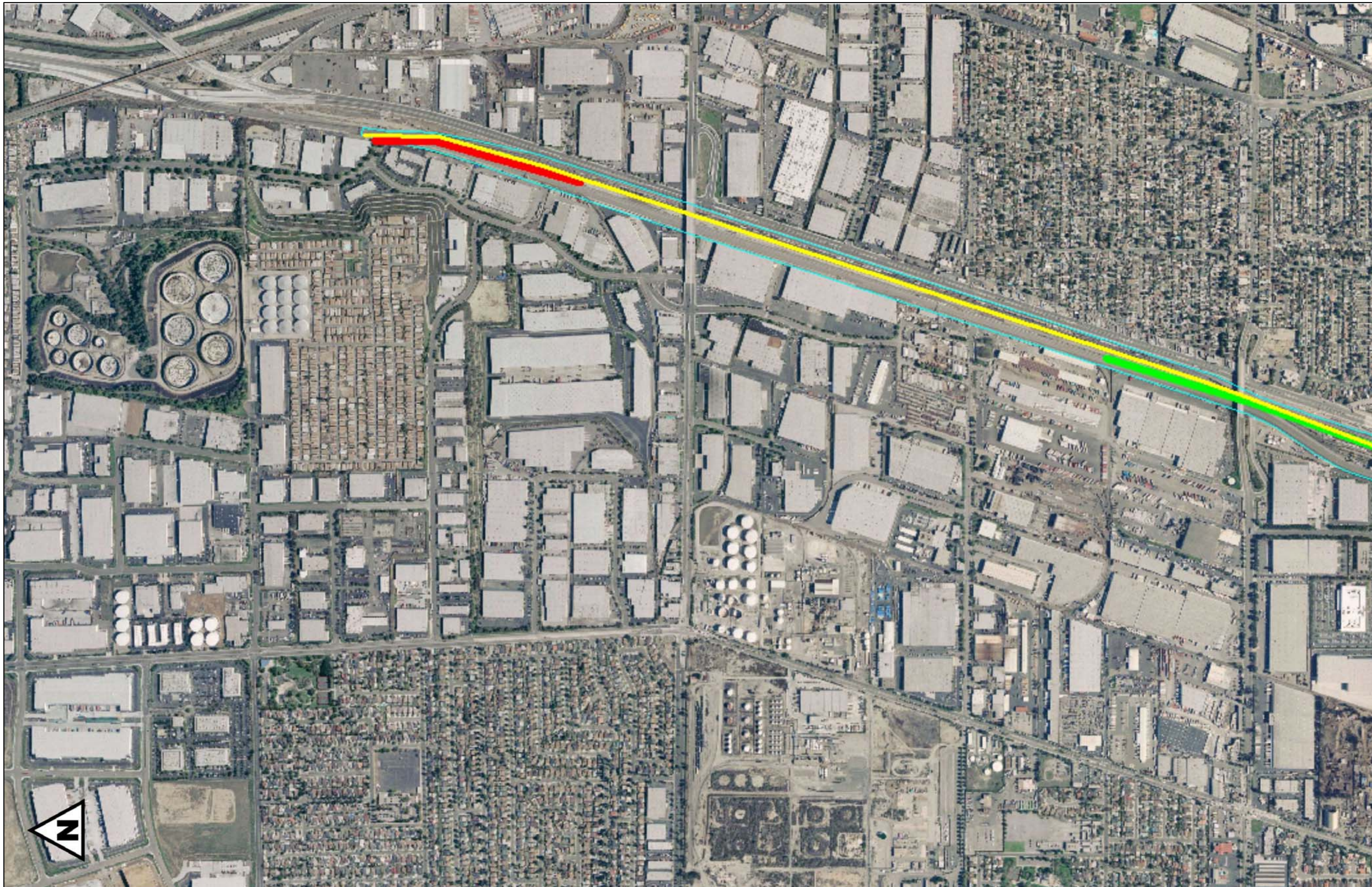
Appendix A-5
Through Train Routes (continued)



CONFIDENTIAL BUSINESS INFORMATION/TRADE SECRET

Appendix A-5
Departing Train Routes



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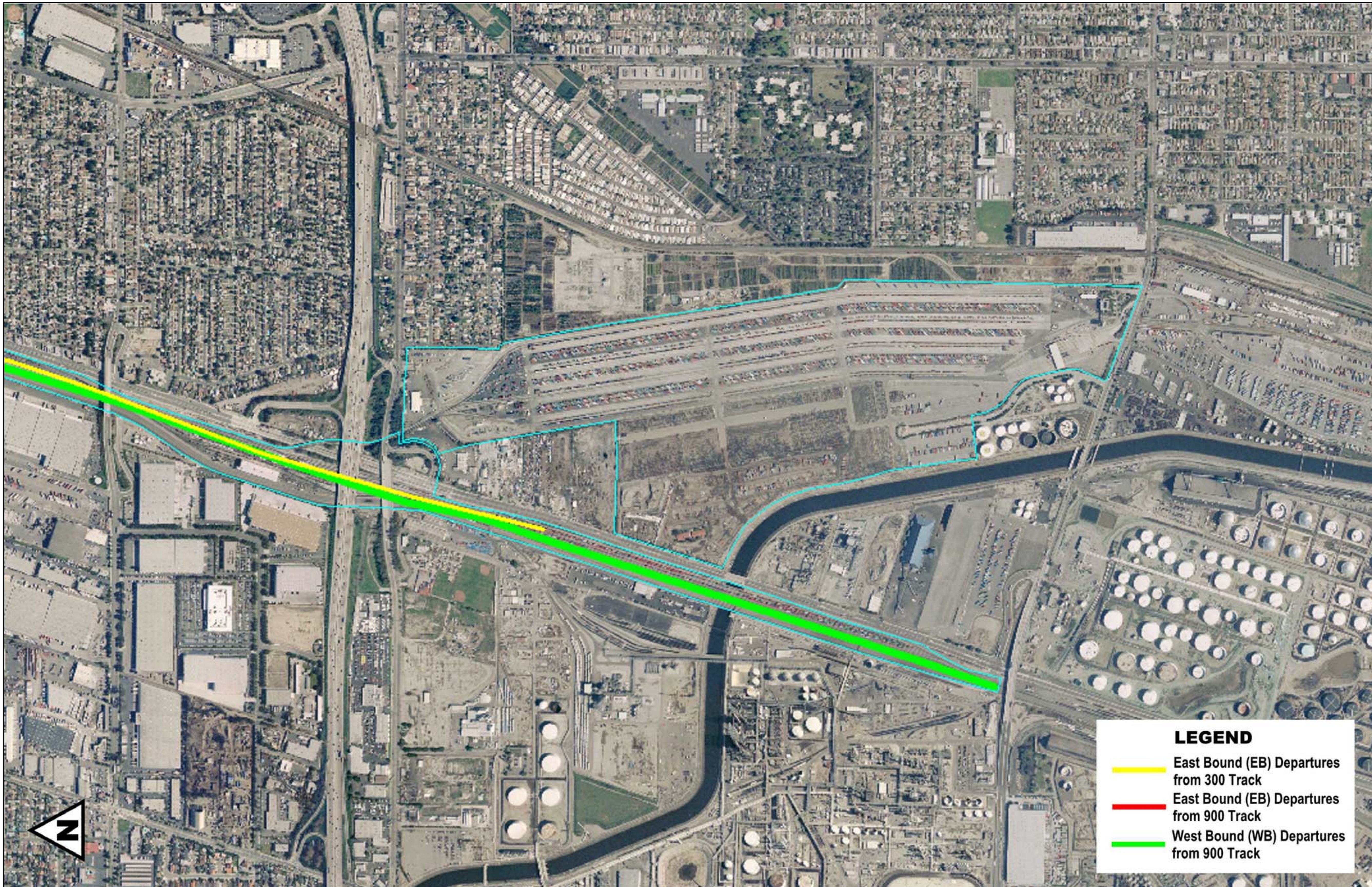
Appendix A-5
Departing Train Routes (continued)



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Appendix A-5
Arriving Intermodal Train Routes

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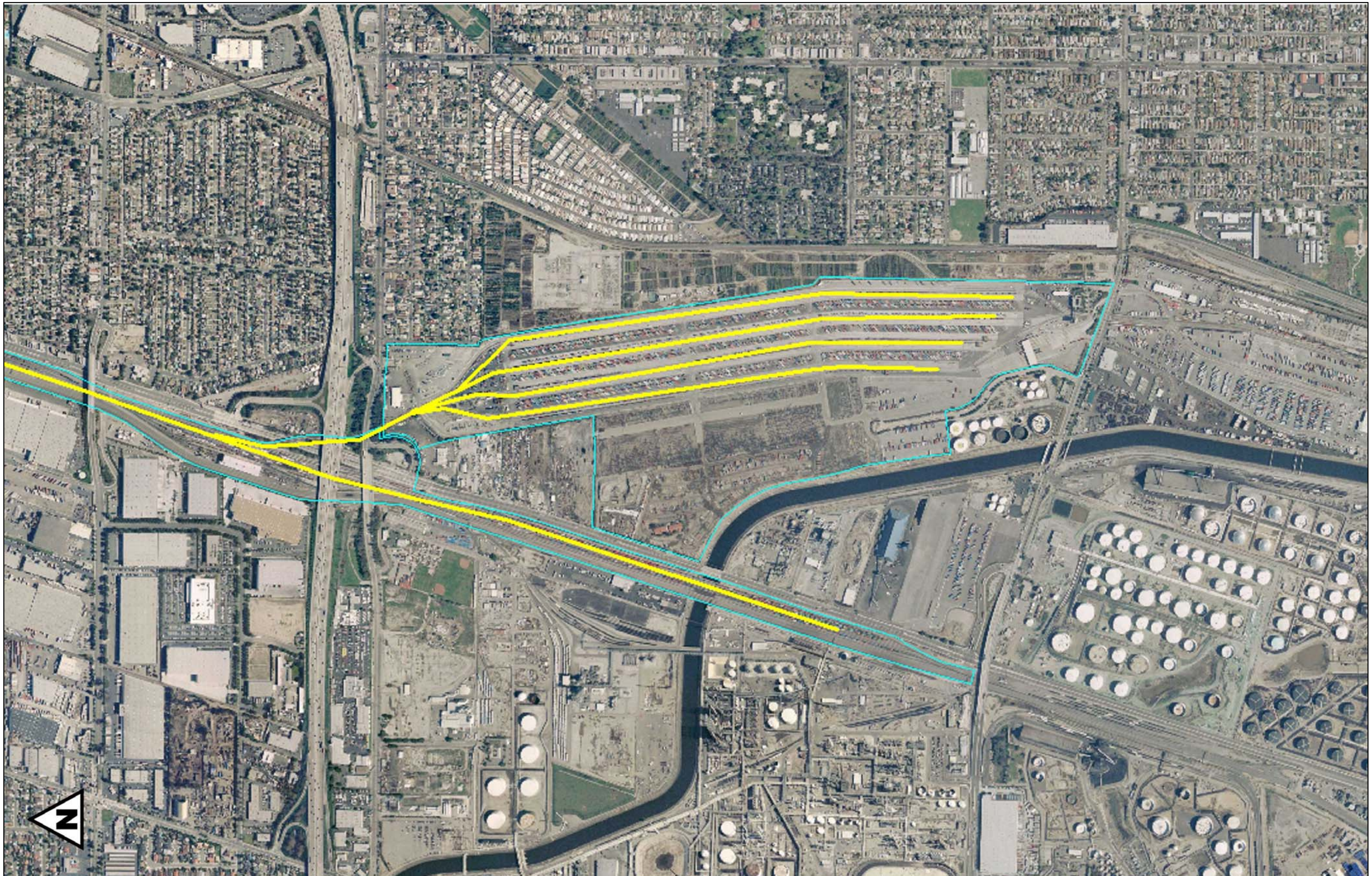
Appendix A-5
Arriving Intermodal Train Routes (continued)



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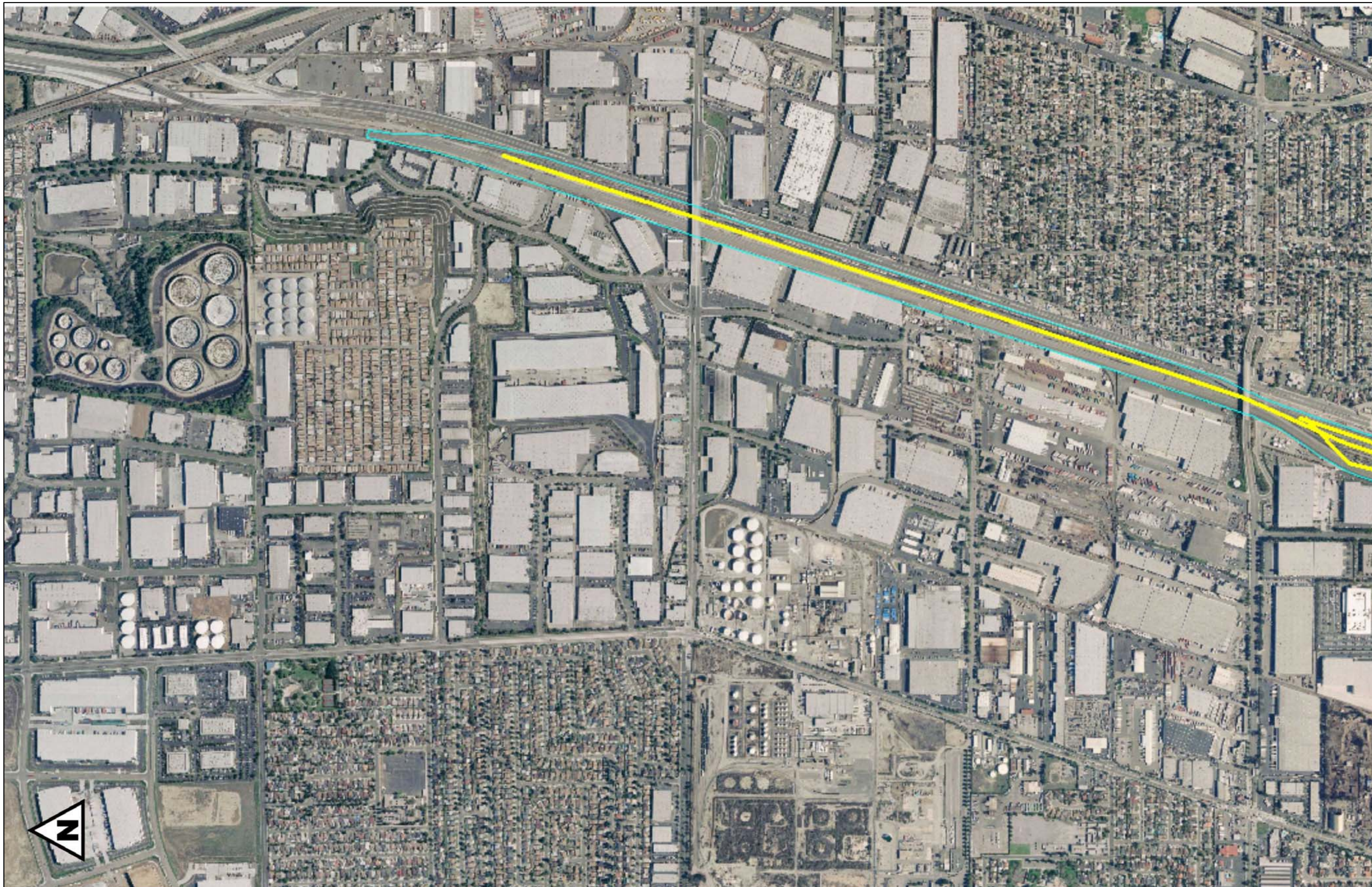
Appendix A-5
Consist Power Move Routes



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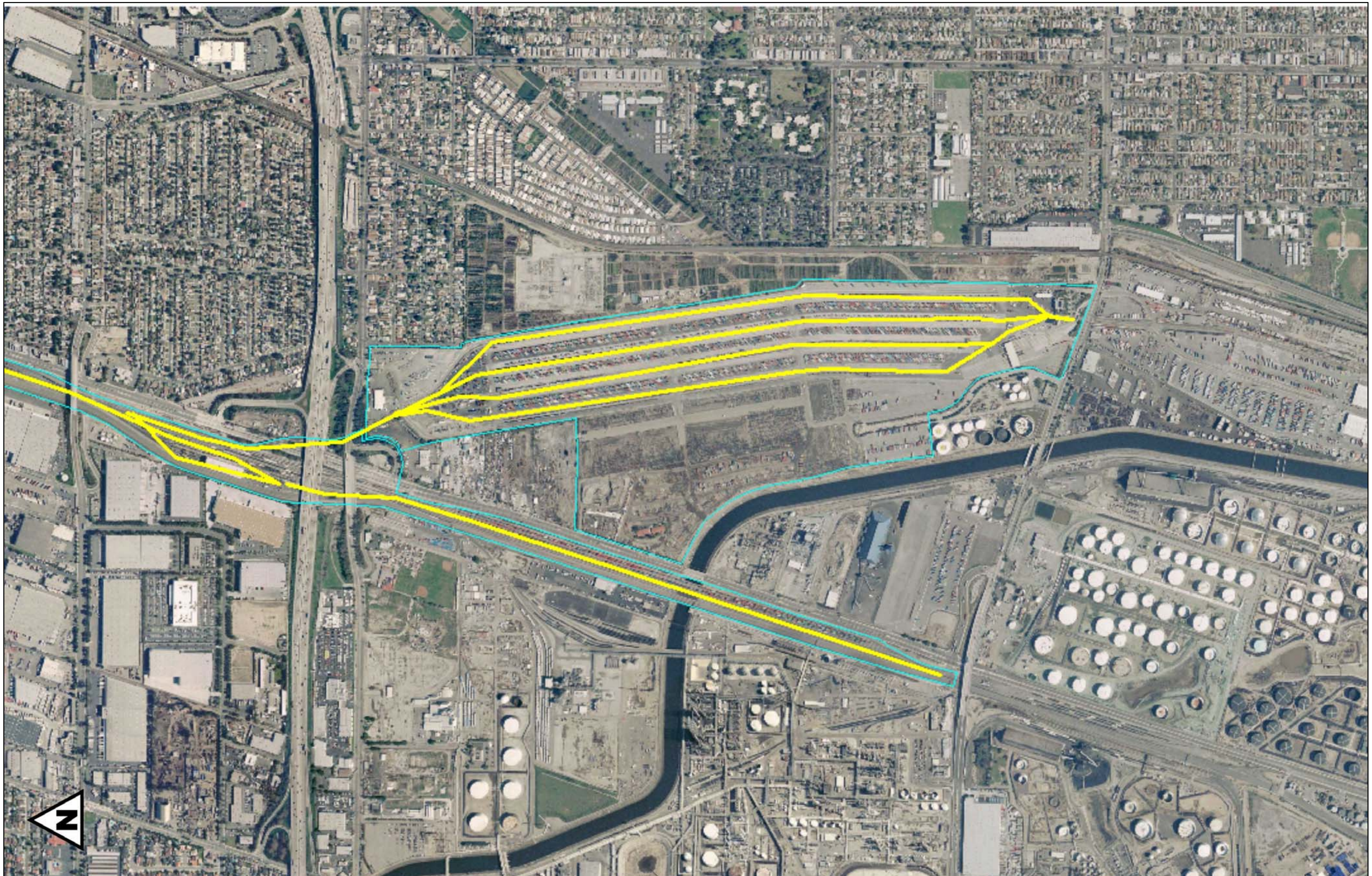
Appendix A-5
Consist Power Move Routes (continued)



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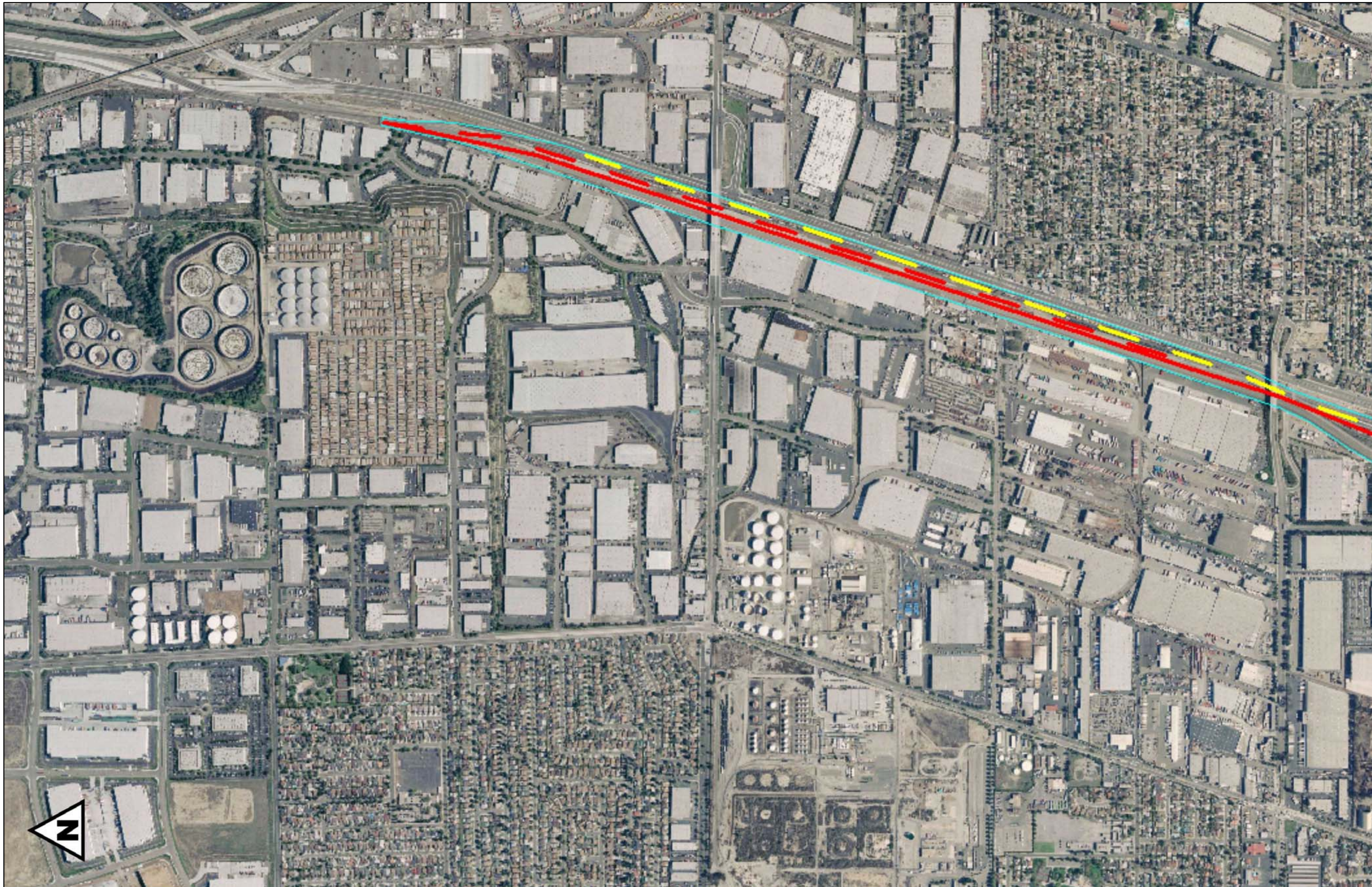
Appendix A-5
Arriving Non-Intermodal Train Routes



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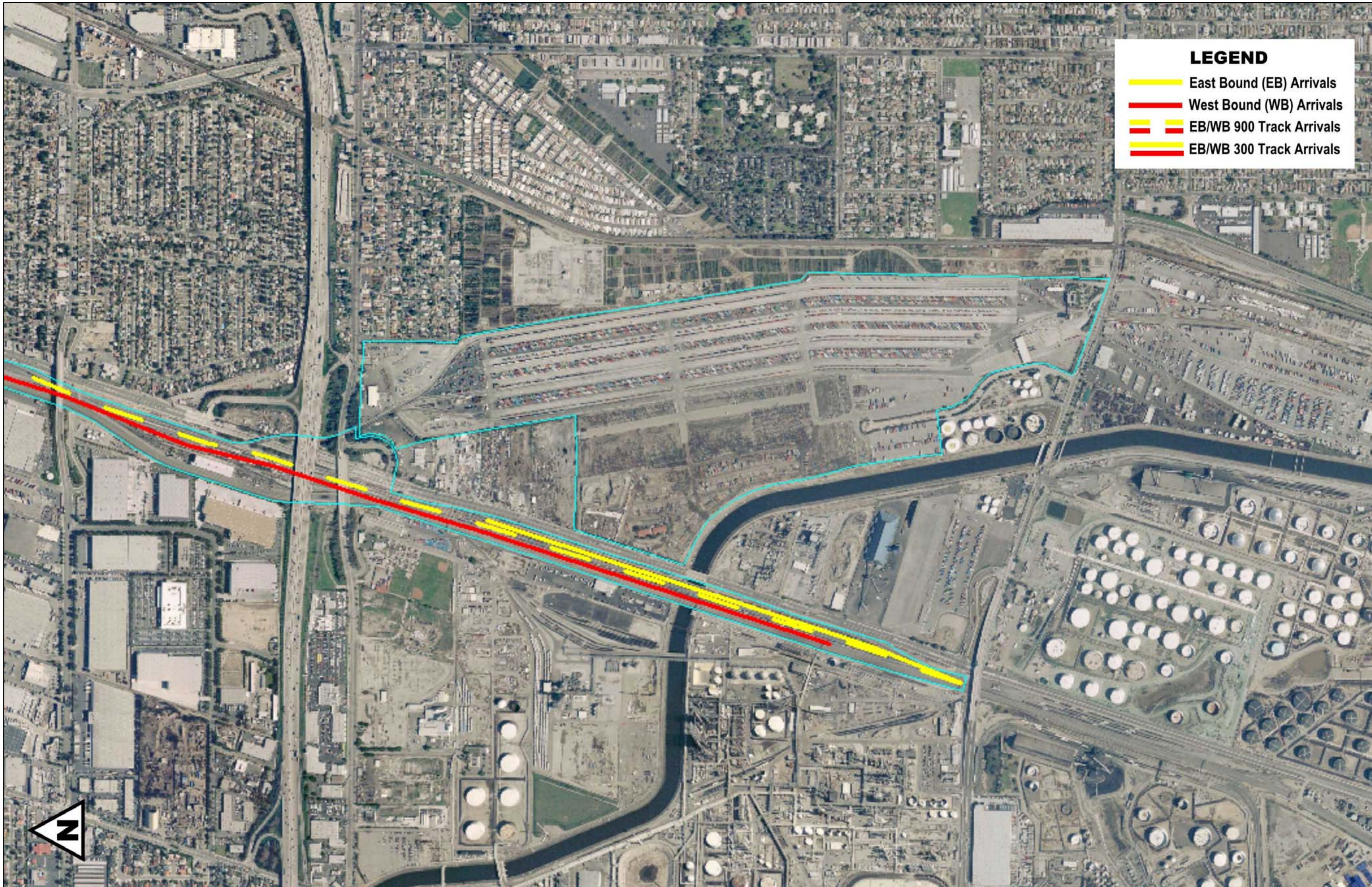
Appendix A-5
Arriving Non-Intermodal Train Routes (continued)



APPENDIX A-6

IRESON ET AL

Development of Detailed Railyard Emissions to Capture Activity, Technology and Operational Changes

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ABSTRACT

Railyard operations involve a variety of complex activities, including inbound and outbound train movements, classification (i.e., separating cars from inbound trains for redirection to multiple destinations, and building new trains), and servicing locomotives. Standard locomotive duty cycles provide long-term average activity patterns for locomotive operations, but they are not appropriate for the specialized activities that occur within railyards or at locations such as ports, and emission densities in such areas can be high relative to those of line haul activities. There are significant emission rate differences between locomotive models, and differences in the types of service for which specific models are used. Data for throttle-specific emissions, activity levels, and locomotive models and operating practices can be used to provide more accurate emissions estimates for such operations. Such data are needed to quantify actual emissions changes in these high activity areas. A calculation scheme has been developed to generate detailed emission inventories based on the types of data that are collected for managing rail operations. This scheme allows improved accuracy in emissions estimation, and also provides a more reliable basis for bottom-up tracking of emissions changes over time. Factors that can be addressed include: changes in the distribution of locomotive models and control technology levels (e.g., increasing fractions of Tier 0, 1, and 2 locomotives) for both line haul and local operations; actual in-yard idling duration and reductions associated with auto-start-stop technologies; fuel quality effects; and detailed operating practices for switching and train-building operations. By providing detailed disaggregation of activity and emissions data, the method also makes it possible to quantify and evaluate the effects of specific emission reduction alternatives.

INTRODUCTION

Freight movement by rail is a key component of the U.S. transportation infrastructure. The combination of rail's low rolling resistance and the fuel-efficient turbocharged diesel engines used in modern locomotives make rail the most efficient mode of transport from both an emissions and economic perspective. Railyards located strategically through the nation's rail network are used to assemble and direct goods movement to their destinations. Railyards may handle dozens of trains per day, each powered by a "consist" of several locomotives. While in railyards, these locomotives are serviced and regrouped into new consists as needed for specific departing trains. In addition to train arrivals and departures and locomotive servicing, so-called "classification" yards separate rail cars in inbound trains into segments with different destinations, and build new trains with a common destination. This work is accomplished by switcher locomotives (typically of lower horsepower than the locomotives used for "line-haul" operations). Some railyards also have major locomotive repair facilities whose activities include load testing of locomotives prior to or after maintenance. Collectively, the locomotive operations associated with these activities can result in relatively high localized emission densities.

The Union Pacific Railroad (UPRR) is the largest railroad in North America, operating throughout the western two-thirds of the United States. It operates a number of railyards throughout its system, including the J. R. Davis Yard in Roseville, California. The Davis Yard is UPRR's largest classification yard in the western U.S. It is approximately one-quarter mile wide and four miles long, and is visited by over 40,000 locomotives per year. The California Air Resources Board (CARB) recently completed a detailed dispersion modeling study to estimate concentrations of diesel particulate matter in the vicinity of the railyard.[1] UPRR cooperated closely with CARB in this study, including the identification, retrieval and analysis of data needed to assemble a detailed emission inventory for railyard operations. This effort produced the most detailed emission inventory for railyard operations to-date, including empirically developed train counts, locomotive model distributions, locomotive service and maintenance activities, and dedicated on-site switching operations. The results of this effort have been further adapted to allow UPRR to track the effect of locomotive fleet modernization, freight volume, and operational changes on emissions, and to identify opportunities for further emission reductions at the Davis Yard.

RAILYARD ACTIVITY ESTIMATION

At state and national levels, locomotive emissions have been estimated using locomotive fleet population data and average locomotive emission factors, expressed in g/bhp-hr, in conjunction with fuel efficiency estimates and fuel consumption. For freight locomotives, the emission factors are typically derived using both a switching duty cycle and a line haul duty cycle, each of which gives the fraction of operating time locomotives spend at different throttle settings, referred to as notch positions.[2] These throttle settings (see Table 1) include idle, notches 1 through 8, and dynamic braking (in which the locomotive traction motors are used to generate power which is dissipated through resistor grids). While this approach can provide reasonable estimates for larger regions, neither the overall locomotive fleet composition nor the standard duty cycles accurately reflect the specific activities that occur within an individual railyard. The g/bhp-hr emission factors vary substantially between throttle settings and between locomotive models. Other confounding factors include: speed limits within yards (which preclude the high throttle settings used for line-haul activity outside of yards); locomotive load (consists commonly move within yards with only one locomotive pulling and no trailing cars); and time spent either shut down or idling. Classification activities are carried out with duty cycles that are unique to yard operations and may vary from yard to yard. To develop more accurate emissions estimates, it is necessary to explicitly identify railyard activities at the level of individual locomotives.

Table 1. Locomotive Duty Cycles.

	Throttle Position (Percent Time in Notch)									
Duty Cycle	**D.B.**	**Idle**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
EPA Line-Haul	12.5	38.0	6.5	6.5	5.2	4.4	3.8	3.9	3.0	16.2
EPA Switch	0.0	59.8	12.4	12.3	5.8	3.6	3.6	1.5	0.2	0.8
Trim Operations	0.0	44.2	5.0	25.0	2.3	21.5	1.5	0.6	0.0	0.0
Hump Pull-Back	0.0	60.4	12.5	12.4	5.9	3.6	3.6	1.5	0.0	0.0
Hump Push	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0
Consist Movement	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0
Load Tests:										
10-Minute	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0
15-Minute	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7
30-Minute	0.0	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	33.3

To accomplish this, UPRR reviewed the types of databases available for its operations to identify where explicit emission-related activity information could be generated for the Davis Yard. UPRR operates approximately 7000 locomotives over a network spanning 23 states. Large amounts of data are generated and retained by UPRR for management purposes. These include tracking the location and status of capital assets (e.g., locomotives and rail cars), tracking performance of specific activities, and managing operations. These databases can be queried for data records specific to the Davis Yard, but their content does not directly relate to emissions. Where possible, data providing a complete record of emissions-related events (e.g., locomotive arrivals and departures) were identified and retrieved. Where 100 percent data for an activity could not be obtained (e.g., locomotive model number for each arriving locomotive), distributions were developed based on available data. In some cases, data are not available for specific types of emission events (e.g., the duration of idling for individual trains prior to departure). In these cases, UPRR yard personnel were consulted to derive estimates of averages or typical operating practices.

Railyard Operations – Inbound and Outbound Trains

The majority of locomotive activity in a railyard arises from inbound and outbound freight traffic. Following arrival, consists are decoupled from their trains in receiving areas and are either taken directly to outbound trains, or more commonly, are sent through servicing which can include washing, sanding, oiling, and minor maintenance prior to connecting to outbound trains. Some fraction of trains arriving at a yard simply pass through, possibly stopping briefly for a crew change. UPRR maintains a database that, when properly queried, can produce detailed information regarding both arriving and departing trains. Table 2 lists some of the key parameters that are available in this database. In this study, 12 months of data were obtained for all trains passing through the Davis Yard. The extracted data (over 60,000 records) included at least one record for every arriving and departing train, and each record contained specific information about a single locomotive, as well as other data for the train as a whole. The data were processed using a commercial relational database program and special purpose FORTRAN code to identify individual train arrivals and departures and train and consist characteristics.

Table 2. Selected Train Database Parameters.

	Used to Identify				
Parameter	Identification of Train Events	Location in Railyard	Consist Composition	Temporal Profile	Train Characteristics
Train Symbol	X	X			
Train Section	X				
Train Date	X				
Arrival or Departure	X	X			
Originating or Terminating	X	X			
Direction		X			
Crew Change?		X			
Arrival & Departure Times				X	
# of Locomotives			X		
# of Working Locomotives			X		
Trailing Tons					X
Locomotive ID #			X		
Locomotive Model			X		

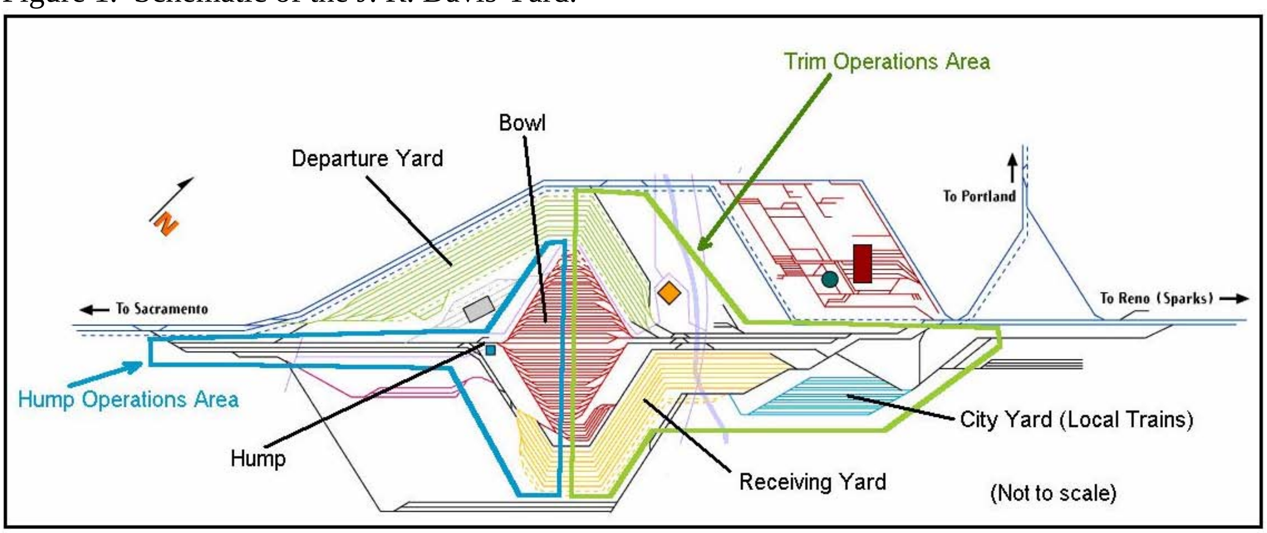
The parameters listed in Table 2 were used to calculate the number of trains by time of day arriving or departing from each area of the yard, as well as average composition of their consists (number of locomotives and distribution of locomotive models). The combination of train symbol, train segment, and train date provided a unique identifier for a single arrival or departure, and the individual locomotive models were tabulated to generate model distributions. Where necessary, working horsepower and total horsepower were used to estimate the number of working locomotives in the consist.

Emission calculations associated with inbound and outbound trains included both periods of movement within the yard boundaries and locomotive idling while consists we connected to their trains. Based on train direction and the location of its arrival or departure, moving emissions were based on calculations of time at different throttle settings based on distance traveled and estimated speed profiles, considering speed limits on different tracks. Yard operators provided estimates for the average duration of such idling for both inbound and outbound trains.

Railyard Operations – Classification

On arrival, inbound trains are "broken" into sections of rail cars destined for different outgoing trains. Figure 1 shows a schematic diagram of the Davis Yard including a large central "bowl" consisting of a large number of parallel tracks connected by automated switching controls to a single track to the west. Trains are pulled back to the west and then pushed to the "hump," a slightly elevated portion of track just west of the bowl. As cars pass over the hump, they are disconnected and roll by gravity into the appropriate track in the bowl. Dedicated special purpose locomotives, known as "hump sets," are used in this operation. Unlike most locomotives, these units have continuously variable throttles, rather than discrete throttle notch settings, to allow precise control of speed approaching the hump. Switching locomotives, known as "trim sets" are responsible for retrieving the train segments or trains being "built" in the bowl and moving them to the appropriate outbound track. The Davis Yard operates a fixed number of hump sets and trim sets at any given time, with backup sets standing by for shift changes and possible breakdowns.

Figure 1. Schematic of the J. R. Davis Yard.



Emission calculations for hump and trim operations were based on the number of working hump and trim sets at any given time, plus assumed idling times of standby units. For the hump sets, yard operators provided estimates of average pull-back and pushing times, and the duty cycles associated with these operations. For pull-back, based on distance and speed limits, the EPA switcher duty cycle, excluding notch 7 and 8 was used. Pushing is conducted at the equivalent of notch 2. For the trim sets, speed limits within the Yard preclude any high throttle setting operation, but there is a greater time spent in mid-throttle settings than reflected in the EPA switcher cycle. A revised duty cycle was developed for these units based on the EPA switcher duty cycle, with high throttle fractions (notches 7 and 8) excluded, but with increased notch 1 and notch 4 operating time. These duty cycles are also shown in Table 1.

Railyard Operations – Consist Movement, Service, Repair and Testing

After disconnecting from inbound trains, consists move to one of several servicing locations for refueling and other maintenance, following designated routes in the yard. Typically, one locomotive in each consist will pull the others, with throttle settings at notch 1 or 2. Based on distance and speed limits, movement times were estimated for each route, and emissions calculated using the number of locomotives following each route.

While being serviced, locomotives may be either idling or shut down. Locomotives must be idling while oil and other routine checks are performed. In addition, since locomotive engines are water-cooled and do not use antifreeze, they are commonly left idling during cold weather conditions. New idling reduction technologies known as SmartStart and AESS provide computer-controlled engine shut down and restart as necessary, considering temperature, air pressure, battery charge, and other parameters. Yard personnel provided estimates of the average potential duration of idling associated with different servicing events. Databases for service and maintenance activities maintained by UPRR provide details on the number and types of service events at different locations in the yard. As for train activity, these data were processed with a commercial relational database program and special purpose FORTRAN code to characterize and tabulate service events. These results were used in conjunction with data for the number of inbound and outbound consists to estimate total idling emissions for different service event types and locations. Following service, consists are dispatched to outbound trains. The same procedures were followed for estimating idle time, number of locomotives moving to each outbound area of the yard, and the duration of each movement for emission calculations.

In addition to routine service, the databases include service codes indicating periodic inspections of various types, as well as major maintenance activities requiring load testing of stationary locomotives. Several types of load tests are conducted, including planned maintenance pre- and post-tests, quarterly maintenance tests, and unscheduled maintenance diagnostic and post-repair tests. Depending on the test type and locomotive model, these tests include some period of idling, notch 1 operation, and notch 8 operation. Data are not collected on the exact duration of individual tests, so estimates of average duration for each throttle setting were provided by shop personnel, as shown in Table 1. The number of tests of each type for each locomotive model group were tabulated based on the service codes in the database for each service event.

Trends in Activity and Technology

The initial study was based on data from December 1999 through November 2000. Since that time, UPRR's locomotive fleet modernization program as well as changes in freight volumes have occurred. A subsequent data retrieval for the period from May 2003 through April 2004 was made, and emission calculations updated. A number of significant changes occurred over this 40-month period. The distribution of locomotive models in line-haul operation showed a substantial shift from older, lower horsepower units to new high horsepower units. The average number of locomotives per consist remained the same at about 3, but the higher horsepower allowed an increase in train capacity (trailing tons per train). The decrease in older units also resulted in a decrease in the frequency of major maintenance load testing. In addition to updating activity inputs (number of locomotives by model) for emission calculations, calculations were modified to reflect the penetration of new and retrofit technologies in the locomotive fleet, including SmartStart and AESS idling controls and Tier 0 and Tier 1 locomotives. UPRR data identifying the specific technologies installed on individual locomotives were matched with locomotive ID numbers in the train and servicing data retrievals to obtain a specific count of the number of locomotives of each model for which emissions reductions were achieved by these technologies. Historical temperature data for the Roseville area were used to estimate the fraction of time computer controls would require idling when the locomotive would otherwise be shut down.

EMISSION FACTORS

Data Sources

The study of the J. R. Davis Yard focused on diesel exhaust particulate matter emissions. At present, there is no unified database of emission test results for in-use locomotives. Appendix B of the USEPA's Regulatory Support Document for setting new emission standards for locomotives[2] contains a compilation of notch-specific emission factors. These data were supplemented by test data reported by Southwest Research Institute[3,4], as well as test data provided by locomotive manufacturers to assemble emission factors for each of 11 locomotive model groups.

There are dozens of specific locomotive model designations, and emissions tests are not available for all of them. However many models are expected to have nearly identical emission characteristics. Depending on their intended use, locomotives of different models may have different configurations (e.g., number of axles), but share a common diesel engine. For this project, 11 locomotive model groups were defined based on their engine models (manufacturer, horsepower, number of cylinders, and turbo- or super-charging of intake air). Table 3 lists these model groups and some of the typical locomotive models assigned to each group.

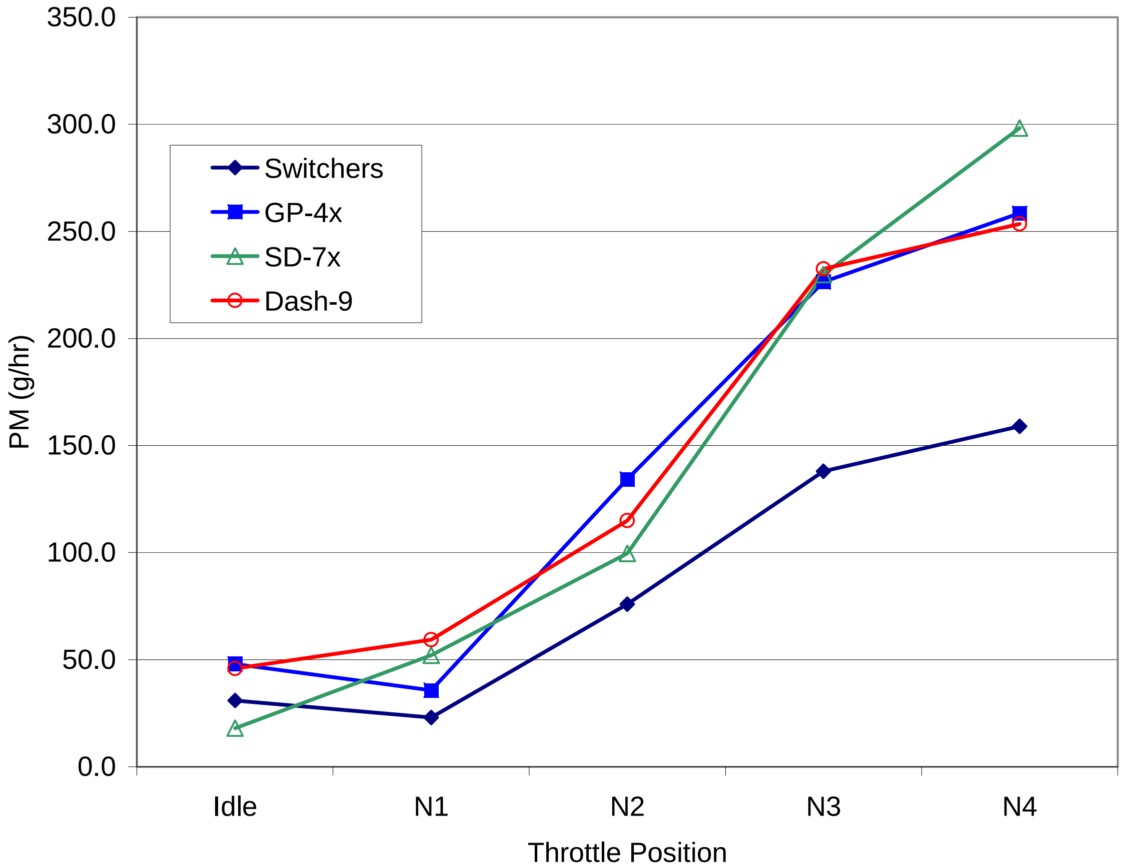
Table 3. Locomotive Model Groups

Model Group	Engine Family	Representative Models
Switchers	EMD 12-645E	GP-15, SW1500
GP-3x	EMD 16-645E	GP-30, GP-38
GP-4x	EMD 16-645E3B	GP-40, SD-40-2, SD-45-2
GP-50	EMD 16-645F3B	GP-50, SD-50M
GP-60	EMD 16-710G3A	GP-60, SD-60M
SD-7x	EMD 16-710G3B	SD-70MAC, SD-75
SD-90	EMD 16V265H	SD-90AC, SD-90-43AC
Dash-7	GE7FDL (12 cyl)	B23-7, B30-7, C36-7
Dash-8	GE7FDL (12 or 16 cyl)	B39-8, B40-8, C41-8
Dash-9	GE7FDL (16 cyl)	C44-9, C44AC
C60-A	GE7HDL	C60AC

Emission Factors and Fuel Effects

Figure 2 shows particulate matter (PM) emission factors for several of the more common locomotive model groups at the low to intermediate throttle settings typical of yard operations. As shown in the figure, emission rates generally increase with throttle setting. However, the older 3000 hp GP-4x series shows emissions comparable to (and in some cases, higher than) the newer 4000 to 4500 hp SD-7x and Dash-9 models. Due to the relatively large fraction of time locomotives spend at low throttle settings while in railyards, the relative differences in emission rates between models at these settings can significantly affect emissions estimates if locomotive model distributions change over time.

Figure 2. Locomotive PM Emission Factors (g/hr).

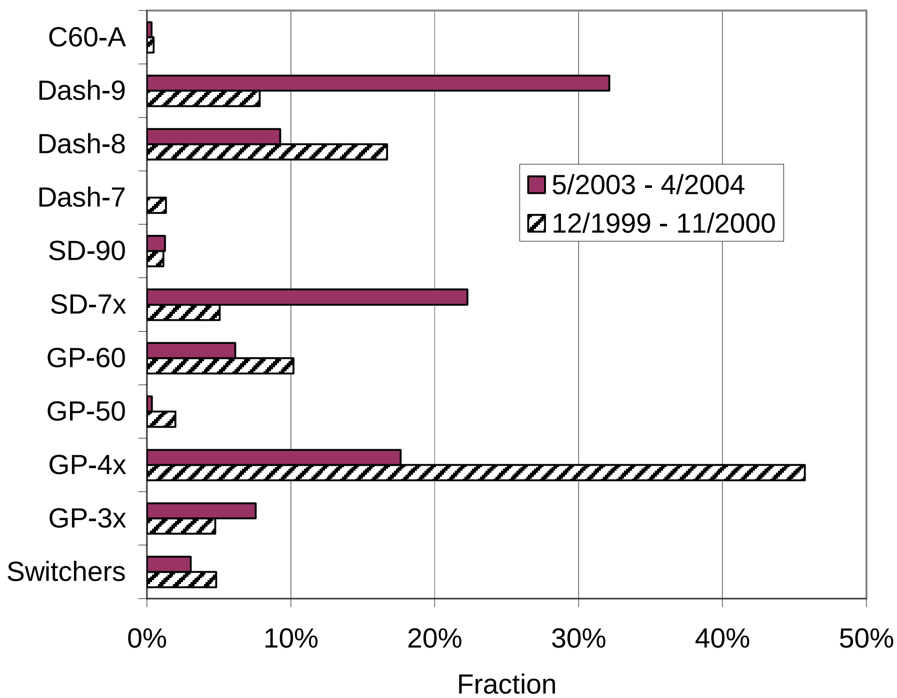


The emission factors used were based on tests using fuel typical of national off-road diesel. Initial emission estimates were derived by multiplying model-specific g/hr emission rates by the total hours of operation and locomotive model fraction for each activity within the yard. At the Davis Yard, over half of the diesel fuel dispensed to locomotives meets California on-road diesel fuel specifications (so-called "CARB diesel"). To account for the effect of fuel quality on emissions, estimates of the fraction of locally dispensed fuel burned by locomotives in different yard activities were developed. These ranged from 100 percent for hump and trim sets to zero percent for inbound line-haul units prior to refueling. These fractions were multiplied by the fraction of CARB diesel dispensed at the yard and an estimate of 14 percent reduction in PM emissions for locomotives burning CARB diesel to develop fuel effects adjustments for individual activities.

EMISSION TRENDS

Using the procedures described in the preceding sections, emissions estimates were developed for the December 1999 to November 2000 period, and the May 2003 to April 2004 period. During this period, significant changes in the UPRR locomotive fleet occurred, with the addition of new locomotives and the retirement of older units. Figure 3 shows the locomotive model distributions for all servicing events at the Davis Yard during these two periods. Service events include both the line-haul and local units arriving and departing on trains (which make up the bulk of these events), as well as the hump and trim sets. A significant increase in the relative fraction of high horsepower SD-7x and Dash-9 units is seen, and a corresponding decrease in the fraction of older GP-4x, GP-50, GP-60, Dash-7 and Dash-8 models. In addition to the fleet modernization, tabulations of specific emission control technologies on units serviced at the Davis Yard showed substantial penetration of new and retrofit technologies. Approximately 31 percent of locomotives serviced at the yard were equipped with computer-controlled shut-down and restart technology, resulting in reduced idling times. Also, approximately 27 percent of servicings were for Tier 0 locomotives, and approximately 25 percent were Tier 1 units. Although the Tier 0 and Tier 1 technologies are not expected to substantially reduce PM emissions, their nitrogen oxides emissions are lower. A few prototype Tier 2 units were observed in 2003 – 2004 data, and their reduced PM emissions will show benefits in the future.

Figure 3. Changes in Locomotive Model Distributions.



The freight volume passing through the yard also changed between these periods. Table 4 lists the percent change in the number of arriving and departing trains, locomotives, and trailing tons (a measure of freight volume). The number of trains and locomotives showed little change, however the trailing tons increased by approximately 15 percent, implying that the average train weight (and correspondingly, the required consist horsepower) increased. This is a result of the increased availability of high horsepower units in the UPRR fleet. A higher fraction of trains bypass the yard, either not stopping, or stopping only for crew changes.

Table 4. Percent Change in Yard Activity Levels from 12/1999 – 11/2000 to 5/2003 – 4/2004.

	Trains	**Locomotives**	**Trailing Tons**
Arrivals	-5.2%	-3.5%	--
Departures	-7.0%	-7.3%	--
Throughs (Bypassing the yard)	8.0%	6.8%	--
Total Arrivals and Departures	-0.3%	-0.9%	15.1%

The newer locomotive fleet also affected the level of load testing activity required. Table 5 lists the percent change in the number of load tests of different types, and the corresponding change in total locomotive testing time at idle, notch 1, and notch 8. The extended 30-minute post-maintenance tests were substantially reduced, and total hours of testing were reduced for the various throttle settings between 12 and 43 percent.

Table 5. Percent Change in Load Test Activity from 12/1999 – 11/2000 to 5/2003 – 4/2004.

10-Minute Tests	-18.9%
15-Minute Tests	14.6%
30-Minute Tests	-43.2%
Total Tests	-12.3%
Idling Hours	-20.6%
Notch 1 Hours	-43.2%
Notch 8 Hours	-12.0%

The combined net result of these changes is shown in Table 6. Between November 2000 and April 2003, total estimated PM emissions in the yard decreased by approximately 15 percent. Reductions in idling and movement emissions of about 20 percent were calculated, due to the combination of a newer, lower emitting locomotive fleet and the computer-controlled shutdown technologies (both retrofits and standard equipment on newer units). Hump and trim emissions were reduced by about 6 percent, and load testing emissions by about 14 percent.

Table 6. Emissions Changes from 12/1999 – 11/2000 to 5/2003 – 4/2004.

	Estimated Emissions (tons per year)		**Percent Change**
	12/1999 – 11/2000	**5/2003 – 4/2004**	
Idling and Movement of Trains	5.2	4.2	-20.3%
Idling and Movement of Consists	8.5	6.8	-20.2%
Testing	1.5	1.3	-14.1%
Hump and Trim	7.0	6.6	-5.7%
Total	22.3	18.9	-15.3%

CONCLUSIONS

Because of the unique features of each individual railyard, top-down methods (e.g., based only on tons of freight handled or number of arriving locomotives) cannot provide reliable estimates of railyard emissions. Yard-specific data are needed. In-yard activity patterns (and emissions) will vary between yards depending on factors such as: the type of yard (e.g., hump or flat switching classification yards, or intermodal facilities); the presence and capabilities of service tracks or locomotive repair shops; the types of freight handled; the location of the yard in the rail network; and yard configuration. The development of procedures for retrieving and analyzing activity data and locomotive characteristics for a specific railyard is a substantial improvement of alternatives based on top-down estimation. By obtaining disaggregate data for the range of specific activities occurring within railyards, it is possible to reliably estimate historical trends in emissions, as well as to evaluate the potential effects of operational changes and new technologies. Railyard operations cannot be treated in isolation, since these yards are only one component of complex national level systems. Nevertheless, the ability to assess the details of yard operations and their emissions provides an improved basis for environmental management decisions at both local and larger scales.

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KEY WORDS

Emission inventories
Locomotives
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APPENDIX A-7

SULFUR ADJUSTMENT CALCULATIONS

Appendix A-7

Development of Adjustment Factors for Locomotive DPM Emissions Based on Sulfur Content

Wong (undated) provides equations for estimating g/bhp-hr emission rates for 4-Stroke (GE) and 2-Stroke (EMD) locomotives. Rather than using these statistically derived estimates for absolute emissions when model- and notch-specific emission factors are available, we used these equations to develop *relative* emission rate changes for different sulfur levels. The basic form of the equation is

$$q = a \cdot S + b$$

Where,

q is the predicted g/bhp-hr emission rate of a locomotive at a specific throttle setting and sulfur content;

a and b are coefficients specific to a locomotive type (2- or 4-stroke) and throttle notch; and

S is the fuel sulfur content in ppm.

Thus, to calculate the emission adjustment factor for a specific fuel sulfur content, it is necessary to calculate the nominal emission rate q_0 for the baseline fuel sulfur content S_0, and the emission rate q_i for the fuel of interest with sulfur content S_i. This adjustment factor k_i is simply

$$k_i = 1 - \frac{(q_0 - q_i)}{q_0},$$

Where, q_0 and q_i are calculated using the equation above. Tables 1 and 2 give the values of the a and b coefficients for 4-stroke and 2-stroke locomotives. For throttle settings below notch 3, sulfur content is not expected to affect emission rates. The baseline emission rates from which actual emissions are estimated were derived from emission tests of different locomotive models. Although full documentation of fuels is not available for all of these tests, they are assumed to be representative of actual emissions of the different models running on 3,000 ppm sulfur EPA non-road Diesel fuel. For the purposes of modeling 2005 emissions, these factors are needed to adjust the baseline emission factors to emission factors representative of two fuels – 221 ppm and 2639 ppm. Table 3 shows the resulting correction factors for these two fuels by notch and engine type. To generate locomotive model-, throttle-, tier-, and fuel-specific emission factors, the base case (nominal 3,000 ppm S) emission factors in Table 4 were multiplied by the corresponding correction factors for throttle settings between notch 3 and notch 8.

Table 1 Sulfur Correction Coefficients for 4-Stroke Engines		
Throttle Setting	***a***	***b***
Notch 8	0.00001308	0.0967
Notch 7	0.00001102	0.0845
Notch 6	0.00000654	0.1037
Notch 5	0.00000548	0.1320
Notch 4	0.00000663	0.1513
Notch 3	0.00000979	0.1565

Table 2 Sulfur Correction Coefficients for 2-Stroke Engines		
Throttle Setting	***a***	***b***
Notch 8	0.0000123	0.3563
Notch 7	0.0000096	0.2840
Notch 6	0.0000134	0.2843
Notch 5	0.0000150	0.2572
Notch 4	0.0000125	0.2629
Notch 3	0.0000065	0.2635

Table 3

DPM Emission Adjustment Factors for Different Fuel Sulfur Levels

Throttle Setting	4-Stroke (GE)		2-Stroke (EMD)	
	2,639 ppm S	221 ppm S	2,639 ppm S	221 ppm S
Notch 8	0.9653	0.7326	0.9887	0.9131
Notch 7	0.9662	0.7395	0.9889	0.9147
Notch 6	0.9809	0.8526	0.9851	0.8852
Notch 5	0.9867	0.8974	0.9821	0.8621
Notch 4	0.9860	0.8924	0.9850	0.8844
Notch 3	0.9810	0.8536	0.9917	0.9362

Table 4
Base Case Locomotive Diesel Particulate Matter Emission Factors (g/hr)
(3,000 PPM Sulfur Assumed)

Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	138.0	159.0	201.0	308.0	345.0	448.0	ARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	186.0	212.0	267.0	417.0	463.0	608.0	ARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	226.4	258.5	336.0	551.9	638.6	821.3	ARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	301.5	311.2	394.0	663.8	725.3	927.8	ARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	284.5	299.4	375.3	645.7	743.6	941.6	ARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	239.4	352.2	517.8	724.8	1125.9	1319.8	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	156.8	243.1	321.1	374.8	475.2	589.2	ARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	230.4	379.8	450.8	866.2	1019.1	1105.7	ARB and ENVIRON
SD-7x	1	29.2	31.8	37.1	66.2	219.3	295.9	436.7	713.2	783.2	847.7	NS2630[3]
SD-7x	2	55.4	59.5	38.3	134.2	271.7	300.4	335.2	551.5	672.0	704.2	UP8353[3]
SD-90	0	61.1	108.5	50.1	99.1	255.9	423.7	561.6	329.3	258.2	933.6	EMD 16V265H
Dash 7	N	65.0	180.5	108.2	121.2	359.5	327.7	331.5	299.4	336.7	420.0	ARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	291.4	293.2	327.7	373.5	469.4	615.2	ARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	219.9	289.1	370.6	437.7	486.1	705.7	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	229.2	263.8	615.9	573.9	608.0	566.6	Average of ARB & CN2508[1]
Dash 9	1	16.9	88.4	62.1	140.2	304.0	383.5	423.9	520.2	544.6	778.1	CSXT595[2]
Dash 9	2	7.7	42.0	69.3	145.8	304.3	365.0	405.2	418.4	513.5	607.5	BNSF 7736[2]
C60-A	0	71.0	83.9	68.6	78.6	277.9	234.1	276.0	311.4	228.0	362.7	ARB and ENVIRON

Notes:

1. Except as noted below, the base emission rates were originally developed for the ARB *Roseville Rail Yard Study* (October 2004)
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).

OFFROAD Modeling Change Technical Memo

SUBJECT: Changes to the Locomotive Inventory

LEAD: Walter Wong

Summary

The statewide locomotive emission inventory has not been updated since 2002. Using the Booz-Allen Hamilton's (BAH) study (Locomotive Emission Study) published in 1992 as a guideline (summary of inventory methodology can be found in Appendix A), staff updated the locomotive inventory.

The history of locomotive emission inventory updates began in 1992 using the results from the BAH report as the baseline inventory. In 2003, staff began updating the emissions inventory by revising the growth assumptions used in the inventory. The revised growth factors were incorporated into the ARB's 2003 Almanac Emission Inventory. With additional data, staff is proposing further update to the locomotive inventory to incorporate fuel correction factors, add passenger train data and Class III locomotives. Changes from updated locomotive activity data have made a significant impact on the total inventory (see Table 1).

Table 1. Impact of Changes on Statewide Locomotive Inventory

	Pre 2003 ARB Almanac Inventory (tons/day)			Revised Inventory (tons/day)			Difference (tons/day)		
Year	HC	NOx	PM	HC	NOx	PM	HC	NOx	PM
1987	7.2	158.8	3.6	7.2	158.8	3.6	0.0	0.0	0.0
2000	7.2	144.8	2.8	9.8	207.2	4.7	2.6	62.4	1.9
2010	7.2	77.8	2.8	9.5	131.9	4.2	2.3	54.1	1.4
2020	7.2	77.8	2.8	9.4	134.6	4.1	2.2	56.8	1.3

Reasons For Change

During the 2003 South Coast's State Implementation Plan (SIP) development process, industry consultants approached Air Resources Board (ARB) staff to refine the locomotive emissions inventory. Specifically, their concerns were related to the growth factors and fuel correction factors used in the inventory calculations. This document outlines how the locomotive emissions inventory was updated and the subsequent changes made to address industry's concerns.

Background : Baseline 1987 Locomotive Emissions Inventory (BAH report)

Locomotive operations can be characterized by the type of service performed. For emission inventory purposes, locomotives are classified into five different service types as defined in BAH's report.

Line-haul/intermodal – Intermodal locomotives generally operate at higher speeds and with higher power than other types and incorporate modern, high-speed engines.

Mixed/bulk – Mixed locomotives are the most common and operate with a wide range of power. They also perform line-haul duties.

Local/Short Haul – Local locomotives perform services that are a mixture of mixed freight and yard service. They operate with lower power and use older horsepower engines.

Yard/Switcher – Yard operations are used in switching locomotives and characterized by stop and start type movements. They operate with smaller engines and have the oldest locomotive engines.

Passenger – Passenger locomotives are generally high speed line haul type operations.

Categories of railroads are further explained by a precise revenue-based definition found in the regulations of the Surface Transportation Board (STB). Rail carriers are grouped into three classes for the purposes of accounting and reporting:

Class I –Carriers with annual operating revenues of $250 million or more

Class II – Carriers with annual operating revenues of less than $250 million but in excess of $20 million

Class III – Carriers with annual operating revenues of less than $20 million or less, and all switching companies regardless of operating revenues.

The threshold figures are adjusted annually for inflation using the base year of 1991.

The 1987 locomotive inventory as shown in Table 2 is taken from the BAH report prepared for the ARB entitled “Locomotive Emission Study” completed in 1992 (http://www.arb.ca.gov/app/library/libcc.php). Information was gathered from many sources including ARB, the South Coast Air Quality Management District, the California Energy Commission, the Association of American Railroads (AAR), locomotive and large engine manufacturers, and Southwest Research Institute. Railroad companies, such as Southern Pacific, Union Pacific, and Atchison, Topeka and Santa Fe (ATSF), provided emission factors, train operation data, and throttle position profiles for trains operating in their respective territories. Southwest Research Institute provided emission test data.

Table 2. 1987 Locomotive Inventory in Tons Per Day, Statewide, BAH report

TYPE	HC	CO	NOX	PM	SOX
Line-Haul/Intermodal	3.97	12.89	86.21	1.97	6.36
Short-Haul/Local	0.96	3.06	21.30	0.46	1.59
Mixed	1.51	4.85	37.34	0.81	2.76
Passenger	0.10	0.22	3.24	0.07	0.30
Yard/Switcher	0.62	1.57	10.69	0.24	0.58
Total	7.16	22.59	158.78	3.55	11.59

The assumed average fuel sulfur content is 2700 parts per million (ppm) obtained from the BAH report.

Current Growth Estimates

Prior to the 2003 South Coast SIP update, growth factors were based on employment data in the railroad industry. Staff believes that the use of historic employment data, which translates to a decline in emissions in future years, may be masking actual positive growth in locomotive operations. It may be assumed that the number of employees is declining due to increased efficiency.

Changes to the Locomotive Inventory

Summary of Growth in Emission Based on BAH Report

Growth is estimated based on train operation type and by several operating characteristics.

> Increased Rail Lube and Aerodynamics – this arises from reduction in friction and will help reduce power requirements.

Introduction of New Locomotives – older locomotive units will be replaced by newer models.

Changes in Traffic Level – the increase or decrease in railroad activity

In the BAH report, projected emission estimates for years 2000 and 2010 were based on the factors shown in Tables 3 and 4. A substantial part of the locomotive emission inventory forecast is based upon projections of rail traffic levels. BAH projected future rail traffic level as a function of population and economic growth in the state. BAH also projected growth in emission only to 2010.

Table 3. Changes in Emissions from 1987-2000 (Exhibit 4 p. 11 of the 8/92 Locomotive Emission Study Supplement) (1987 Base Year)

Train Operation Type	Increased Rail Lube and Aerodynamics	Introduction of New Locomotive	Changes in Traffic Levels	Cumulative Net Growth in Emissions
Intermodal	-7.0%	-8.0%	17.0%	2.0%
Mixed & Bulk	-7.0%	-8.0%	2.0%	-13.0%
Local	-3.0%	-3.0%	-2.0%	-8.0%
Yard	0.0%	-1.0%	-25.0%	-26.0%
Passenger	-7.0%	-8.0%	10.0%	-5.0%

Table 4. Changes in Emissions from 2001-2010 (Exhibit 4 p. 11 of the 8/92 Locomotive Emission Study Supplement) (2000 Base Year)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Introduction of New Locomotive	Changes in Traffic Levels	Cumulative Net Growth in Emissions
Intermodal	-2.0%	-3.0%	-8.0%	25.0%	12.0%
Mixed & Bulk	-2.0%	-3.0%	-8.0%	0.0%	-13.0%
Local	-1.0%	0.0%	-12.0%	-10.0%	-23.0%
Yard	0.0%	0.0%	-10.0%	-15.0%	-25.0%
Passenger	-2.0%	-3.0%	-8.0%	15.0%	2.0%

BAH added “Improved Dispatching and Train Control” to differentiate these impacts from the “Increased Rail Lubing” which helps to improve fuel efficiency from locomotive engines. Since train control techniques are emerging from the signal company research work, these assumed changes will not impact emission until year 2000.

Based on industry's input, staff recommends several changes to the locomotive emissions inventory. These include modifying growth factors, making adjustments to control factors reflecting the U. S. EPA regulations that went into effect in year 2000, incorporating fuel correction factors, adding smaller class III railroad and industrial locomotive, and updating passenger data.

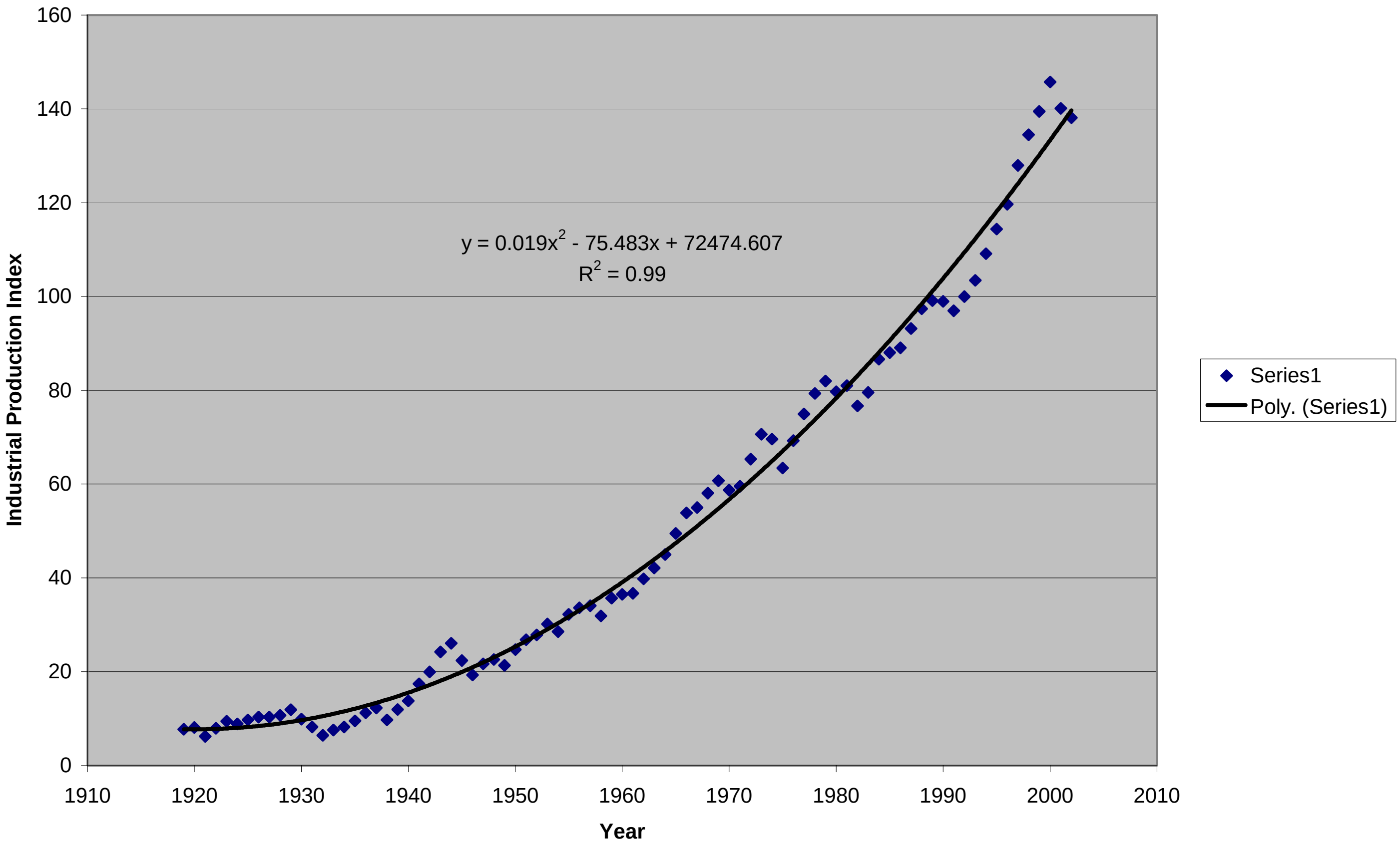
Revised Growth in Emissions

Staff revised the growth factors for locomotives based on new data that better reflect locomotive operations. This includes U.S. industrial production and various railroad statistics available from the AAR.

Based on historic data recently obtained from U.S. industrial productions and the AAR, the changes in traffic levels were revised. A better estimate for changes in traffic levels for locomotives can be made to the line-haul class of railroad, which are the intermodal and mixed and bulk type of locomotives, using industrial production and AAR's data.

Industrial production data is considered to be a surrogate for changes in traffic levels of the line-haul locomotive. It is assumed that railroad activity would increase in order to accommodate the need to move more product. Industrial production is the total output of U.S. factories and mines, and is a key economic indicator released monthly by the Federal Reserve Board. U.S. industrial production historical data from 1920 to 2002 was obtained and analyzed from government sources. Figure 1 shows the historical industrial production trend (Source : http://www.research.stlouisfed.org/fred2/series/INDPRO/3/Max). Statistical analysis was used to derive a polynomial equation to fit the data.

Figure 1. Long-term Industrial Production



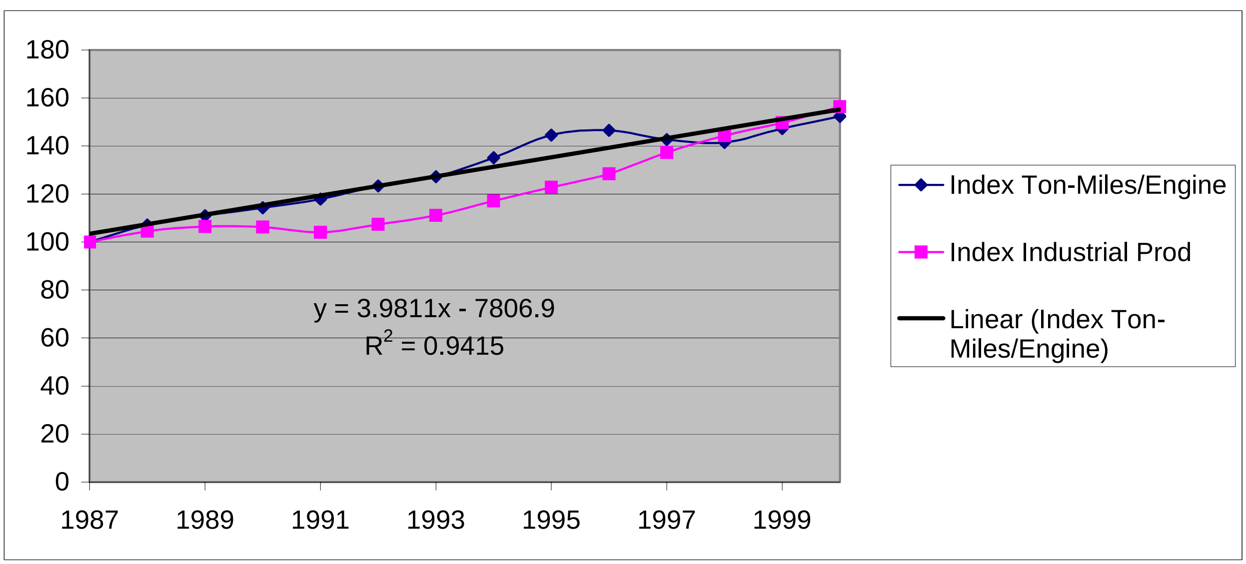
Another surrogate for growth is net ton-miles per engine. Consequently, staff analyzed railroad data from the AAR's Railroad Facts booklet (2001 edition). The booklet contains line-haul railroad statistics including financial status, operation and employment data, and usage profiles. Revenue ton-mile and locomotives in service data from the booklet were used to compute the net ton-miles per engine as shown in Table 5.

Table 5. Revenue Ton-Miles and Ton-Miles/Engine (AAR Railroad Facts 2001 edition)

Year	Locomotive Diesel in Service (US)	Revenue Ton-Miles	Ton-Miles/Engine
1987	19,647	943,747	48.04
1988	19,364	996,182	51.45
1989	19,015	1,013,841	53.32
1990	18,835	1,033,969	54.90
1991	18,344	1,038,875	56.63
1992	18,004	1,066,781	59.25
1993	18,161	1,109,309	61.08
1994	18,496	1,200,701	64.92
1995	18,810	1,305,688	69.41
1996	19,267	1,355,975	70.38
1997	19,682	1,348,926	68.54
1998	20,259	1,376,802	67.96
1999	20,254	1,433,461	70.77
2000	20,026	1,465,960	73.20

As shown in Figure 2, there is a relatively good correlation between net ton-miles per engine growth and industrial production. Because net ton-miles per engine data are compiled by the railroad industry and pertains directly to the railroad segment, staff believes that net ton-miles per engine will better characterize future traffic level changes.

Figure 2. Ton-miles/Engine vs. Industrial Production (index base year = 1987)



The ton-miles/engine data were projected to calculate the future growth rate of traffic level using a linear equation.

Staff also made changes to the "Increased Rail Lube and Aerodynamics" assumption shown in Tables 3 and 4. Rail lubing does not benefit the idling portion of locomotive activity. Since idling contributes 20% of the weighting in the line-haul duty cycle, staff reduced the rail lubing benefit by 20%. Meanwhile, improved dispatching and train control is assumed only to reduce engine idling. Therefore, staff reduced the improved dispatching benefit by 80%.

The benefit of the introduction of new locomotives to the fleet was decreased from the original BAH assumption. BAH assumed 50% penetration of the new engines by 2000. Literature research suggests that the new engines accounted for only about 34% of the fleet in 2000 (www.railwatch.com, http://utahrails.net/all-time/modern-index.php). These new engines are assumed to be 15% cleaner. Therefore, the benefit from new locomotive engines has been reduced to 5% (34% x 15% = 5% reduction).

Tables 6, 7, and 8 present the revised growth factors to be used to project the baseline (1987) locomotive emissions inventory into the future.

Table 6. ARB Revised Growth 1987-2000, ARB's 2003 Almanac Emission Inventory

Train Operation Type	Increased Rail Lube and Aerodynamics	Introduction of New Locos	Population Increase	Changes in Traffic Levels	Cumulative Net Growth in Emissions	Annual Growth
Intermodal	-5.6%	-5.1%	1.9%	50.0%	41.2%	2.69%
Mixed & Bulk	-5.6%	-5.1%	1.9%	50.0%	41.2%	2.69%
Local	-2.4%	0%	0%	-2.0%	-4.4%	-0.35%
Yard	0.0%	0%	0%	-25.0%	-25.0%	-2.19%
Passenger	-5.6%	0%	1.9%	10.0%	6.3%	0.47%

The benefit of new locomotives with cleaner burning engines is accounted for in the control factor from EPA's regulation beginning in 2001, which takes into account introduction of new locomotive engines meeting Tier I and Tier II standards.

Table 7. ARB Revised Growth 2001-2010 (2000 Base Year, ARB's 2003 Almanac Emission Inventory)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Changes in Traffic Levels	Cumulative Net Growth in Emissions	Annual Growth
Intermodal	-1.6%	-0.6%	22.5%	20.3%	1.87%
Mixed & Bulk	-1.6%	-0.6%	22.5%	20.3%	1.87%
Local	-0.8%	-0.6%	-10.0%	-11.4%	-1.20%
Yard	0.0%	0.0%	-15.0%	-15.0%	-1.61%
Passenger	-1.6%	0.0%	15.0%	13.4%	1.27%

Table 8. ARB Revised Growth 2010-2020 (2010 Base Year, ARB's 2003 Almanac Emission Inventory)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Changes in Traffic Levels	Cumulative Net Growth	Annual Growth
Intermodal	0.0%	0.0%	18.0%	18.0%	1.67%
Mixed & Bulk	0.0%	0.0%	18.0%	18.0%	1.67%
Local	0.0%	0.0%	0.0%	0.0%	0.00%
Yard	0.0%	0.0%	0.0%	0.0%	0.00%
Passenger	0.0%	0.0%	0.0%	0.0%	0.00%

In Table 8, staff assumes no benefit from aerodynamics and improved train controls. Staff seeks guidance from industry as to their input regarding future benefits.

Table 9. Revised Growth in Emissions (Base Year 1987)

Year	Intermodal	Mixed & Bulk	Local	Yard	Passenger
1987	1.00	1.00	1.00	1.00	1.00
1988	1.03	1.03	1.00	0.98	1.00
1989	1.05	1.05	0.99	0.96	1.01
1990	1.08	1.08	0.99	0.94	1.01
1991	1.11	1.11	0.99	0.92	1.02
1992	1.14	1.14	0.98	0.90	1.02
1993	1.17	1.17	0.98	0.88	1.03
1994	1.20	1.20	0.98	0.86	1.03
1995	1.24	1.24	0.97	0.84	1.04
1996	1.27	1.27	0.97	0.82	1.04
1997	1.30	1.30	0.97	0.80	1.05
1998	1.34	1.34	0.96	0.78	1.05
1999	1.38	1.38	0.96	0.77	1.06
2000	1.41	1.41	0.96	0.75	1.06
2001	1.44	1.44	0.94	0.74	1.08
2002	1.47	1.47	0.93	0.73	1.09
2003	1.49	1.49	0.92	0.71	1.10
2004	1.52	1.52	0.91	0.70	1.12
2005	1.55	1.55	0.90	0.69	1.13
2006	1.58	1.58	0.89	0.68	1.15
2007	1.61	1.61	0.88	0.67	1.16
2008	1.64	1.64	0.87	0.66	1.18
2009	1.67	1.67	0.86	0.65	1.19
2010	1.70	1.70	0.85	0.64	1.21
2011	1.73	1.73	0.85	0.64	1.21
2012	1.76	1.76	0.85	0.64	1.21
2013	1.79	1.79	0.85	0.64	1.21
2014	1.81	1.81	0.85	0.64	1.21
2015	1.85	1.85	0.85	0.64	1.21
2016	1.88	1.88	0.85	0.64	1.21
2017	1.91	1.91	0.85	0.64	1.21
2018	1.94	1.94	0.85	0.64	1.21
2019	1.97	1.97	0.85	0.64	1.21
2020	2.00	2.00	0.85	0.64	1.21

Control Factors for U.S. EPA regulation

In December 1997, the U.S. EPA finalized the locomotive emission standard regulation. The regulatory support document lists the control factors used (http://www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf). Staff modified the control factors to incorporate the existing memorandum of understanding (http://www.arb.ca.gov/msprog/offroad/loco/loco.htm) between the South Coast AQMD and the railroads that operate in the region. Previously, one control factor was applied statewide. In the revised emissions inventory starting in 2010, a lower control factor reflecting the introduction of lower emitting locomotive engines in the SCAB region was applied. Tables 10 and 11 show the revised control factors. Road hauling definition as used by U.S. EPA applies to the line-haul/intermodal, mixed, and local/short haul train type in the emissions inventory.

Table 10. Revised Statewide Control Factors

Year	State Road Hauling HC	State Road Hauling NOx	State Road Hauling PM	State Switcher HC	State Switcher NOx	State Switcher PM	State Passenger HC	State Passenger NOx	State Passenger PM
1999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2001	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2002	1.00	0.88	1.00	1.00	0.98	1.00	1.00	0.98	1.00
2003	1.00	0.82	1.00	1.00	0.97	1.00	1.00	0.96	1.00
2004	1.00	0.75	1.00	1.00	0.95	1.00	1.00	0.94	1.00
2005	0.96	0.68	0.96	0.99	0.93	0.99	0.98	0.92	0.98
2006	0.92	0.62	0.92	0.99	0.91	0.99	0.96	0.90	0.96
2007	0.89	0.59	0.89	0.98	0.89	0.98	0.94	0.83	0.94
2008	0.87	0.57	0.86	0.98	0.87	0.97	0.92	0.76	0.92
2009	0.84	0.55	0.84	0.97	0.85	0.97	0.91	0.69	0.90
2010	0.82	0.54	0.81	0.96	0.83	0.96	0.89	0.62	0.88
2011	0.81	0.53	0.80	0.96	0.81	0.95	0.87	0.57	0.87
2012	0.80	0.53	0.79	0.95	0.79	0.94	0.85	0.56	0.85
2013	0.79	0.52	0.78	0.94	0.77	0.93	0.83	0.54	0.83
2014	0.77	0.51	0.76	0.94	0.75	0.93	0.82	0.53	0.81
2015	0.76	0.50	0.75	0.93	0.73	0.92	0.80	0.52	0.79
2016	0.75	0.50	0.74	0.92	0.71	0.91	0.78	0.51	0.77
2017	0.74	0.49	0.72	0.91	0.70	0.90	0.76	0.50	0.75
2018	0.73	0.48	0.71	0.90	0.69	0.89	0.74	0.49	0.73
2019	0.71	0.48	0.70	0.89	0.68	0.88	0.73	0.48	0.71
2020+	0.70	0.47	0.69	0.89	0.67	0.87	0.71	0.47	0.69

Table 11. Revised SCAB Control Factors

Year	SCAB Road Hauling HC	SCAB Road Hauling NOx	SCAB Road Hauling PM	SCAB Switcher HC	SCAB Switcher NOx	SCAB Switcher PM
1999	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.00	0.99	1.00	1.00	1.00	1.00
2001	1.00	0.95	1.00	1.00	1.00	1.00
2002	1.00	0.88	1.00	1.00	0.98	1.00
2003	1.00	0.82	1.00	1.00	0.97	1.00
2004	1.00	0.75	1.00	1.00	0.95	1.00
2005	0.96	0.68	0.96	0.99	0.93	0.99
2006	0.92	0.62	0.92	0.99	0.91	0.99
2007	0.89	0.59	0.89	0.98	0.89	0.98
2008	0.87	0.57	0.86	0.98	0.87	0.97
2009	0.84	0.55	0.84	0.97	0.85	0.97
2010	0.82	0.36	0.81	0.96	0.36	0.96
2011	0.81	0.36	0.80	0.96	0.36	0.95
2012	0.80	0.36	0.79	0.95	0.36	0.94
2013	0.79	0.36	0.78	0.94	0.36	0.93
2014	0.77	0.36	0.76	0.94	0.36	0.93
2015	0.76	0.36	0.75	0.93	0.36	0.92
2016	0.75	0.36	0.74	0.92	0.36	0.91
2017	0.74	0.36	0.72	0.91	0.36	0.90
2018	0.73	0.36	0.71	0.90	0.36	0.89
2019	0.71	0.36	0.70	0.89	0.36	0.88
2020+	0.70	0.36	0.69	0.89	0.36	0.87

Addition of Class III Locomotive and Industrial/Military Locomotive

The annual hours operated by the class III railroads are shown in Table 12. The results were tabulated from ARB Stationary Source Division's (SSD) survey (http://www.arb.ca.gov/regact/carblohc/carblohc.htm) conducted to support regulation with regards to ARB ultra-clean diesel fuel.

Table 12. Short-Haul and Switcher Annual Hours for Class III Railroads

Air Basin	Operations	Population	Annual Hours Operated
Mountain Counties	SW	2	10214
Mojave Desert	L	10	27440
North Coast	L	3	5700
North Central Coast	L	1	1332
	SW	3	3996
Northeast Plateau	L	5	9892
South Coast	SW	21	75379
South Central Coast	L	5	3200
San Diego	L	4	5000
San Francisco	L	8	31600
	SW	4	5059
San Joaquin Valley	L	29	68780
	SW	19	72248
Sacramento Valley	L	6	11400
Total		120	331240

L = local short-haul, SW = switcher

The short-haul and switcher emission rate are derived from BAH report. The report cites studies from testing done at EPA and Southwest Research Institute.

Table 13. Short-Haul and Switcher Emission Rate

Emission Rate	Short-Haul (g/bhp-hr)	Switcher (g/bhp-hr)
HC	0.38	0.44
CO	1.61	1.45
NOx	12.86	15.82
PM	0.26	0.28
SOx	0.89	0.90
Fuel Rate (lb/hr)	120.00	60.00

Table 14. Statewide Summary of Industrial Locomotives

Air Basin	Number of Locomotives	Avg. HP	Avg. Age
Mojave Desert	9	1,138	56
Others	11	587	54
San Francisco	11	525	54
San Joaquin Valley	38	1,176	54
South Coast	24	1,290	55
TOTALS	93	1,055	55

Table 15. Statewide Summary of Military Locomotives

Air Basin	Number of Locomotives	Avg. HP	Avg. Age
Mojave Desert	7	900	50
Northeast Plateau	2	1,850	50
Sacramento Valley	1	500	50
San Diego	7	835	50
San Francisco	4	1525	47.5
San Joaquin Valley	2	400	50
South Central Coast	1	500	50
TOTALS	24	930	49.6

The data from the survey provides a reasonable depiction of railroad activities in 2003. To forecast and backcast, an assumption was made to keep the data constant and have no growth. More research is needed to quantify the growth projections of smaller, local railroad activities.

Update to Passenger Trains

ARB's survey of intrastate locomotives included passenger agency trains that operated within the state. Staff attempted to reconcile the survey results by calculating the operation schedules posted by the operating agency to obtain hours of operation and mileage information. The results of the survey and calculated operating hours were comparable. Table 16 lists the calculated annual hours operated and miles traveled used to estimate emissions.

Table 16. Passenger Trains Annual Miles and Hours

Air Basin	Annual Miles Operated	Annual Hours Operated
South Coast	3,700,795	92,392
South Central Coast	151,864	4,020
San Diego	914,893	25,278
San Francisco	2,578,862	77,944
San Joaquin Valley	674,824	17,313
Sacramento Valley	635,384	20,058
Total	8,656,621	237,006

The passenger train emission rate is derived from testing done at SWRI on several passenger locomotives.

Table 17. Passenger Train Emission Rate

Emission Rate	Passenger Train (g/bhp-hr)
HC	0.50
CO	0.69
Nox	12.83
PM	0.36
Sox	0.90
Fuel Rate (lb/hr)	455.00

Fuel Correction Factors

<u>Aromatics</u>

Previous studies quantifying the effects of lowering aromatic content are listed in Table 18. These studies tested four-stroke heavy-duty diesel engines (HDD). Although staff would have preferred to analyze data from tests performed on various locomotive engines to determine the effects of lower aromatics, these HDD tests are the best available resources to determine the fuel corrections factors due to lower aromatics.

Table 18. Effect of Lowering Aromatic Volume on PM Emission

STUDY	**Sulfur (ppm)**	**Aromatics (Volume %)**	**PM Reduction (%)**
Chevron (1984)	2,800	31	Baseline
Chevron (1984)	500	31	23.8
Chevron (1984)	500	20	32.2
Chevron (1984)	500	15	36.0
Chevron (1984)	500	10	39.9
CRC-SWRI (1988)	500	31	Baseline
CRC-SWRI (1988)	500	20	9
CRC-SWRI (1988)	500	15	13
CRC-SWRI (1988)	500	10	17

Source : http://www.arb.ca.gov/fuels/diesel/diesel.htm

Using a linear regression of the data from the Table 18, the PM reduction from a change in aromatic content can be described as :

<u>4-Stroke Engine</u>
PM reduction = [(Difference in Aromatic Volume) * 0.785 + 0.05666]/100

For 2-Stroke engines, staff used test data from SWRI's report published in 2000 entitled "Diesel Fuel Effects on Locomotive Exhaust Emissions" to estimate indirectly the potential PM reduction for 2-Stroke engines due to lower aromatics. Table 19 lists the summary of the test results.

Table 19. SWRI 2000 Study Summary Results

Locomotive Engine	Aromatic Changes (Volume %)	PM Difference (g/bhp-hr)	PM % Difference
4 Stroke	28.35 to 21.84	0.080	37.6%
2 Stroke	28.35 to 21.84	0.056	14.1%

Staff assumes that PM emission reduction from 2-Stroke engine will have a factor of 0.38 (14.1%/37.6%) to the 4-Stroke engine PM emission reduction.

Currently, the baseline locomotive emissions inventory assumes an aromatic total volume percent of 31%. Table 21 describes the changes in PM emission due to changes in total volume percent of aromatics.

Table 20. Examples of PM Reductions Due to Changes in Aromatic Total Volume Percent

Aromatic Volume Percent		PM Reduction	PM Reduction	PM Reduction
From	To	2 Stroke	4 Stroke	Composite
31	28	0.9%	2.4%	1.3%
31	19	3.6%	9.5%	5.1%
31	10	6.3%	16.5%	8.9%

*composite is 75% 2 Stroke Engine and 25% 4 Stroke Engine

Table 21,Table 22, and Table 23 show the PM emission reduction for the different type of fuels used in the state.

Table 21. PM Emission Percent Change of Line-Haul Due to Aromatics, Statewide

Calendar Year	CARB Aromatic Volume (%)	EPA Aromatic Volume (%)	Off-road Aromatic Volume (%)	Weighted Aromatic Volume (%)	PM Emission Percent Change
1992	31	31	31	31.00	0.00
1993	10	31	31	31.00	0.00
1994	10	31	31	31.00	0.00
1995	10	31	31	31.00	0.00
1996	10	31	31	31.00	0.00
1997	10	31	31	31.00	0.00
1998-2001	10	31	31	30.18	-0.004
2002-2006	10	31	31	29.05	-0.009
2007+	10	31	31	29.05	-0.009

Table 22. Class I Line Haul Weighted Aromatic Volume Percent by Air Basin

Interstate Locomotive	Air Basin	1993-2001 Weighted Aromatic	2002+ Weighted Aromatic
		Volume Percent	Volume Percent
Class I Line Haul	SCC	31.0	31.0
	MC	31.0	26.6
	MD	30.0	29.8
	NEP	31.0	27.9
	SC	31.0	31.0
	SF	28.6	23.1
	SJV	29.1	29.4
	SS	31.0	31.0
	SV	31.0	27.4

Table 23. PM Emission Reduction from Intrastate Locomotives Due to Aromatics by Air Basin, 1993+

Intrastate Locomotive	Air Basin	CARB Aromatic Volume Percent	EPA Aromatic Volume Percent	Nonroad Aromatic Volume Percent	Weighted Aromatic Volume Percent	PM Emission Reduction Percent
Class I Local/Switcher	SC	10	31	31	29.0	-0.9%
	SJV	10	31	31	25.2	-2.4%
	MD	10	31	31	31.0	0.0%
	BA	10	31	31	13.9	-7.2%
	SD	10	31	31	13.2	-7.5%
	SV	10	31	31	13.2	-7.5%
	SCC	10	31	31	13.2	-7.5%
Class III Local/Switcher	SC	10	31	31	31.0	0.0%
	SJV	10	31	31	18.6	-5.2%
	MD	10	31	31	10.0	-8.8%
	BA	10	31	31	10.0	-8.8%
	SD	10	31	31	10.0	-8.8%
	SV	10	31	31	10.0	-8.8%
	SCC	10	31	31	10.0	-8.8%
	NEP	10	31	31	26.6	-1.9%
	MC	10	31	31	31.0	0.0%
	NC	10	31	31	10.0	-8.8%
	NCC	10	31	31	10.0	-8.8%
Industrial/Military	SC	10	31	31	24.0	-3.0%
	SJV	10	31	31	24.0	-3.0%
	MD	10	31	31	24.0	-3.0%
	BA	10	31	31	24.0	-3.0%
	NEP	10	31	31	24.0	-3.0%
	SD	10	31	31	24.0	-3.0%
	SV	10	31	31	24.0	-3.0%
	SCC	10	31	31	24.0	-3.0%
Passenger	SC	10	31	31	10.8	-8.5%
	SJV	10	31	31	10.0	-8.8%
	BA	10	31	31	10.0	-8.8%
	SD	10	31	31	10.0	-8.8%
	SV	10	31	31	10.0	-8.8%
	SCC	10	31	31	12.1	-8.0%

Source : Fuel Estimate from http://www.arb.ca.gov/regact/carblohc/carblohc.htm

Sulfur

Currently, the baseline locomotive emissions inventory assumes an average fuel sulfur content of 2700 ppm. Industry has provided information on the sulfur content of the fuel that is currently being used by intrastate locomotives. Together with industry data and prior locomotive tests, staff believes a fuel correction factor should be incorporated into the model.

Table 24 shows the test data collected by the ARB, U.S. EPA, and others, where locomotive engines were tested on different fuel sulfur levels.

Table 24. Locomotive Engine Test with Different Sulfur Levels

Locomotive Engine	Fuel Properties Sulfur Content	Percent Change PM	Percent Change NOX	Percent Change CO	Percent Change HC	Source
EMD 12-645E3B	100/3300ppm	-0.29	-0.06	0.17	0.07	Fritz, 1991
GE DASH9-40C	330/3150ppm	-0.43	-0.07	-0.05	-0.18	Fritz (1995, EPA/SWRI)
MK 5000C	330/3150ppm	-0.71	-0.03	-0.03	-0.07	Fritz (1995, EPA/SWRI)
EMD 16-710G3B, SD70MAC	330/3150ppm	-0.38	-0.08	-0.30	-0.01	Fritz (1995, EPA/SWRI)
EMD SD70MAC	50/330ppm	-0.03	-0.04	0.07	0.01	Fritz (ARB/AAR, 2000)
EMD SD70MAC	50/4760ppm	-0.16	-0.06	0.08	0.03	Fritz (ARB/AAR, 2000)
EMD SD70MAC	330/4760ppm	-0.13	-0.03	0.01	0.01	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/330ppm	-0.03	-0.03	-0.01	-0.04	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/4760ppm	-0.39	-0.07	-0.02	0.02	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	330/4760ppm	-0.38	-0.04	-0.02	0.06	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/3190ppm	-0.27	-0.05	-0.03	0.01	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	330/3190ppm	-0.25	-0.02	-0.02	0.04	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	3190/4760ppm	-0.17	-.02	0.00	0.02	Fritz (ARB/AAR, 2000)
Average		-0.28	-0.05	-0.01	0.00	

From the above table, staff concluded that HC and CO emissions are not affected by different sulfur levels in the fuel. From these tests, staff computed the changes in PM emissions associated with changes in sulfur level. Staff corrected the PM emissions to account for the aromatic differences because the test data were not tested at the same aromatic volume percent. Because the locomotive engine testing was performed at various fuel sulfur levels (some at 330 ppm vs. 3190 ppm and some at 50 ppm vs. 3190 ppm), staff cannot assume the average percent change in PM emission is characteristics over the whole range of sulfur levels. From previous studies that staff has analyzed, it is possible to generate estimates of the percent change at various sulfur levels and throttle positions. Locomotive engines have 8 throttle positions plus dynamic braking and idle. During idle, braking, and throttle positions 1 and 2, there are no significant differences in emissions attributable to sulfur level. For the GE 4-

stroke engine, effect of sulfur on PM for throttle positions 3 to 8 can be defined by using the following equations:

<u>Equations to correct for PM for GE (4-Stroke) engines</u>

Notch 8 : PM (g/bhp-hr) = 0.00001308 * (sulfur level,ppm) + 0.0967
Notch 7 : PM (g/bhp-hr) = 0.00001102 * (sulfur level,ppm) + 0.0845
Notch 6 : PM (g/bhp-hr) = 0.00000654 * (sulfur level,ppm) + 0.1037
Notch 5 : PM (g/bhp-hr) = 0.00000548 * (sulfur level,ppm) + 0.1320
Notch 4 : PM (g/bhp-hr) = 0.00000663 * (sulfur level,ppm) + 0.1513
Notch 3 : PM (g/bhp-hr) = 0.00000979 * (sulfur level,ppm) + 0.1565

For the EMD 2-stroke engine, throttle positions 3 to 8 can be defined by using the following equations:

<u>Equations to correct for PM for EMD (2-Stroke) engines</u>

Notch 8 : PM (g/bhp-hr) = 0.0000123 * (sulfur level,ppm) + 0.3563
Notch 7 : PM (g/bhp-hr) = 0.0000096 * (sulfur level,ppm) + 0.2840
Notch 6 : PM (g/bhp-hr) = 0.0000134 * (sulfur level,ppm) + 0.2843
Notch 5 : PM (g/bhp-hr) = 0.0000150 * (sulfur level,ppm) + 0.2572
Notch 4 : PM (g/bhp-hr) = 0.0000125 * (sulfur level,ppm) + 0.2629
Notch 3 : PM (g/bhp-hr) = 0.0000065 * (sulfur level,ppm) + 0.2635

Table 25. Examples of PM Reductions Due to Changes in Sulfur Level

Sulfur Level (ppm)		PM Reduction	PM Reduction	PM Reduction
From	To	2 Stroke	4 Stroke	Composite
3100	1900	4.1%	8.4%	5.2%
3100	1300	6.1%	12.6%	7.7%
1300	330	3.5%	7.9%	4.6%
1300	140	4.2%	9.5%	5.5%
140	15	1.8%	4.0%	2.4%

*composite is 75% 2 Stroke Engine and 25% 4 Stroke Engine

Data provided by industry show that when operating in California, the three main types of diesel fuel used in locomotive engines consists of CARB diesel, EPA On-Highway diesel fuel, and EPA Off-road or High Sulfur diesel fuel. Four-stroke engines and two-stroke engines show different characteristics with respect to sulfur content. From the BAH report, 4-stroke engines make up about 25%, and 2-stroke engines make up about 75% of the locomotive engine fleet. Combining industry data, 4-stroke/2-stroke engine percent change and fleet makeup, Table 26 shows the percent change in PM emissions by year for the line-haul segment of the fleet.

Table 26. PM Emission Percent Change of Line-Haul Due to Sulfur, Statewide

Calendar Year	CARB Sulfur Content	EPA On-Highway Sulfur Content	EPA Off-road Sulfur Content	Weighted Fuel Sulfur Content	4-Stroke Engines PM Percent Change	2-Stroke Engines PM Percent Change	Weighted PM Emission Percent Change
1992	3100	3100	3100	3100	0.03	0.01	0.015
1993	500	330	3100	2919	0.02	0.01	0.009
1994	150	330	3100	2740	0.01	0.00	0.003
1995	140	330	3100	2557	-0.01	0.00	-0.006
1996	140	330	3100	2377	-0.02	-0.01	-0.014
1997	140	330	3100	2196	-0.04	-0.02	-0.022
1998-2001	140	330	3100	1899	-0.06	-0.03	-0.035
2002-2006	140	330	3100	1312	-0.10	-0.05	-0.061
2007+	15	15	330	129	-0.19	-0.09	-0.113

Table 27 and Table 28 provide further details of weighted fuel sulfur level by air basin. Weighted sulfur levels vary significantly from one air basin to another.

Table 27. Class I Line Haul Weighted Fuel Sulfur by Air Basin

Interstate Locomotive	Air Basin	1998 Weighted Sulfur	2002-2006 Weighted Sulfur	2007+ Weighted Sulfur
		ppm	ppm	ppm
Class I Line Haul	SCC	1023	467	31
	MC	2333	1149	113
	MD	2352	1767	180
	NEP	2560	1632	166
	SC	1985	1472	145
	SF	1711	899	88
	SJV	1600	868	78
	SS	2425	1328	129
	SV	2473	1456	147

Table 28. Intrastate Locomotives Weighted Fuel Sulfur by Air Basin

Intrastate Locomotive	Air Basin	1993 Weighted Sulfur	1994-2006 Weighted Sulfur	2007+ Weighted Sulfur
		ppm	ppm	ppm
Class I Local/Switcher	SC	346	312	15
	SJV	377	278	15
	MD	330	330	15
	BA	468	175	15
	SD	475	169	15
	SV	475	169	15
	SCC	475	169	15
Class III Local/Switcher	SC	388	388	21
	SJV	1016	804	80
	MD	500	140	15
	BA	500	140	15
	SD	500	140	15
	SV	500	140	15
	SCC	500	140	15
	NEP	2628	2553	264
	MC	1573	1573	152
	NC	500	140	15
	NCC	500	140	15
Industrial/Military	SC	1340	1220	120
	SJV	1340	1220	120
	MD	1340	1220	120
	BA	1340	1220	120
	NEP	1340	1220	120
	SD	1340	1220	120
	SV	1340	1220	120
	SCC	1340	1220	120
Passenger	SC	493	147	15
	SJV	500	140	15
	BA	500	140	15
	SD	500	140	15
	SV	500	140	15
	SCC	483	159	15

Appendix B,C, and D contains the fuel correction factors for PM, NOx, and SOx emissions by air basin.

Revised Locomotive Emission Inventory

Tables 29-31 shows the revised locomotive emission inventory for calendar years 2000,2010 and 2020.

Table 29. 2000 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.61	18.21	113.03	2.68	6.22
Local/Short-Run	1.01	3.33	22.58	0.41	0.22
Mixed/Bulk	2.13	6.85	48.95	1.09	2.20
Passenger/Amtrak	0.53	1.01	12.21	0.29	0.05
Yard/Switcher	0.55	1.46	10.43	0.20	0.09
Total	9.83	30.86	207.20	4.67	8.78

Table 30. 2010 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.56	21.90	71.35	2.40	0.60
Local/Short-Run	0.77	2.99	12.03	0.30	0.01
Mixed/Bulk	2.11	8.24	29.46	0.99	0.19
Passenger/Amtrak	0.58	1.14	12.29	0.31	0.02
Yard/Switcher	0.47	1.29	6.78	0.17	0.01
Total	9.49	35.56	131.91	4.17	0.83

Table 31. 2020 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.60	25.84	74.33	2.38	0.71
Local/Short-Run	0.67	2.99	11.17	0.26	0.01
Mixed/Bulk	2.13	9.72	31.14	0.98	0.23
Passenger/Amtrak	0.56	1.14	11.72	0.30	0.02
Yard/Switcher	0.44	1.29	6.22	0.16	0.01
Total	9.40	40.98	134.58	4.08	0.98

Appendix A

Methodology to Calculate Locomotive Inventory

Methodology

The methodology and assumptions used for estimating locomotive emissions consists of several steps taken from the Booz-Allen Hamilton's Locomotive Emission Study report (http://www.arb.ca.gov/app/library/libcc.php). First, emission factor data from various engine manufacturers such as EMD and General Electric (GE) must be gathered to calculate average emission factors for locomotives operated by the railroad companies. Second, train operations data, including throttle position profiles and time spent on various types of operations from different railroad companies needs to be estimated. Finally, the locomotive emission inventory can be calculated using train operations data, emission factors, and throttle position profiles.

Step 1 – Average Emission Factors

Engine emission factors are required for the different locomotive engines manufactured by the major locomotive suppliers EMD or GE. Emission factors are obtained from testing done by either the engine manufacturers or by Southwest Research Institute, a consulting company that has performed many tests on locomotive engines. Table A-1 lists the available emission factors.

Table A-1. Available Emission Factors for Different Locomotive Engines

Engine Manufacturer	Engine Model	Locomotive Model
EMD	12-567BC	SW10
EMD	12-645E	SW1500,MP15,GP15-1
EMD	16-567C	GP9
EMD	16-645E	GP38,GP38-2, GP28
EMD	12-645E3B	GP39-2
EMD	12-645E3	GP39-2, SD39
EMD	16-645E3	GP40, SD40, F40PH
EMD	16-645E3B	GP40-2, SD40-2, SDF40-2, F40PH
EMD	16-645F3	GP40X, GP50, SD45
EMD	16-645F3B	SD50
EMD	20-645E3	SD45,SD45-2, F45, FP45
EMD	16-710G3	GP60, SD60, SD60M
GE	127FDL2500	B23-7
GE	127FDL3000	SF30B
GE	167FDL3000	C30-7, SF30C
GE	167FDL4000	B40-8

Source: BAH report, 1992

Next, the locomotive roster from the largest railroad companies operating in the state were obtained. Table A-2 lists the locomotive roster for railroad companies in 1987.

Table A-2. Locomotive Roster 1987

					Type of Service		
Railroad Company	Engine Manufacturer	Engine Model	Horspower Rating	Units	Line Haul	Local	Yard/Switcher
ATSF	EMD	16-567BC	1500	211			X
ATSF	EMD	16-567C	1750	53			X
ATSF	EMD	16-567D2	2000	71		X	X
ATSF	EMD	16-645E	2000	69		X	X
ATSF	EMD	12-645E3	2300	62		X	
ATSF	EMD	12-645E3B	2300	60		X	
ATSF	EMD	16-645E3	2500	231	X	X	
ATSF	EMD	16-645E3	3000	18	X	X	
ATSF	EMD	16-645E3B	3000	203	X	X	
ATSF	EMD	16-645F3	3500	52	X		
ATSF	EMD	16-645F3B	3600	15	X		
ATSF	EMD	20-645E3	3600	243	X		
ATSF	EMD	16-710G3	3800	20	X		
ATSF	GE	GE-12	2350	60		X	
ATSF	GE	GE-12	3000	10	X	X	
ATSF	GE	GE-16	3000	226	X	X	

ATSF	GE	GE-16	3600	43	X		
ATSF	GE	GE-16	3900	3	X		
ATSF	GE	GE-16	4000	20	X		
Union Pacific	EMD	16-645BC	1200	56			X
Union Pacific	EMD	12-567A	1200	12			X
Union Pacific	EMD	12-645E	1500	281			X
Union Pacific	EMD	16-567CE	1500	35			X
Union Pacific	EMD	16-645E	2000	365		X	X
Union Pacific	EMD	12-645E3C	2300	24		X	
Union Pacific	EMD	16-567D3A	2500	16		X	
Union Pacific	EMD	16-645E3	3000	828	X	X	
Union Pacific	EMD	16-645E3B	3000	446	X	X	
Union Pacific	EMD	16-645F3	3500	36	X		
Union Pacific	EMD	16-645F3B	3600	60	X		
Union Pacific	EMD	16-710G3	3800	227	X		
Union Pacific	GE	GE-12	2300	106		X	
Union Pacific	GE	GE-12	3000	57	X	X	
Union Pacific	GE	GE-16	3000	156	X	X	
Union Pacific	GE	GE-16	3750	60	X		
Union Pacific	GE	GE-16	3800	256	X		
Southern Pacific	EMD	12-567C	1200	11			X
Southern Pacific	EMD	12-645E	1500	286			X
Southern Pacific	EMD	16-567BC	1500	37			X
Southern Pacific	EMD	16-567C	1750	326		X	
Southern Pacific	EMD	16-567D2	2000	145		X	
Southern Pacific	EMD	16-645E	2000	84		X	
Southern Pacific	EMD	12-645E3	2300	12		X	
Southern Pacific	EMD	16-645E3	2500	137	X	X	
Southern Pacific	EMD	16-645E3	3000	92	X		
Southern Pacific	EMD	16-645E3B	3000	353	X		
Southern Pacific	EMD	16-645F3	3500	4	X		
Southern Pacific	EMD	20-645E3	3600	425	X		
Southern Pacific	EMD	16-710G3	3800	65	X		
Southern Pacific	GE	GE-12	2300	15		X	
Southern Pacific	GE	GE-12	3000	107	X		
Southern Pacific	GE	GE-16	3600	20	X		
Southern Pacific	GE	GE-16	3900	92	X		

Source : BAH report, 1992

Using the available emission factors and the locomotive rosters, the average emission factors for each class of service can be calculated. Emission factors for models that were not available were assigned an emission factor based on horsepower rating and the number of cylinders from similar engine models.

Step 2 – Throttle Position Profiles and Train Operations Data

The railroad companies provided throttle position profiles. Locomotive engines operate at eight different constant loads and speeds called throttle notches. In addition, several other settings (idle and dynamic brake) are also common. For line haul and local operations, profiles were obtained from Train Performance Calculation (TPC) data and actual event recorder data, which are summarized in the BAH report.

For line haul operations, the data was modified to account for additional idle time between dispatch. Data supplied by Atchison, Topeka and Santa Fe (ATSF) indicates that the turnaround time for line haul locomotives in yards is approximately eight hours.

For local operations, several assumptions were used to develop throttle profiles. First, ten hours was used as an average hours per assignment. Second, the additional average idle time per day per locomotive was assumed to be ten hours.

The switch engine duty cycle is based upon actual tape data supplied by the ATSF railroad company on a switch engine that operated over a 2-day period. Yard engines are assumed to operate 350 days per year, with 2 weeks off for inspections and maintenance.

Train operations data provided by the railroad companies included :

Line Haul	**Local**	**Yard/Switcher**
Train type	Average trailing tons	Number of units assigned
Number of runs per year	Number of runs per year	Number of assignments
Average horsepower	Average horsepower	Average horsepower
Average units	Average units	
Origin/destination	Origin/destination	
Link miles		

Step 3 – Calculate Locomotive Emission Inventory

Emission inventories are calculated on a train-by-train basis using train operations data, average emission factor, and throttle position profiles.

Emission Inventory = Emission factor x average horsepower x time in notch per train x number of runs per year

Appendix B
PM Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	PM Fuel Correction Factor														
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.991	0.982	0.973	0.964	0.955	0.937	0.931	0.925	0.919	0.913	0.913	0.913	0.913	0.913	0.883
	MC	1.000	0.998	0.996	0.994	0.992	0.990	0.987	0.971	0.955	0.939	0.923	0.923	0.923	0.923	0.923	0.867
	MD	1.000	0.998	0.995	0.993	0.991	0.988	0.984	0.978	0.973	0.967	0.962	0.962	0.962	0.962	0.962	0.884
	NEP	1.000	0.999	0.998	0.998	0.997	0.996	0.995	0.983	0.971	0.959	0.947	0.947	0.947	0.947	0.947	0.875
	SC	1.000	0.996	0.993	0.989	0.986	0.982	0.975	0.970	0.965	0.960	0.955	0.955	0.955	0.955	0.955	0.888
	SF	1.000	0.993	0.987	0.980	0.974	0.967	0.954	0.940	0.926	0.912	0.898	0.898	0.898	0.898	0.898	0.851
	SJV	1.000	0.993	0.986	0.979	0.972	0.965	0.952	0.944	0.937	0.930	0.923	0.923	0.923	0.923	0.923	0.878
	SS	1.000	0.999	0.997	0.996	0.995	0.993	0.991	0.980	0.970	0.959	0.949	0.949	0.949	0.949	0.949	0.887
	SV	1.000	0.993	0.986	0.979	0.972	0.965	0.952	0.948	0.945	0.942	0.939	0.939	0.939	0.939	0.939	0.873

Intrastate Loc	Air Basin	PM Fuel Correction Factor														
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.890	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.865
	SJV	1.000	0.863	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.836
	MD	1.000	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.882
	BA	1.000	0.778	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.747
	SD	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
	SV	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
	SCC	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
Class III Loca	SC	1.000	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.882
	SJV	1.000	0.839	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.787
	MD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	BA	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SCC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	NEP	1.000	0.963	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.858
	MC	1.000	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.888
	NC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	NCC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.722
Industrial/Milit	SC	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SJV	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	MD	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	BA	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	NEP	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SD	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SV	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SCC	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
Passenger	SC	1.000	0.754	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.723
	SJV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	BA	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SCC	1.000	0.764	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.733

PRELIMINARY DRAFT – DO NOT CITE OR QUOTE

Appendix C
NOx Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	NOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SF	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SS	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940

Intrastate Loc	Air Basin	NOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Class III Loca	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Industrial/Milit	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Passenger	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940

Appendix D
SOx Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	SOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.896	0.793	0.689	0.586	0.482	0.379	0.327	0.276	0.225	0.173	0.173	0.173	0.173	0.173	0.011
	MC	1.000	0.977	0.955	0.932	0.909	0.887	0.864	0.755	0.645	0.535	0.426	0.426	0.426	0.426	0.426	0.042
	MD	1.000	0.979	0.957	0.936	0.914	0.893	0.871	0.817	0.763	0.709	0.654	0.654	0.654	0.654	0.654	0.067
	NEP	1.000	0.991	0.983	0.974	0.965	0.957	0.948	0.862	0.776	0.690	0.605	0.605	0.605	0.605	0.605	0.062
	SC	1.000	0.956	0.912	0.868	0.823	0.779	0.735	0.688	0.640	0.593	0.545	0.545	0.545	0.545	0.545	0.054
	SF	1.000	0.939	0.878	0.817	0.756	0.695	0.634	0.559	0.483	0.408	0.333	0.333	0.333	0.333	0.333	0.033
	SJV	1.000	0.932	0.864	0.796	0.728	0.660	0.593	0.525	0.457	0.389	0.322	0.322	0.322	0.322	0.322	0.029
	SS	1.000	0.983	0.966	0.949	0.932	0.915	0.898	0.797	0.695	0.594	0.492	0.492	0.492	0.492	0.492	0.048
	SV	1.000	0.986	0.972	0.958	0.944	0.930	0.916	0.822	0.728	0.634	0.539	0.539	0.539	0.539	0.539	0.054

Intrastate Loc	Air Basin	SOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.128	0.127	0.126	0.125	0.124	0.122	0.121	0.120	0.119	0.118	0.117	0.115	0.115	0.115	0.006
	SJV	1.000	0.139	0.136	0.133	0.130	0.126	0.123	0.120	0.116	0.113	0.110	0.106	0.103	0.103	0.103	0.006
	MD	1.000	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.006
	BA	1.000	0.173	0.164	0.154	0.144	0.134	0.124	0.114	0.104	0.095	0.085	0.075	0.065	0.065	0.065	0.006
	SD	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
	SV	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
	SCC	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
Class III Loca	SC	1.000	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.008
	SJV	1.000	0.376	0.369	0.362	0.355	0.348	0.341	0.333	0.326	0.319	0.312	0.305	0.298	0.298	0.298	0.029
	MD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	BA	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SCC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	NEP	1.000	0.973	0.971	0.968	0.966	0.963	0.961	0.958	0.956	0.953	0.951	0.948	0.946	0.946	0.946	0.098
	MC	1.000	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.056
	NC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	NCC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
Industrial/Milit	SC	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SJV	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	MD	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	BA	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	NEP	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SD	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SV	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SCC	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
Passenger	SC	1.000	0.183	0.171	0.159	0.148	0.136	0.124	0.113	0.101	0.090	0.078	0.066	0.055	0.055	0.055	0.006
	SJV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	BA	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SCC	1.000	0.179	0.168	0.157	0.146	0.135	0.124	0.113	0.103	0.092	0.081	0.070	0.059	0.059	0.059	0.006

APPENDIX A-8

DEATILED EMISSION CALCULATIONS, FOR OFFSITE LOCOMOTIVE EMISSIONS

UPRR 2005 On-Port Emissions Calculations

(based on PHL trailing ton-mile and train-mile data, and UPRR-observed locomotive model distribution)

Movements	Train Miles	Ton Miles	PM (tpy)	NOx (tpy)	HC (tpy)	CO (tpy)	SO2 (tpy)	CO2 (MTpy)	CH4 (MTpy)	N2O (MTpy)
Intermodal Movement	8583	35878774	**0.53**	**20.72**	**0.98**	**2.10**	**1.23**	**1271**	**0.100**	**0.032**
IM Power Moves	7597	0	**0.16**	**6.13**	**0.29**	**0.62**	**0.36**	**376**	**0.030**	**0.009**
Local	1558	2374345	**0.03**	**1.59**	**0.08**	**0.17**	**0.02**	**101**	**0.008**	**0.003**
Local Power Moves	447	0	**0.01**	**0.24**	**0.01**	**0.03**	**0.00**	**15**	**0.001**	**0.000**
Intermodal Idling										
	# of Trains									
Terminating	393		**0.01**	**0.27**	**0.04**	**0.06**	**0.02**	**22**	**0.002**	**0.001**
Originating	1604		**0.10**	**2.98**	**0.47**	**0.69**	**0.25**	**258**	**0.020**	**0.006**
Total			**0.83**	**31.92**	**1.87**	**3.67**	**1.88**	**2044**	**0.161**	**0.051**

UPRR 2005 Dolores/ICTF Emissions

(based on UPRR train and service data counts of locomotives by traintype and locomotive model)

(Note -- Does not include Alameda Corridor Traffic adjacent to Dolores)

ICTF	PM (tpy)	NOx (tpy)	HC (tpy)	CO (tpy)	SO2 (tpy)	CO2 (MTpy)	CH4 (MTpy)	N2O (MTpy)
Intermodal	**0.32**	**13.09**	**1.00**	**1.49**	**0.84**	**840**	**0.066**	**0.021**
Yard Switching	**2.82**	**129.46**	**5.78**	**13.51**	**0.91**	**6075**	**0.478**	**0.153**
Service Load Testing	**0.25**	**10.81**	**0.42**	**1.17**	**0.20**	**632**	**0.050**	**0.016**
Service Idling	**0.28**	**8.37**	**1.35**	**1.97**	**1.30**	**777**	**0.061**	**0.020**
Subtotal	**3.67**	**161.72**	**8.54**	**18.14**	**3.24**	**8325**	**0.654**	**0.209**

On-Dock Intermodal at Dolores	PM (tpy)	NOx (tpy)	HC (tpy)	CO (tpy)	SO2 (tpy)	CO2 (MTpy)	CH4 (MTpy)	N2O (MTpy)
Intermodal	**0.32**	**13.09**	**1.00**	**1.49**	**0.84**	**840**	**0.066**	**0.021**
Yard Switching	**2.08**	**95.54**	**4.27**	**9.97**	**0.67**	**4483**	**0.352**	**0.113**
Service Load Testing	**0.25**	**10.81**	**0.42**	**1.17**	**0.20**	**632**	**0.050**	**0.016**
Service Idling	**0.28**	**8.37**	**1.35**	**1.97**	**1.30**	**777**	**0.061**	**0.020**
Subtotal	**2.94**	**127.80**	**7.03**	**14.60**	**3.01**	**6733**	**0.529**	**0.169**

Manifest Freight (Dolores)	PM (tpy)	NOx (tpy)	HC (tpy)	CO (tpy)	SO2 (tpy)	CO2 (MTpy)	CH4 (MTpy)	N2O (MTpy)
Freight	**0.58**	**23.90**	**1.32**	**2.54**	**1.26**	**1550**	**0.122**	**0.039**
Yard Switching	**0.68**	**31.11**	**1.39**	**3.25**	**0.22**	**1460**	**0.115**	**0.037**
Service Load Testing	**0.08**	**3.52**	**0.14**	**0.38**	**0.06**	**206**	**0.016**	**0.005**
Service Idling	**0.09**	**2.72**	**0.44**	**0.64**	**0.42**	**253**	**0.020**	**0.006**
Subtotal	**1.43**	**61.25**	**3.29**	**6.81**	**1.97**	**3468**	**0.273**	**0.087**
Dolores/ICTF In-Yard Total	**8.04**	**350.77**	**18.86**	**39.55**	**8.21**	**18526**	**1.456**	**0.466**
Other Offsite (not within Dolores/ICTF)								
UP Line Haul from AC to SoCAB Boundary	**26.90**	**1034.38**	**45.79**	**109.46**	**60.73**	**62113**	**4.883**	**1.560**

UPRR 2005 Line-Haul Off-Port Emissions Calculations
(based on UPRR MGT data, emission factors for 2005 UPRR intermodal fleet distribution, and EPA line-haul duty cycle)
(GHG emissions based on UPRR fuel consumption and CARB emission factors)

		Yuma	Cajon	Palmdale	Coast	
Entry/Exit Point from SoCAB						
Fraction of Port Traffic		78.6%	17.8%	3.5%	0.1%	100%
Distance from Port to Exit Point (add 3.9 mi. to ICTF number)		103.1	101.6	72.9	57.9	
Distance from ICTF to Exit Point		99.2	97.7	69.0	54.0	

		MGT-Miles			
UPRR Only -- Does not include BNSF					
MGT originating and terminating in Port terminals	**11.00**	891	199	28	1
MGT originating and terminating at Dolores/ICTF	**36.83**	2872	641	89	2

Total Port-Related Off Port MGT-Miles in Basin	**4722**

	2005 HC		
	Fuel C-Rate Gal/Ton Mile	**0.001296**	
Emission factor using EPA line-haul duty cycle and	**HC Emfac (g/gal)**	**6.79**	
2005 UPRR ICTF/Port intermodal lcomotive fleet	**Total Port-Related Off Port Emissions in Basin**	**41537933**	**g/yr**
		45.79	**TPY**

	2005 CO		
	Fuel C-Rate Gal/Ton Mile	**0.001296**	
Emission factor using EPA line-haul duty cycle and	**CO Emfac (g/gal)**	**16.23**	
2005 UPRR ICTF/Port intermodal lcomotive fleet	**Total Port-Related Off Port Emissions in Basin**	**99302388**	**g/yr**
		109.46	**TPY**

	2005 NOx		
	Fuel C-Rate Gal/Ton Mile	**0.001296**	
Emission factor using EPA line-haul duty cycle and	**NOx Emfac (g/gal)**	**153.34**	
2005 UPRR ICTF/Port intermodal lcomotive fleet	**Total Port-Related Off Port Emissions in Basin**	**938392975**	**g/yr**
		1034.38	**TPY**

	2005 PM		
	Fuel C-Rate Gal/Ton Mile	**0.001296**	
Emission factor using EPA line-haul duty cycle and	**PM Emfac (g/gal)**	**3.99**	
2005 UPRR ICTF/Port intermodal lcomotive fleet	**Total Port-Related Off Port Emissions in Basin**	**24406080**	**g/yr**
		26.90	**TPY**

	2005 SO2		
	Fuel C-Rate Gal/Ton Mile	**0.001296**	
Emission factor using EPA line-haul duty cycle and	**SO2 Emfac (g/gal)**	**9.00**	
2005 UPRR ICTF/Port intermodal lcomotive fleet	**Total Port-Related Off Port Emissions in Basin**	**55092723**	**g/yr**
		60.73	**TPY**

APPENDIX B

DIESEL-FUELED DRAYAGE TRUCKS

APPENDIX B-1

METHODOLOGY FOR DETERMINING THE NUMBER OF DRAYAGE TRUCK TRIPS PER YEAR

Appendix B

Methodology for Estimating the Number of Drayage Truck Trips per Year

Activity data is used to calculate emissions from HHD Diesel-fueled drayage trucks. Emissions were estimated based on the number of truck trips, the length of each trip, and the amount of time spent idling. The number of truck trips at ICTF for the 2005 calendar year were based on historic actual lift counts, gate counts for the facility, and forecasts of future lifts. The following terms are used in this assessment:

- Lift: This is the transfer of a container or trailer (empty or loaded) from a rail car to a truck chassis, or from a truck chassis to a rail car. This count does not include flips.
- Gate Count: This is the count of trailers (empty or loaded) and chassis with containers (empty or loaded) going past the plant gate. This count does not include bobtails (truck without a chassis) or trucks with an empty chassis (no container).

The 2005 lift count was multiplied by the gate balancing factor (GBF) to determine the number of containers that should have passed through the "in gate" (C_I) in 2005. The container lift count for 2005 was 626,339 lifts.

$$C_I = Lift\ Count\ x\ GBF$$

The GBF was calculating by dividing the number of containers passing through the "in gate" by the total gate count as follows:

$$GBF = \left(\frac{"in\ gate"\ count}{"in\ gate"\ count + "out\ gate"\ count} \right) x 100$$

The GBF for 2005 was 62.8%, which means that roughly 63% of the total container passing though an ICTF gate passed though the "in gate".

The calculated "in gate" (C_I) value was subtracted from the total number of lifts to determine the number of containers that should have passed through the "out gate" (C_O) in 2005.

$$C_O = Lift\ Count - C_I$$

The calculated gate counts were compared with the actual facility gate counts to verify accuracy.

The minimum number of trucks trips is achieved when every truck that enters with a container also leaves with a container. The actual percentage of trucks that both enter and leave ICTF with a container is not known. Based on aerial photos of the ICTF and data contained in the Port of Los Angeles Baseline Traffic Study (Meyer, Mohaddis Associates, Inc., April 2004)[1] it was assumed that 40% of the trucks entering ICTF with a container also leave ICTF with a container[2]. This factor was used to calculate the number of bobtails and empty chassis that entered the facility (BI) and the number of bobtails and empty chassis that exited the facility (BO) based on the following formulas.

$$B_I = C_O - \left(C_I \ x\, 40\%\right)$$

$$B_O = C_I - \left(C_I \ x\, 40\%\right)$$

The total number of truck trips for 2005 was calculated as follows:

$$Trips = C_I + C_O + B_I + B_O$$

[1] Available at http://www.portoflosangeles.org/DOC/REPORT_Draft_Traffic_Baseline.pdf
[2] Personal communication from Greg Chiodo of HDR on September 24, 2007.

APPENDIX B-2

DEATILED EMISSION CALCULATIONS, EMISSION FACTOR DERIVATION AND EMFAC2007 OUTPUT

Summary of Emissions from HHD Diesel-Fueled Drayage Trucks
Dolores and ICTF Rail Yards, Long Beach, CA

Running Exhaust Emissions

Yard	Number of Truck Trips[1]	VMT per Trip[2]	VMT per Year	2005 Emission Factors (g/mi)[3,4]						2005 Emission Estimates (tpy)					
				ROG	CO	NOx	PM10[5]	DPM[5]	SOx	ROG	CO	NOx	PM10	DPM	SOx
ICTF - Onsite	938,074	1.75	1,641,629.38	6.40	17.23	28.68	2.53	2.47	0.24	11.58	31.18	51.91	4.58	4.46	0.44

Idling Exhaust Emissions

Yard	Number of Truck Trips	Idling[6]		2005 Emission Factors (g/hr)[7]						2005 Emission Estimates (tpy)					
		(mins/trip)	(hr/yr)	ROG	CO	NOx	PM10	DPM	SOx	ROG	CO	NOx	PM10	DPM	SOx
ICTF - Onsite	938,074	30	469,036.97	16.16	52.99	100.38	2.85	2.85	0.55	8.36	27.40	51.90	1.47	1.47	0.28

Notes:
1. Number of truck trips is based on the 2005 lift count and was calculated using a spreadsheet provided by HDR. See Appendix B for additional detail.
2. VMT per trip estimated from aerial photos.
3. Running exhaust emission factors (g/mi) from EMFAC 2007 using the BURDEN output option. The EMFAC default model year distribution for L.A. County was used.
4. Emission factor calculations assumed an average speed of 15 mph.
5. The PM10 emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.
6. Idling time (mins/trip) per UPRR staff.
7. Idling exhaust emission factors from EMFAC 2007 using the EMFAC output option. The EMFAC default model year distribution for L.A. County was used.

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2006/12/14 07:57:01
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	27425
VMT/1000	5538
Trips	138783
Reactive Organic Gas Emissions	
Run Exh	39.07
Idle Exh	0.82
Start Ex	0

Total Ex	39.9
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	39.9
Carbon Monoxide Emissions	
Run Exh	105.2
Idle Exh	2.7
Start Ex	0

Total Ex	107.91
Oxides of Nitrogen Emissions	
Run Exh	175.11
Idle Exh	5.12
Start Ex	0

Total Ex	180.23
Carbon Dioxide Emissions (000)	
Run Exh	17.5
Idle Exh	0.34
Start Ex	0

Total Ex	17.84
PM10 Emissions	
Run Exh	15.05
Idle Exh	0.15
Start Ex	0

Total Ex	15.19
TireWear	0.22
BrakeWr	0.17

Total	15.59
Lead	0
SOx	1.48
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	1605.41

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2006/12/14 08:09:32
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1965 to 2005 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	16.163	15.188

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	52.988	49.792

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	100.382	94.327

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	6617.134	6192.269

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.55	0.517

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	2.845	2.674

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

APPENDIX B-3

DEATILED EMISSION CALCULATIONS, EMISSION FACTOR DERIVATION AND EMFAC2007 OUTPUT FOR OFFSITE DRAYAGE TRUCK EMISSIONS

Summary of Emissions from Intermodal HHD Diesel-Fueled Truck Traffic within 0.5 Miles of Yard Boundaries
Dolores and ICTF Rail Yards, Long Beach, CA

Road Segment	Number of Truck Trips[1,2]	VMT per Trip[3]	VMT per Year	2005 Emission Factors (g/mi)[4]						2005 Emission Estimates (tpy)					
				ROG	CO	NOx	PM10[5]	DPM[5]	SOx	ROG	CO	NOx	PM10	DPM	SOx
Route A															
Gate - L of Sepulveda to T.I. Fwy Enterance	647,271	0.13	84,145.23	1.95	7.53	22.04	1.24	1.18	0.16	0.18	0.70	2.04	0.12	0.11	0.01
S on T.I. Fwy	647,271	0.50	323,635.51	1.95	7.53	22.04	1.24	1.18	0.16	0.70	2.69	7.86	0.44	0.42	0.06
Route B															
Gate - R on Sepulveda to Alameda St	215,757	0.74	159,660.18	1.95	7.53	22.04	1.24	1.18	0.16	0.34	1.33	3.88	0.22	0.21	0.03
R on Alameda to I-405	215,757	1.40	302,059.81	1.95	7.53	22.04	1.24	1.18	0.16	0.65	2.51	7.34	0.41	0.39	0.05
I-405 S towards I-710	215,757	0.50	107,878.50	1.95	7.53	22.04	1.24	1.18	0.16	0.23	0.90	2.62	0.15	0.14	0.02
Route C															
Gate - R on Sepulveda to Alameda St	75,046	0.74	55,533.98	1.95	7.53	22.04	1.24	1.18	0.16	0.12	0.46	1.35	0.08	0.07	0.01
R on Alameda towards West Basin Area	75,046	2.20	165,101.01	1.95	7.53	22.04	1.24	1.18	0.16	0.36	1.37	4.01	0.23	0.21	0.03
Total	**938,074**		**1,198,014.22**							**2.58**	**9.95**	**29.11**	**1.64**	**1.56**	**0.21**

Notes:
1. Number of truck trips is equal to the total number of intermodal trucks multiplied by the percentage of trucks following each route.
2. Percentage of trucks following each route from the *Preliminary Traffic Study.*
3. VTM per trip was determined for each road segment from Google Earth.
4. Emission factors include traveling and idling and are from EMFAC 2007 using the BURDEN output option. The EMFAC default model year and speed distributions for L.A. County were used.
5. The PM10 emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2007/08/22 09:21:49
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	27425
VMT/1000	5538
Trips	138783
Reactive Organic Gas Emissions	
Run Exh	11.09
Idle Exh	0.82
Start Ex	0

Total Ex	11.92
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	11.92
Carbon Monoxide Emissions	
Run Exh	43.29
Idle Exh	2.7
Start Ex	0

Total Ex	45.99
Oxides of Nitrogen Emissions	
Run Exh	129.44
Idle Exh	5.12
Start Ex	0

Total Ex	134.56
Carbon Dioxide Emissions (000)	
Run Exh	11.45
Idle Exh	0.34
Start Ex	0

Total Ex	11.79
PM10 Emissions	
Run Exh	7.04
Idle Exh	0.15
Start Ex	0

Total Ex	7.19
TireWear	0.22
BrakeWr	0.17

Total	7.58
Lead	0
SOx	0.98
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	1061.03

APPENDIX C

DEATILED EMISSION CALCULATIONS, EMISSION FACTOR DERIVATION AND OFFROAD2007 OUTPUT FOR CARGO HANDLING EQUIPMENT

Summary of Emissions from Cargo Handling Equipment
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Equipment Type	Make	Model	Engine Make	Engine Model	Model Year	No of Units	Rating (hp)	Hours of Operation (hrs/yr)[1,2,3]	Load Factor[4]	2005 Emission Factors (g/bhp-hr)[5]						2005 Emission Estimates (tons/yr)					
											HC	CO	NOx	PM10	DPM	SOx	ROG	CO	NOx	PM10	DPM	SOx
ICTF	Forklift	Toyota	6FDU25	Toyota	Unknown	1997	1	85	730	0.30	0.803	3.741	8.818	0.679	0.679	0.062	0.02	0.08	0.18	0.01	0.01	0.00
ICTF	RTG #2	Mi Jack	850R	Detroit	DDEC	1997	1	300	2448	0.43	0.281	1.035	6.547	0.165	0.165	0.052	0.10	0.36	2.28	0.06	0.06	0.02
ICTF	RTG #7	Mi Jack	1000R	Detroit	671N	1988	1	250	2448	0.43	0.705	3.375	9.194	0.476	0.476	0.060	0.20	0.98	2.67	0.14	0.14	0.02
ICTF	RTG #15-18	Mi Jack	1000R	Detroit	671TA	1995	4	300	2448	0.43	0.621	3.113	8.573	0.402	0.402	0.052	0.87	4.33	11.94	0.56	0.56	0.07
ICTF	RTG #19-20	Mi Jack	1000RC	Detroit	DDEC	2002	2	300	2448	0.43	0.111	0.971	4.475	0.104	0.104	0.052	0.08	0.68	3.12	0.07	0.07	0.04
ICTF	RTG #21	Mi Jack	1200 R	Detroit	DDEC	2005	1	350	2448	0.43	0.074	0.933	3.836	0.094	0.094	0.052	0.03	0.38	1.56	0.04	0.04	0.02
ICTF	Top Pick	Mi Jack	PC-90	Cummins	NA335	1972	1	335	208	0.43	1.252	6.183	15.587	0.901	0.901	0.060	0.04	0.20	0.51	0.03	0.03	0.00
ICTF	Top Pick	Taylor	Tay-950	Cummins	L-10	1988	1	350	2190	0.59	0.705	3.375	9.194	0.476	0.476	0.060	0.35	1.68	4.58	0.24	0.24	0.03
ICTF	Top Pick	Taylor	Tay-950	Cummins	L-10	1989	1	350	2190	0.59	0.693	3.338	9.105	0.465	0.465	0.060	0.35	1.66	4.54	0.23	0.23	0.03
ICTF	Yard Hostler	Capacity	TJ5000	Caterpillar	3116	1999	15	150	468	0.39	0.610	3.078	7.342	0.433	0.433	0.060	0.28	1.39	3.32	0.20	0.20	0.03
ICTF	Yard Hostler	Capacity	TJ5000	Caterpillar	3116	2005	58	173	4680	0.39	0.119	2.754	4.283	0.139	0.139	0.060	2.41	55.60	86.46	2.80	2.80	1.21
Total							**86**										**4.71**	**67.35**	**121.16**	**4.38**	**4.38**	**1.46**

Notes:
1. Per UPRR personnel, only one top pick is operated at a time. Top picks are operated a total of 12 hours per day. The Mi Jack top pick is a backup and is used infrequently.
2. Assumed each RTG operates 7 hours per day, based on data collected at UPRR's Commerce Rail Yard.
3. Assumed the 173 hp Yard Hostlers operate 4,680 hours per year based on data collected at UPRR's Commerce Rail Yard. The 150 hp Yard Hostlers are backup units, it was assumed they operate 10% of the time.
4. Load factors for the RTGs and top picks are from OFFROAD2007 model. Load factor for the yard hostlers from personal communication with Harold Holmes of ARB and is based on a study conducted at the POLA/POLB.
5. Emission factors from CARB's Cargo Handling Equipment Emission Calculation Spreadsheet.

Cal Year	Yard	Equipment Type	Code	Useful Life (hours)	Model Year	Age (years)	Population	HP	HP Bin	Yearly Operational Hrs	Cummulative Hours
2005	***(Example Calculation)***	***Yard Tractor onroad engine***	***9***	***8800***	***1985***	***21***	***2***	***500***	***500***	***1100***	***23100***
2005	ICTF	Forklift	3	14600	1997	9	1	85	120	730	6570
2005	ICTF	Crane	1	157680	1997	9	1	300	500	8760	78840
2005	ICTF	Crane	1	157680	1988	18	1	250	250	8760	157680
2005	ICTF	Crane	1	157680	1995	11	1	300	500	8760	96360
2005	ICTF	Crane	1	157680	1995	11	1	300	500	8760	96360
2005	ICTF	Crane	1	157680	1995	11	1	300	500	8760	96360
2005	ICTF	Crane	1	157680	1995	11	1	300	500	8760	96360
2005	ICTF	Crane	1	157680	2002	4	1	300	500	8760	35040
2005	ICTF	Crane	1	157680	2002	4	1	300	500	8760	35040
2005	ICTF	Crane	1	157680	2005	1	1	350	500	8760	8760
2005	ICTF	Material Handling Equip	4	3744	1972	34	1	335	500	208	7072
2005	ICTF	Material Handling Equip	4	39420	1988	18	1	350	500	2190	39420
2005	ICTF	Material Handling Equip	4	39420	1989	17	1	350	500	2190	37230
2005	ICTF	Yard Tractor offroad engine	8	17520	1999	7	15	150	175	2190	15330
2005	ICTF	Yard Tractor offroad engine	8	70080	2005	1	58	173	175	8760	8760

Emission Control Factor? (y/n)	Emission Control (If no emission control leave blank)	Load Factor	HPMY	HC EF	Emission Control HC EF	HC dr	FCF HC	CO EF	Emission Control CO EF	CO dr	NOX EF	Emission Control NOX EF
n		***0.65***	***5001985***	***1.30E+00***	***0.00E+00***	***0.000065***	***0.720000***	***1.55E+01***	***0.00E+00***	***0.000440***	***6.00E+00***	***0.00E+00***
n		0.30	1201997	9.90E-01	0.00E+00	0.000019	0.720000	3.49E+00	0.00E+00	0.000038	8.75E+00	0.00E+00
n		0.43	5001997	3.20E-01	0.00E+00	0.000001	0.720000	9.20E-01	0.00E+00	0.000001	6.25E+00	0.00E+00
n		0.43	2501988	6.80E-01	0.00E+00	0.000002	0.720000	2.70E+00	0.00E+00	0.000004	8.17E+00	0.00E+00
n		0.43	5001995	6.80E-01	0.00E+00	0.000002	0.720000	2.70E+00	0.00E+00	0.000004	8.17E+00	0.00E+00
n		0.43	5001995	6.80E-01	0.00E+00	0.000002	0.720000	2.70E+00	0.00E+00	0.000004	8.17E+00	0.00E+00
n		0.43	5001995	6.80E-01	0.00E+00	0.000002	0.720000	2.70E+00	0.00E+00	0.000004	8.17E+00	0.00E+00
n		0.43	5001995	6.80E-01	0.00E+00	0.000002	0.720000	2.70E+00	0.00E+00	0.000004	8.17E+00	0.00E+00
n		0.43	5002002	1.40E-01	0.00E+00	0.000000	0.720000	9.20E-01	0.00E+00	0.000001	4.51E+00	0.00E+00
n		0.43	5002002	1.40E-01	0.00E+00	0.000000	0.720000	9.20E-01	0.00E+00	0.000001	4.51E+00	0.00E+00
n		0.43	5002005	1.00E-01	0.00E+00	0.000000	0.720000	9.20E-01	0.00E+00	0.000001	4.00E+00	0.00E+00
n		0.59	5001972	9.50E-01	0.00E+00	0.000112	0.720000	4.20E+00	0.00E+00	0.000280	1.20E+01	0.00E+00
n		0.59	5001988	6.80E-01	0.00E+00	0.000008	0.720000	2.70E+00	0.00E+00	0.000017	8.17E+00	0.00E+00
n		0.59	5001989	6.80E-01	0.00E+00	0.000008	0.720000	2.70E+00	0.00E+00	0.000017	8.17E+00	0.00E+00
n		0.65	1751999	6.80E-01	0.00E+00	0.000011	0.720000	2.70E+00	0.00E+00	0.000025	6.90E+00	0.00E+00
n		0.65	1752005	1.60E-01	0.00E+00	0.000001	0.720000	2.70E+00	0.00E+00	0.000006	4.44E+00	0.00E+00

NOX dr	FCF NOX	PM EF	Emission Control PM EF	PM dr	FCF PM	SOX EF	Final EF_HC	Final EF_CO	Final EF_NOX	Final EF_SOX	Final EF_PM	TOG
0.000143	***0.930000***	***6.00E-01***	***0.00E+00***	***0.000046***	***0.750000***	***5.97E-02***	***2.02E+00***	***2.57E+01***	***8.66E+00***	***5.97E-02***	***1.24E+00***	***2.29E+00***
0.000084	0.948000	6.90E-01	0.00E+00	0.000021	0.822000	6.23E-02	8.03E-01	3.74E+00	8.82E+00	6.23E-02	6.79E-01	2.37E-02
0.000008	0.948000	1.50E-01	0.00E+00	0.000001	0.822000	5.21E-02	2.81E-01	1.04E+00	6.55E+00	5.21E-02	1.65E-01	5.04E-01
0.000011	0.930000	3.80E-01	0.00E+00	0.000002	0.750000	5.97E-02	7.05E-01	3.38E+00	9.19E+00	5.97E-02	4.76E-01	1.05E+00
0.000011	0.930000	3.80E-01	0.00E+00	0.000002	0.750000	5.21E-02	6.21E-01	3.11E+00	8.57E+00	5.21E-02	4.02E-01	1.11E+00
0.000011	0.930000	3.80E-01	0.00E+00	0.000002	0.750000	5.21E-02	6.21E-01	3.11E+00	8.57E+00	5.21E-02	4.02E-01	1.11E+00
0.000011	0.930000	3.80E-01	0.00E+00	0.000002	0.750000	5.21E-02	6.21E-01	3.11E+00	8.57E+00	5.21E-02	4.02E-01	1.11E+00
0.000011	0.930000	3.80E-01	0.00E+00	0.000002	0.750000	5.21E-02	6.21E-01	3.11E+00	8.57E+00	5.21E-02	4.02E-01	1.11E+00
0.000006	0.948000	1.10E-01	0.00E+00	0.000000	0.822000	5.21E-02	1.11E-01	9.71E-01	4.48E+00	5.21E-02	1.04E-01	1.98E-01
0.000006	0.948000	1.10E-01	0.00E+00	0.000000	0.822000	5.21E-02	1.11E-01	9.71E-01	4.48E+00	5.21E-02	1.04E-01	1.98E-01
0.000005	0.948000	1.10E-01	0.00E+00	0.000000	0.822000	5.21E-02	7.38E-02	9.33E-01	3.84E+00	5.21E-02	9.38E-02	1.54E-01
0.000673	0.930000	5.30E-01	0.00E+00	0.000095	0.750000	5.97E-02	1.25E+00	6.18E+00	1.56E+01	5.97E-02	9.01E-01	8.17E-02
0.000044	0.930000	3.80E-01	0.00E+00	0.000006	0.750000	5.97E-02	7.05E-01	3.38E+00	9.19E+00	5.97E-02	4.76E-01	5.06E-01
0.000044	0.930000	3.80E-01	0.00E+00	0.000006	0.750000	5.97E-02	6.93E-01	3.34E+00	9.11E+00	5.97E-02	4.65E-01	4.97E-01
0.000055	0.948000	3.80E-01	0.00E+00	0.000010	0.822000	5.97E-02	6.10E-01	3.08E+00	7.34E+00	5.97E-02	4.33E-01	3.10E+00
0.000009	0.948000	1.60E-01	0.00E+00	0.000001	0.822000	5.97E-02	1.19E-01	2.75E+00	4.28E+00	5.97E-02	1.39E-01	1.08E+01

Emissions (tons/year)							Emissions (tons/day)							
ROG	CO	NOX	SOX	PM	PM10	PM2.5	TOG	ROG	CO	NOX	SOX	PM	PM10	PM2.5
2.01E+00	***2.02E+01***	***6.82E+00***	***4.70E-02***	***9.78E-01***	***9.78E-01***	***8.99E-01***	***6.27E-03***	***5.50E-03***	***5.54E-02***	***1.87E-02***	***1.29E-04***	***2.68E-03***	***2.68E-03***	***2.46E-03***
2.08E-02	7.67E-02	1.81E-01	1.28E-03	1.39E-02	1.39E-02	1.28E-02	6.49E-05	5.70E-05	2.10E-04	4.95E-04	3.50E-06	3.82E-05	3.82E-05	3.51E-05
4.43E-01	1.29E+00	8.15E+00	6.49E-02	2.05E-01	2.05E-01	1.88E-01	1.38E-03	1.21E-03	3.53E-03	2.23E-02	1.78E-04	5.61E-04	5.61E-04	5.16E-04
9.25E-01	3.50E+00	9.53E+00	6.20E-02	4.94E-01	4.94E-01	4.54E-01	2.88E-03	2.53E-03	9.59E-03	2.61E-02	1.70E-04	1.35E-03	1.35E-03	1.24E-03
9.78E-01	3.87E+00	1.07E+01	6.49E-02	5.00E-01	5.00E-01	4.60E-01	3.05E-03	2.68E-03	1.06E-02	2.92E-02	1.78E-04	1.37E-03	1.37E-03	1.26E-03
9.78E-01	3.87E+00	1.07E+01	6.49E-02	5.00E-01	5.00E-01	4.60E-01	3.05E-03	2.68E-03	1.06E-02	2.92E-02	1.78E-04	1.37E-03	1.37E-03	1.26E-03
9.78E-01	3.87E+00	1.07E+01	6.49E-02	5.00E-01	5.00E-01	4.60E-01	3.05E-03	2.68E-03	1.06E-02	2.92E-02	1.78E-04	1.37E-03	1.37E-03	1.26E-03
9.78E-01	3.87E+00	1.07E+01	6.49E-02	5.00E-01	5.00E-01	4.60E-01	3.05E-03	2.68E-03	1.06E-02	2.92E-02	1.78E-04	1.37E-03	1.37E-03	1.26E-03
1.74E-01	1.21E+00	5.57E+00	6.49E-02	1.29E-01	1.29E-01	1.19E-01	5.43E-04	4.77E-04	3.31E-03	1.53E-02	1.78E-04	3.54E-04	3.54E-04	3.26E-04
1.74E-01	1.21E+00	5.57E+00	6.49E-02	1.29E-01	1.29E-01	1.19E-01	5.43E-04	4.77E-04	3.31E-03	1.53E-02	1.78E-04	3.54E-04	3.54E-04	3.26E-04
1.35E-01	1.35E+00	5.57E+00	7.57E-02	1.36E-01	1.36E-01	1.25E-01	4.23E-04	3.71E-04	3.71E-03	1.53E-02	2.07E-04	3.73E-04	3.73E-04	3.43E-04
7.17E-02	2.80E-01	7.06E-01	2.71E-03	4.08E-02	4.08E-02	3.75E-02	2.24E-04	1.97E-04	7.67E-04	1.93E-03	7.41E-06	1.12E-04	1.12E-04	1.03E-04
4.44E-01	1.68E+00	4.58E+00	2.98E-02	2.37E-01	2.37E-01	2.18E-01	1.39E-03	1.22E-03	4.61E-03	1.25E-02	8.15E-05	6.49E-04	6.49E-04	5.97E-04
4.37E-01	1.66E+00	4.53E+00	2.98E-02	2.32E-01	2.32E-01	2.13E-01	1.36E-03	1.20E-03	4.55E-03	1.24E-02	8.15E-05	6.35E-04	6.35E-04	5.84E-04
2.72E+00	1.09E+01	2.59E+01	2.11E-01	1.53E+00	1.53E+00	1.40E+00	8.48E-03	7.45E-03	2.97E-02	7.10E-02	5.77E-04	4.18E-03	4.18E-03	3.85E-03
9.49E+00	1.73E+02	2.69E+02	3.76E+00	8.73E+00	8.73E+00	8.03E+00	2.96E-02	2.60E-02	4.75E-01	7.38E-01	1.03E-02	2.39E-02	2.39E-02	2.20E-02

Type	Useful Life	Load Factor
Crane	18	0.43
Excavator	16	0.57
Forklift	20	0.30
Material Handling Equip	18	0.59
Other General Industrial Equip	16	0.51
Sweeper/Scrubber	16	0.68
Tractor/Loader/Backhoe	16	0.55
Yard Tractor offroad engine	8	0.65
Yard Tractor onroad engine	8	0.65

Fuel Correction Factor

t_fcf

	Calyr 1994 -2006		
Model Yr	**NOX**	**PM**	**HC**
1970	0.930	0.750	0.720
1971	0.930	0.750	0.720
1972	0.930	0.750	0.720
1973	0.930	0.750	0.720
1974	0.930	0.750	0.720
1975	0.930	0.750	0.720
1976	0.930	0.750	0.720
1977	0.930	0.750	0.720
1978	0.930	0.750	0.720
1979	0.930	0.750	0.720
1980	0.930	0.750	0.720
1981	0.930	0.750	0.720
1982	0.930	0.750	0.720
1983	0.930	0.750	0.720
1984	0.930	0.750	0.720
1985	0.930	0.750	0.720
1986	0.930	0.750	0.720
1987	0.930	0.750	0.720
1988	0.930	0.750	0.720
1989	0.930	0.750	0.720
1990	0.930	0.750	0.720
1991	0.930	0.750	0.720
1992	0.930	0.750	0.720
1993	0.930	0.750	0.720
1994	0.930	0.750	0.720
1995	0.930	0.750	0.720
1996	0.948	0.822	0.720
1997	0.948	0.822	0.720
1998	0.948	0.822	0.720
1999	0.948	0.822	0.720
2000	0.948	0.822	0.720
2001	0.948	0.822	0.720
2002	0.948	0.822	0.720
2003	0.948	0.822	0.720
2004	0.948	0.822	0.720
2005	0.948	0.822	0.720
2006	0.948	0.822	0.720
2007	0.948	0.822	0.720
2008	0.948	0.822	0.720
2009	0.948	0.822	0.720
2010	0.948	0.822	0.720
2011	0.948	0.822	0.720
2012	0.948	0.822	0.720
2013	0.948	0.822	0.720
2014	0.948	0.822	0.720
2015	0.948	0.822	0.720
2016	0.948	0.822	0.720
2017	0.948	0.822	0.720
2018	0.948	0.822	0.720

HP_dr

	Det. Rate			
HP	**HC**	**CO**	**NOx**	**PM**
50	51%	41%	6%	31%
120	28%	16%	14%	44%
175	28%	16%	14%	44%
250	44%	25%	21%	67%
500	44%	25%	21%	67%

***New Tier4 emfacs included with 43/57% split for 120 hp merged (diesel only)**

units = g/bhp hr

Lookup	Hp	Year	HC	CO	NOX	PM	CO2
251968	25	1968	1.84	5	6.92	0.764	10176.3
251969	25	1969	1.84	5	6.92	0.764	10176.3
251970	25	1970	1.84	5	6.92	0.764	10176.3
251971	25	1971	1.84	5	6.92	0.764	10176.3
251972	25	1972	1.84	5	6.92	0.764	10176.3
251973	25	1973	1.84	5	6.92	0.764	10176.3
251974	25	1974	1.84	5	6.92	0.764	10176.3
251975	25	1975	1.84	5	6.92	0.764	10176.3
251976	25	1976	1.84	5	6.92	0.764	10176.3
251977	25	1977	1.84	5	6.92	0.764	10176.3
251978	25	1978	1.84	5	6.92	0.764	10176.3
251979	25	1979	1.84	5	6.92	0.764	10176.3
251980	25	1980	1.84	5	6.92	0.764	10176.3
251981	25	1981	1.84	5	6.92	0.764	10176.3
251982	25	1982	1.84	5	6.92	0.764	10176.3
251983	25	1983	1.84	5	6.92	0.764	10176.3
251984	25	1984	1.84	5	6.92	0.764	10176.3
251985	25	1985	1.84	5	6.92	0.764	10176.3
251986	25	1986	1.84	5	6.92	0.764	10176.3
251987	25	1987	1.84	5	6.92	0.764	10176.3
251988	25	1988	1.84	5	6.92	0.764	10176.3
251989	25	1989	1.84	5	6.92	0.764	10176.3
251990	25	1990	1.84	5	6.92	0.764	10176.3
251991	25	1991	1.84	5	6.92	0.764	10176.3
251992	25	1992	1.84	5	6.92	0.764	10176.3
251993	25	1993	1.84	5	6.92	0.764	10176.3
251994	25	1994	1.84	5	6.92	0.764	10176.3
251995	25	1995	1.63	1.4	3.89	0.417	10176.3
251996	25	1996	1.63	1.4	3.89	0.417	10176.3
251997	25	1997	1.63	1.4	3.89	0.417	10176.3
251998	25	1998	1.63	1.4	3.89	0.417	10176.3
251999	25	1999	0.52	0.5	1.24	0.116	10176.3
252000	25	2000	0.52	0.5	1.24	0.116	10176.3
252001	25	2001	0.52	0.5	1.24	0.116	10176.3
252002	25	2002	0.52	0.5	1.24	0.116	10176.3
252003	25	2003	0.52	0.5	1.24	0.116	10176.3
252004	25	2004	0.52	0.5	1.24	0.116	10176.3
252005	25	2005	0.52	0.5	1.24	0.116	10176.3
252006	25	2006	0.52	0.5	1.24	0.116	10176.3
252007	25	2007	0.52	0.5	1.24	0.116	10176.3
252008	25	2008	0.52	0.5	1.24	0.116	10176.3
252009	25	2009	0.52	0.5	1.24	0.116	10176.3
252010	25	2010	0.52	0.5	1.24	0.116	10176.3
252011	25	2011	0.52	0.5	1.24	0.116	10176.3
252012	25	2012	0.52	0.5	1.24	0.116	10176.3
252013	25	2013	0.52	0.5	1.24	0.116	10176.3
252014	25	2014	0.52	0.5	1.24	0.116	10176.3
252015	25	2015	0.52	0.5	1.24	0.116	10176.3
252016	25	2016	0.52	0.5	1.24	0.116	10176.3
252017	25	2017	0.52	0.5	1.24	0.116	10176.3
252018	25	2018	0.52	0.5	1.24	0.116	10176.3
252019	25	2019	0.52	0.5	1.24	0.116	10176.3
252020	25	2020	0.52	0.5	1.24	0.116	10176.3
252021	25	2021	0.52	0.5	1.24	0.116	10176.3
252022	25	2022	0.52	0.5	1.24	0.116	10176.3
252023	25	2023	0.52	0.5	1.24	0.116	10176.3
252024	25	2024	0.52	0.5	1.24	0.116	10176.3
252025	25	2025	0.52	0.5	1.24	0.116	10176.3
252026	25	2026	0.52	0.5	1.24	0.116	10176.3
501969	50	1969	1.84	5	7	0.76	10176.3
501969	50	1969	1.84	5	7	0.76	10176.3
501970	50	1970	1.84	5	7	0.76	10176.3
501971	50	1971	1.84	5	7	0.76	10176.3
501972	50	1972	1.84	5	7	0.76	10176.3
501973	50	1973	1.84	5	7	0.76	10176.3
501974	50	1974	1.84	5	7	0.76	10176.3
501975	50	1975	1.84	5	7	0.76	10176.3

501976	50	1976	1.84	5	7	0.76	10176.3
501977	50	1977	1.84	5	7	0.76	10176.3
501978	50	1978	1.84	5	7	0.76	10176.3
501979	50	1979	1.84	5	7	0.76	10176.3
501980	50	1980	1.84	5	7	0.76	10176.3
501981	50	1981	1.84	5	7	0.76	10176.3
501982	50	1982	1.84	5	7	0.76	10176.3
501983	50	1983	1.84	5	7	0.76	10176.3
501984	50	1984	1.84	5	7	0.76	10176.3
501985	50	1985	1.84	5	7	0.76	10176.3
501986	50	1986	1.84	5	7	0.76	10176.3
501987	50	1987	1.84	5	7	0.76	10176.3
501988	50	1988	1.8	5	6.9	0.76	10176.3
501989	50	1989	1.8	5	6.9	0.76	10176.3
501990	50	1990	1.8	5	6.9	0.76	10176.3
501991	50	1991	1.8	5	6.9	0.76	10176.3
501992	50	1992	1.8	5	6.9	0.76	10176.3
501993	50	1993	1.8	5	6.9	0.76	10176.3
501994	50	1994	1.8	5	6.9	0.76	10176.3
501995	50	1995	1.8	5	6.9	0.76	10176.3
501996	50	1996	1.8	5	6.9	0.76	10176.3
501997	50	1997	1.8	5	6.9	0.76	10176.3
501998	50	1998	1.8	5	6.9	0.76	10176.3
501999	50	1999	1.45	4.1	5.55	0.6	10176.3
502000	50	2000	1.45	4.1	5.55	0.6	10176.3
502001	50	2001	1.45	4.1	5.55	0.6	10176.3
502002	50	2002	1.45	4.1	5.55	0.6	10176.3
502003	50	2003	1.45	4.1	5.55	0.6	10176.3
502004	50	2004	0.64	3.27	5.1	0.43	10176.3
502005	50	2005	0.37	3	4.95	0.38	10176.3
502006	50	2006	0.24	2.86	4.88	0.35	10176.3
502007	50	2007	0.24	2.86	4.88	0.35	10176.3
502008	50	2008	0.1	2.72	4.8	0.16	10176.3
502009	50	2009	0.1	2.72	4.8	0.16	10176.3
502010	50	2010	0.1	2.72	4.8	0.16	10176.3
502011	50	2011	0.1	2.72	4.8	0.16	10176.3
502012	50	2012	0.1	2.72	4.8	0.16	10176.3
502013	50	2013	0.1	2.72	2.9	0.01	10176.3
502014	50	2014	0.1	2.72	2.9	0.01	10176.3
502015	50	2015	0.1	2.72	2.9	0.01	10176.3
502016	50	2016	0.1	2.72	2.9	0.01	10176.3
502017	50	2017	0.1	2.72	2.9	0.01	10176.3
502018	50	2018	0.1	2.72	2.9	0.01	10176.3
502019	50	2019	0.1	2.72	2.9	0.01	10176.3
502020	50	2020	0.1	2.72	2.9	0.01	10176.3
502021	50	2021	0.1	2.72	2.9	0.01	10176.3
502022	50	2022	0.1	2.72	2.9	0.01	10176.3
502023	50	2023	0.1	2.72	2.9	0.01	10176.3
502024	50	2024	0.1	2.72	2.9	0.01	10176.3
502025	50	2025	0.1	2.72	2.9	0.01	10176.3
502026	50	2026	0.1	2.72	2.9	0.01	10176.3
1201968	120	1968	1.44	4.8	13	0.84	10176.3
1201969	120	1969	1.44	4.8	13	0.84	10176.3
1201970	120	1970	1.44	4.8	13	0.84	10176.3
1201971	120	1971	1.44	4.8	13	0.84	10176.3
1201972	120	1972	1.44	4.8	13	0.84	10176.3
1201973	120	1973	1.44	4.8	13	0.84	10176.3
1201974	120	1974	1.44	4.8	13	0.84	10176.3
1201975	120	1975	1.44	4.8	13	0.84	10176.3
1201976	120	1976	1.44	4.8	13	0.84	10176.3
1201977	120	1977	1.44	4.8	13	0.84	10176.3
1201978	120	1978	1.44	4.8	13	0.84	10176.3
1201979	120	1979	1.44	4.8	13	0.84	10176.3
1201980	120	1980	1.44	4.8	13	0.84	10176.3
1201981	120	1981	1.44	4.8	13	0.84	10176.3
1201982	120	1982	1.44	4.8	13	0.84	10176.3
1201983	120	1983	1.44	4.8	13	0.84	10176.3
1201984	120	1984	1.44	4.8	13	0.84	10176.3
1201985	120	1985	1.44	4.8	13	0.84	10176.3
1201986	120	1986	1.44	4.8	13	0.84	10176.3
1201987	120	1987	1.44	4.8	13	0.84	10176.3

1201988	120	1988	0.99	3.49	8.75	0.69	10176.3
1201989	120	1989	0.99	3.49	8.75	0.69	10176.3
1201990	120	1990	0.99	3.49	8.75	0.69	10176.3
1201991	120	1991	0.99	3.49	8.75	0.69	10176.3
1201992	120	1992	0.99	3.49	8.75	0.69	10176.3
1201993	120	1993	0.99	3.49	8.75	0.69	10176.3
1201994	120	1994	0.99	3.49	8.75	0.69	10176.3
1201995	120	1995	0.99	3.49	8.75	0.69	10176.3
1201996	120	1996	0.99	3.49	8.75	0.69	10176.3
1201997	120	1997	0.99	3.49	8.75	0.69	10176.3
1201998	120	1998	0.99	3.49	6.9	0.69	10176.3
1201999	120	1999	0.99	3.49	6.9	0.69	10176.3
1202000	120	2000	0.99	3.49	6.9	0.69	10176.3
1202001	120	2001	0.99	3.49	6.9	0.69	10176.3
1202002	120	2002	0.99	3.49	6.9	0.69	10176.3
1202003	120	2003	0.99	3.49	6.9	0.69	10176.3
1202004	120	2004	0.46	3.23	5.64	0.39	10176.3
1202005	120	2005	0.28	3.14	5.22	0.29	10176.3
1202006	120	2006	0.19	3.09	5.01	0.24	10176.3
1202007	120	2007	0.19	3.09	5.01	0.24	10176.3
1202008	120	2008	0.1	3.05	2.89	0.197	10176.3
1202009	120	2009	0.1	3.05	2.89	0.197	10176.3
1202010	120	2010	0.1	3.05	2.89	0.197	10176.3
1202011	120	2011	0.1	3.05	2.89	0.197	10176.3
1202012	120	2012	0.0943	3.05	2.5309	0.0659	10176.3
1202013	120	2013	0.0943	3.05	2.5309	0.01	10176.3
1202014	120	2014	0.0943	3.05	2.5309	0.01	10176.3
1202015	120	2015	0.0715	3.05	1.3966	0.01	10176.3
1202016	120	2016	0.0715	3.05	1.3966	0.01	10176.3
1202017	120	2017	0.0715	3.05	1.3966	0.01	10176.3
1202018	120	2018	0.0715	3.05	1.3966	0.01	10176.3
1202019	120	2019	0.0715	3.05	1.3966	0.01	10176.3
1202020	120	2020	0.0715	3.05	1.3966	0.01	10176.3
1202021	120	2021	0.0715	3.05	1.3966	0.01	10176.3
1202022	120	2022	0.0715	3.05	1.3966	0.01	10176.3
1202023	120	2023	0.0715	3.05	1.3966	0.01	10176.3
1202024	120	2024	0.0715	3.05	1.3966	0.01	10176.3
1202025	120	2025	0.0715	3.05	1.3966	0.01	10176.3
1202026	120	2026	0.0715	3.05	1.3966	0.01	10176.3
1751968	175	1968	1.32	4.4	14	0.77	10176.3
1751969	175	1969	1.32	4.4	14	0.77	10176.3
1751970	175	1970	1.1	4.4	13	0.66	10176.3
1751971	175	1971	1.1	4.4	13	0.66	10176.3
1751972	175	1972	1	4.4	12	0.55	10176.3
1751973	175	1973	1	4.4	12	0.55	10176.3
1751974	175	1974	1	4.4	12	0.55	10176.3
1751975	175	1975	1	4.4	12	0.55	10176.3
1751976	175	1976	1	4.4	12	0.55	10176.3
1751977	175	1977	1	4.4	12	0.55	10176.3
1751978	175	1978	1	4.4	12	0.55	10176.3
1751979	175	1979	1	4.4	12	0.55	10176.3
1751980	175	1980	0.94	4.3	11	0.55	10176.3
1751981	175	1981	0.94	4.3	11	0.55	10176.3
1751982	175	1982	0.94	4.3	11	0.55	10176.3
1751983	175	1983	0.94	4.3	11	0.55	10176.3
1751984	175	1984	0.94	4.3	11	0.55	10176.3
1751985	175	1985	0.88	4.2	11	0.55	10176.3
1751986	175	1986	0.88	4.2	11	0.55	10176.3
1751987	175	1987	0.88	4.2	11	0.55	10176.3
1751988	175	1988	0.68	2.7	8.17	0.38	10176.3
1751989	175	1989	0.68	2.7	8.17	0.38	10176.3
1751990	175	1990	0.68	2.7	8.17	0.38	10176.3
1751991	175	1991	0.68	2.7	8.17	0.38	10176.3
1751992	175	1992	0.68	2.7	8.17	0.38	10176.3
1751993	175	1993	0.68	2.7	8.17	0.38	10176.3
1751994	175	1994	0.68	2.7	8.17	0.38	10176.3
1751995	175	1995	0.68	2.7	8.17	0.38	10176.3
1751996	175	1996	0.68	2.7	8.17	0.38	10176.3
1751997	175	1997	0.68	2.7	6.9	0.38	10176.3
1751998	175	1998	0.68	2.7	6.9	0.38	10176.3
1751999	175	1999	0.68	2.7	6.9	0.38	10176.3

1752000	175	2000	0.68	2.7	6.9	0.38	10176.3
1752001	175	2001	0.68	2.7	6.9	0.38	10176.3
1752002	175	2002	0.68	2.7	6.9	0.38	10176.3
1752003	175	2003	0.33	2.7	5.26	0.24	10176.3
1752004	175	2004	0.22	2.7	4.72	0.19	10176.3
1752005	175	2005	0.16	2.7	4.44	0.16	10176.3
1752006	175	2006	0.16	2.7	4.44	0.16	10176.3
1752007	175	2007	0.1	2.7	2.45	0.14	10176.3
1752008	175	2008	0.1	2.7	2.45	0.14	10176.3
1752009	175	2009	0.1	2.7	2.45	0.14	10176.3
1752010	175	2010	0.1	2.7	2.45	0.14	10176.3
1752011	175	2011	0.1	2.7	2.45	0.14	10176.3
1752012	175	2012	0.09	2.7	2.27	0.01	10176.3
1752013	175	2013	0.09	2.7	2.27	0.01	10176.3
1752014	175	2014	0.09	2.7	2.27	0.01	10176.3
1752015	175	2015	0.05	2.7	0.27	0.01	10176.3
1752016	175	2016	0.05	2.7	0.27	0.01	10176.3
1752017	175	2017	0.05	2.7	0.27	0.01	10176.3
1752018	175	2018	0.05	2.7	0.27	0.01	10176.3
1752019	175	2019	0.05	2.7	0.27	0.01	10176.3
1752020	175	2020	0.05	2.7	0.27	0.01	10176.3
1752021	175	2021	0.05	2.7	0.27	0.01	10176.3
1752022	175	2022	0.05	2.7	0.27	0.01	10176.3
1752023	175	2023	0.05	2.7	0.27	0.01	10176.3
1752024	175	2024	0.05	2.7	0.27	0.01	10176.3
1752025	175	2025	0.05	2.7	0.27	0.01	10176.3
1752026	175	2026	0.05	2.7	0.27	0.01	10176.3
2501968	250	1968	1.32	4.4	14	0.77	10176.3
2501969	250	1969	1.32	4.4	14	0.77	10176.3
2501970	250	1970	1.1	4.4	13	0.66	10176.3
2501971	250	1971	1.1	4.4	13	0.66	10176.3
2501972	250	1972	1	4.4	12	0.55	10176.3
2501973	250	1973	1	4.4	12	0.55	10176.3
2501974	250	1974	1	4.4	12	0.55	10176.3
2501975	250	1975	1	4.4	12	0.55	10176.3
2501976	250	1976	1	4.4	12	0.55	10176.3
2501977	250	1977	1	4.4	12	0.55	10176.3
2501978	250	1978	1	4.4	12	0.55	10176.3
2501979	250	1979	1	4.4	12	0.55	10176.3
2501980	250	1980	0.94	4.3	11	0.55	10176.3
2501981	250	1981	0.94	4.3	11	0.55	10176.3
2501982	250	1982	0.94	4.3	11	0.55	10176.3
2501983	250	1983	0.94	4.3	11	0.55	10176.3
2501984	250	1984	0.94	4.3	11	0.55	10176.3
2501985	250	1985	0.88	4.2	11	0.55	10176.3
2501986	250	1986	0.88	4.2	11	0.55	10176.3
2501987	250	1987	0.88	4.2	11	0.55	10176.3
2501988	250	1988	0.68	2.7	8.17	0.38	10176.3
2501989	250	1989	0.68	2.7	8.17	0.38	10176.3
2501990	250	1990	0.68	2.7	8.17	0.38	10176.3
2501991	250	1991	0.68	2.7	8.17	0.38	10176.3
2501992	250	1992	0.68	2.7	8.17	0.38	10176.3
2501993	250	1993	0.68	2.7	8.17	0.38	10176.3
2501994	250	1994	0.68	2.7	8.17	0.38	10176.3
2501995	250	1995	0.68	2.7	8.17	0.38	10176.3
2501996	250	1996	0.32	0.92	6.25	0.15	10176.3
2501997	250	1997	0.32	0.92	6.25	0.15	10176.3
2501998	250	1998	0.32	0.92	6.25	0.15	10176.3
2501999	250	1999	0.32	0.92	6.25	0.15	10176.3
2502000	250	2000	0.32	0.92	6.25	0.15	10176.3
2502001	250	2001	0.32	0.92	6.25	0.15	10176.3
2502002	250	2002	0.32	0.92	6.25	0.15	10176.3
2502003	250	2003	0.19	0.92	5	0.12	10176.3
2502004	250	2004	0.14	0.92	4.58	0.11	10176.3
2502005	250	2005	0.12	0.92	4.38	0.11	10176.3
2502006	250	2006	0.12	0.92	4.38	0.11	10176.3
2502007	250	2007	0.1	0.92	2.45	0.11	10176.3
2502008	250	2008	0.1	0.92	2.45	0.11	10176.3
2502009	250	2009	0.1	0.92	2.45	0.11	10176.3
2502010	250	2010	0.1	0.92	2.45	0.11	10176.3
2502011	250	2011	0.07	0.92	1.36	0.01	10176.3

2502012	250	2012	0.07	0.92	1.36	0.01	10176.3
2502013	250	2013	0.07	0.92	1.36	0.01	10176.3
2502014	250	2014	0.05	0.92	0.27	0.01	10176.3
2502015	250	2015	0.05	0.92	0.27	0.01	10176.3
2502016	250	2016	0.05	0.92	0.27	0.01	10176.3
2502017	250	2017	0.05	0.92	0.27	0.01	10176.3
2502018	250	2018	0.05	0.92	0.27	0.01	10176.3
2502019	250	2019	0.05	0.92	0.27	0.01	10176.3
2502020	250	2020	0.05	0.92	0.27	0.01	10176.3
2502021	250	2021	0.05	0.92	0.27	0.01	10176.3
2502022	250	2022	0.05	0.92	0.27	0.01	10176.3
2502023	250	2023	0.05	0.92	0.27	0.01	10176.3
2502024	250	2024	0.05	0.92	0.27	0.01	10176.3
2502025	250	2025	0.05	0.92	0.27	0.01	10176.3
2502026	250	2026	0.05	0.92	0.27	0.01	10176.3
5001968	500	1968	1.26	4.2	14	0.74	10176.3
5001969	500	1969	1.26	4.2	14	0.74	10176.3
5001970	500	1970	1.05	4.2	13	0.63	10176.3
5001971	500	1971	1.05	4.2	13	0.63	10176.3
5001972	500	1972	0.95	4.2	12	0.53	10176.3
5001973	500	1973	0.95	4.2	12	0.53	10176.3
5001974	500	1974	0.95	4.2	12	0.53	10176.3
5001975	500	1975	0.95	4.2	12	0.53	10176.3
5001976	500	1976	0.95	4.2	12	0.53	10176.3
5001977	500	1977	0.95	4.2	12	0.53	10176.3
5001978	500	1978	0.95	4.2	12	0.53	10176.3
5001979	500	1979	0.95	4.2	12	0.53	10176.3
5001980	500	1980	0.9	4.2	11	0.53	10176.3
5001981	500	1981	0.9	4.2	11	0.53	10176.3
5001982	500	1982	0.9	4.2	11	0.53	10176.3
5001983	500	1983	0.9	4.2	11	0.53	10176.3
5001984	500	1984	0.9	4.2	11	0.53	10176.3
5001985	500	1985	0.84	4.1	11	0.53	10176.3
5001986	500	1986	0.84	4.1	11	0.53	10176.3
5001987	500	1987	0.84	4.1	11	0.53	10176.3
5001988	500	1988	0.68	2.7	8.17	0.38	10176.3
5001989	500	1989	0.68	2.7	8.17	0.38	10176.3
5001990	500	1990	0.68	2.7	8.17	0.38	10176.3
5001991	500	1991	0.68	2.7	8.17	0.38	10176.3
5001992	500	1992	0.68	2.7	8.17	0.38	10176.3
5001993	500	1993	0.68	2.7	8.17	0.38	10176.3
5001994	500	1994	0.68	2.7	8.17	0.38	10176.3
5001995	500	1995	0.68	2.7	8.17	0.38	10176.3
5001996	500	1996	0.32	0.92	6.25	0.15	10176.3
5001997	500	1997	0.32	0.92	6.25	0.15	10176.3
5001998	500	1998	0.32	0.92	6.25	0.15	10176.3
5001999	500	1999	0.32	0.92	6.25	0.15	10176.3
5002000	500	2000	0.32	0.92	6.25	0.15	10176.3
5002001	500	2001	0.19	0.92	4.95	0.12	10176.3
5002002	500	2002	0.14	0.92	4.51	0.11	10176.3
5002003	500	2003	0.12	0.92	4.29	0.11	10176.3
5002004	500	2004	0.12	0.92	4.29	0.11	10176.3
5002005	500	2005	0.1	0.92	4	0.11	10176.3
5002006	500	2006	0.1	0.92	2.45	0.11	10176.3
5002007	500	2007	0.1	0.92	2.45	0.11	10176.3
5002008	500	2008	0.1	0.92	2.45	0.11	10176.3
5002009	500	2009	0.1	0.92	2.45	0.11	10176.3
5002010	500	2010	0.1	0.92	2.45	0.11	10176.3
5002011	500	2011	0.07	0.92	1.36	0.01	10176.3
5002012	500	2012	0.07	0.92	1.36	0.01	10176.3
5002013	500	2013	0.07	0.92	1.36	0.01	10176.3
5002014	500	2014	0.05	0.92	0.27	0.01	10176.3
5002015	500	2015	0.05	0.92	0.27	0.01	10176.3
5002016	500	2016	0.05	0.92	0.27	0.01	10176.3
5002017	500	2017	0.05	0.92	0.27	0.01	10176.3
5002018	500	2018	0.05	0.92	0.27	0.01	10176.3
5002019	500	2019	0.05	0.92	0.27	0.01	10176.3
5002020	500	2020	0.05	0.92	0.27	0.01	10176.3
5002021	500	2021	0.05	0.92	0.27	0.01	10176.3
5002022	500	2022	0.05	0.92	0.27	0.01	10176.3
5002023	500	2023	0.05	0.92	0.27	0.01	10176.3

5002024	500	2024	0.05	0.92	0.27	0.01	10176.3
5002025	500	2025	0.05	0.92	0.27	0.01	10176.3
5002026	500	2026	0.05	0.92	0.27	0.01	10176.3
7501968	750	1968	1.26	4.2	14	0.74	10176.3
7501969	750	1969	1.26	4.2	14	0.74	10176.3
7501970	750	1970	1.05	4.2	13	0.63	10176.3
7501971	750	1971	1.05	4.2	13	0.63	10176.3
7501972	750	1972	0.95	4.2	12	0.53	10176.3
7501973	750	1973	0.95	4.2	12	0.53	10176.3
7501974	750	1974	0.95	4.2	12	0.53	10176.3
7501975	750	1975	0.95	4.2	12	0.53	10176.3
7501976	750	1976	0.95	4.2	12	0.53	10176.3
7501977	750	1977	0.95	4.2	12	0.53	10176.3
7501978	750	1978	0.95	4.2	12	0.53	10176.3
7501979	750	1979	0.95	4.2	12	0.53	10176.3
7501980	750	1980	0.9	4.2	11	0.53	10176.3
7501981	750	1981	0.9	4.2	11	0.53	10176.3
7501982	750	1982	0.9	4.2	11	0.53	10176.3
7501983	750	1983	0.9	4.2	11	0.53	10176.3
7501984	750	1984	0.9	4.2	11	0.53	10176.3
7501985	750	1985	0.84	4.1	11	0.53	10176.3
7501986	750	1986	0.84	4.1	11	0.53	10176.3
7501987	750	1987	0.84	4.1	11	0.53	10176.3
7501988	750	1988	0.68	2.7	8.17	0.38	10176.3
7501989	750	1989	0.68	2.7	8.17	0.38	10176.3
7501990	750	1990	0.68	2.7	8.17	0.38	10176.3
7501991	750	1991	0.68	2.7	8.17	0.38	10176.3
7501992	750	1992	0.68	2.7	8.17	0.38	10176.3
7501993	750	1993	0.68	2.7	8.17	0.38	10176.3
7501994	750	1994	0.68	2.7	8.17	0.38	10176.3
7501995	750	1995	0.68	2.7	8.17	0.38	10176.3
7501996	750	1996	0.32	0.92	6.25	0.15	10176.3
7501997	750	1997	0.32	0.92	6.25	0.15	10176.3
7501998	750	1998	0.32	0.92	6.25	0.15	10176.3
7501999	750	1999	0.32	0.92	6.25	0.15	10176.3
7502000	750	2000	0.32	0.92	6.25	0.15	10176.3
7502001	750	2001	0.32	0.92	6.25	0.15	10176.3
7502002	750	2002	0.19	0.92	4.95	0.12	10176.3
7502003	750	2003	0.14	0.92	4.51	0.11	10176.3
7502004	750	2004	0.12	0.92	4.29	0.11	10176.3
7502005	750	2005	0.12	0.92	4.29	0.11	10176.3
7502006	750	2006	0.1	0.92	2.45	0.11	10176.3
7502007	750	2007	0.1	0.92	2.45	0.11	10176.3
7502008	750	2008	0.1	0.92	2.45	0.11	10176.3
7502009	750	2009	0.1	0.92	2.45	0.11	10176.3
7502010	750	2010	0.1	0.92	2.45	0.11	10176.3
7502011	750	2011	0.07	0.92	1.36	0.01	10176.3
7502012	750	2012	0.07	0.92	1.36	0.01	10176.3
7502013	750	2013	0.07	0.92	1.36	0.01	10176.3
7502014	750	2014	0.05	0.92	0.27	0.01	10176.3
7502015	750	2015	0.05	0.92	0.27	0.01	10176.3
7502016	750	2016	0.05	0.92	0.27	0.01	10176.3
7502017	750	2017	0.05	0.92	0.27	0.01	10176.3
7502018	750	2018	0.05	0.92	0.27	0.01	10176.3
7502019	750	2019	0.05	0.92	0.27	0.01	10176.3
7502020	750	2020	0.05	0.92	0.27	0.01	10176.3
7502021	750	2021	0.05	0.92	0.27	0.01	10176.3
7502022	750	2022	0.05	0.92	0.27	0.01	10176.3
7502023	750	2023	0.05	0.92	0.27	0.01	10176.3
7502024	750	2024	0.05	0.92	0.27	0.01	10176.3
7502025	750	2025	0.05	0.92	0.27	0.01	10176.3
7502026	750	2026	0.05	0.92	0.27	0.01	10176.3
9991968	999	1968	1.26	4.2	14	0.74	10176.3
9991969	999	1969	1.26	4.2	14	0.74	10176.3
9991970	999	1970	1.05	4.2	13	0.63	10176.3
9991971	999	1971	1.05	4.2	13	0.63	10176.3
9991972	999	1972	0.95	4.2	12	0.53	10176.3
9991973	999	1973	0.95	4.2	12	0.53	10176.3
9991974	999	1974	0.95	4.2	12	0.53	10176.3
9991975	999	1975	0.95	4.2	12	0.53	10176.3
9991976	999	1976	0.95	4.2	12	0.53	10176.3

9991977	999	1977	0.95	4.2	12	0.53	10176.3
9991978	999	1978	0.95	4.2	12	0.53	10176.3
9991979	999	1979	0.95	4.2	12	0.53	10176.3
9991980	999	1980	0.9	4.2	11	0.53	10176.3
9991981	999	1981	0.9	4.2	11	0.53	10176.3
9991982	999	1982	0.9	4.2	11	0.53	10176.3
9991983	999	1983	0.9	4.2	11	0.53	10176.3
9991984	999	1984	0.9	4.2	11	0.53	10176.3
9991985	999	1985	0.84	4.1	11	0.53	10176.3
9991986	999	1986	0.84	4.1	11	0.53	10176.3
9991987	999	1987	0.84	4.1	11	0.53	10176.3
9991988	999	1988	0.68	2.7	8.17	0.38	10176.3
9991989	999	1989	0.68	2.7	8.17	0.38	10176.3
9991990	999	1990	0.68	2.7	8.17	0.38	10176.3
9991991	999	1991	0.68	2.7	8.17	0.38	10176.3
9991992	999	1992	0.68	2.7	8.17	0.38	10176.3
9991993	999	1993	0.68	2.7	8.17	0.38	10176.3
9991994	999	1994	0.68	2.7	8.17	0.38	10176.3
9991995	999	1995	0.68	2.7	8.17	0.38	10176.3
9991996	999	1996	0.68	2.7	8.17	0.38	10176.3
9991997	999	1997	0.68	2.7	8.17	0.38	10176.3
9991998	999	1998	0.68	2.7	8.17	0.38	10176.3
9991999	999	1999	0.68	2.7	8.17	0.38	10176.3
9992000	999	2000	0.32	0.92	6.25	0.15	10176.3
9992001	999	2001	0.32	0.92	6.25	0.15	10176.3
9992002	999	2002	0.32	0.92	6.25	0.15	10176.3
9992003	999	2003	0.32	0.92	6.25	0.15	10176.3
9992004	999	2004	0.32	0.92	6.25	0.15	10176.3
9992005	999	2005	0.32	0.92	6.25	0.15	10176.3
9992006	999	2006	0.19	0.92	4.95	0.12	10176.3
9992007	999	2007	0.14	0.92	4.51	0.11	10176.3
9992008	999	2008	0.12	0.92	4.29	0.11	10176.3
9992009	999	2009	0.12	0.92	4.29	0.11	10176.3
9992010	999	2010	0.1	0.92	4.08	0.11	10176.3
9992011	999	2011	0.1	0.92	2.36	0.06	10176.3
9992012	999	2012	0.1	0.92	2.36	0.06	10176.3
9992013	999	2013	0.1	0.92	2.36	0.06	10176.3
9992014	999	2014	0.1	0.92	2.36	0.06	10176.3
9992015	999	2015	0.05	0.92	2.36	0.02	10176.3
9992016	999	2016	0.05	0.92	2.36	0.02	10176.3
9992017	999	2017	0.05	0.92	2.36	0.02	10176.3
9992018	999	2018	0.05	0.92	2.36	0.02	10176.3
9992019	999	2019	0.05	0.92	2.36	0.02	10176.3
9992020	999	2020	0.05	0.92	2.36	0.02	10176.3
9992021	999	2021	0.05	0.92	2.36	0.02	10176.3
9992022	999	2022	0.05	0.92	2.36	0.02	10176.3
9992023	999	2023	0.05	0.92	2.36	0.02	10176.3
9992024	999	2024	0.05	0.92	2.36	0.02	10176.3
9992025	999	2025	0.05	0.92	2.36	0.02	10176.3
9992026	999	2026	0.05	0.92	2.36	0.02	10176.3

***New Tier4 emfacs included with 43/57% split for 120 hp merged (diesel only)**

units = g/bhp hr

Lookup	Hp	Year	HC	CO	NOX	PM	CO2
251968	25	1968	1.3	15.5	6	0.6	10176.3
251969	25	1969	1.3	15.5	6	0.6	10176.3
251970	25	1970	1.3	15.5	6	0.6	10176.3
251971	25	1971	1.3	15.5	6	0.6	10176.3
251972	25	1972	1.3	15.5	6	0.6	10176.3
251973	25	1973	1.3	15.5	6	0.6	10176.3
251974	25	1974	1.3	15.5	6	0.6	10176.3
251975	25	1975	1.3	15.5	6	0.6	10176.3
251976	25	1976	1.3	15.5	6	0.6	10176.3
251977	25	1977	1.3	15.5	6	0.6	10176.3
251978	25	1978	1.3	15.5	6	0.6	10176.3
251979	25	1979	1.3	15.5	6	0.6	10176.3
251980	25	1980	1.3	15.5	6	0.6	10176.3
251981	25	1981	1.3	15.5	6	0.6	10176.3
251982	25	1982	1.3	15.5	6	0.6	10176.3
251983	25	1983	1.3	15.5	6	0.6	10176.3
251984	25	1984	1.3	15.5	6	0.6	10176.3
251985	25	1985	1.3	15.5	6	0.6	10176.3
251986	25	1986	1.3	15.5	6	0.6	10176.3
251987	25	1987	1.3	15.5	6	0.6	10176.3
251988	25	1988	1.3	15.5	6	0.6	10176.3
251989	25	1989	1.3	15.5	6	0.6	10176.3
251990	25	1990	1.3	15.5	6	0.6	10176.3
251991	25	1991	1.3	15.5	5	0.25	10176.3
251992	25	1992	1.3	15.5	5	0.25	10176.3
251993	25	1993	1.3	15.5	5	0.25	10176.3
251994	25	1994	1.3	15.5	5	0.1	10176.3
251995	25	1995	1.3	15.5	5	0.1	10176.3
251996	25	1996	1.3	15.5	5	0.1	10176.3
251997	25	1997	1.3	15.5	5	0.1	10176.3
251998	25	1998	1.3	15.5	5	0.1	10176.3
251999	25	1999	1.3	15.5	5	0.1	10176.3
252000	25	2000	1.3	15.5	5	0.1	10176.3
252001	25	2001	1.3	15.5	5	0.1	10176.3
252002	25	2002	1.3	15.5	5	0.1	10176.3
252003	25	2003	1.3	15.5	5	0.1	10176.3
252004	25	2004	0.5	15.5	2	0.1	10176.3
252005	25	2005	0.5	15.5	2	0.1	10176.3
252006	25	2006	0.5	15.5	2	0.1	10176.3
252007	25	2007	0.14	15.5	2	0.01	10176.3
252008	25	2008	0.14	15.5	2	0.01	10176.3
252009	25	2009	0.14	15.5	2	0.01	10176.3
252010	25	2010	0.14	15.5	2	0.01	10176.3
252011	25	2011	0.14	15.5	2	0.01	10176.3
252012	25	2012	0.14	15.5	2	0.01	10176.3
252013	25	2013	0.14	15.5	2	0.01	10176.3
252014	25	2014	0.14	15.5	2	0.01	10176.3
252015	25	2015	0.14	15.5	2	0.01	10176.3
252016	25	2016	0.14	15.5	2	0.01	10176.3
252017	25	2017	0.14	15.5	2	0.01	10176.3
252018	25	2018	0.14	15.5	2	0.01	10176.3
252019	25	2019	0.14	15.5	2	0.01	10176.3
252020	25	2020	0.14	15.5	2	0.01	10176.3
252021	25	2021	0.14	15.5	2	0.01	10176.3
252022	25	2022	0.14	15.5	2	0.01	10176.3
252023	25	2023	0.14	15.5	2	0.01	10176.3
252024	25	2024	0.14	15.5	2	0.01	10176.3
252025	25	2025	0.14	15.5	2	0.01	10176.3
252026	25	2026	0.14	15.5	2	0.01	10176.3
501969	50	1969	1.3	15.5	6	0.6	10176.3
501969	50	1969	1.3	15.5	6	0.6	10176.3
501970	50	1970	1.3	15.5	6	0.6	10176.3
501971	50	1971	1.3	15.5	6	0.6	10176.3
501972	50	1972	1.3	15.5	6	0.6	10176.3
501973	50	1973	1.3	15.5	6	0.6	10176.3
501974	50	1974	1.3	15.5	6	0.6	10176.3
501975	50	1975	1.3	15.5	6	0.6	10176.3
501976	50	1976	1.3	15.5	6	0.6	10176.3
501977	50	1977	1.3	15.5	6	0.6	10176.3
501978	50	1978	1.3	15.5	6	0.6	10176.3
501979	50	1979	1.3	15.5	6	0.6	10176.3
501980	50	1980	1.3	15.5	6	0.6	10176.3
501981	50	1981	1.3	15.5	6	0.6	10176.3
501982	50	1982	1.3	15.5	6	0.6	10176.3
501983	50	1983	1.3	15.5	6	0.6	10176.3
501984	50	1984	1.3	15.5	6	0.6	10176.3
501985	50	1985	1.3	15.5	6	0.6	10176.3

501986	50	1986	1.3	15.5	6	0.6	10176.3
501987	50	1987	1.3	15.5	6	0.6	10176.3
501988	50	1988	1.3	15.5	6	0.6	10176.3
501989	50	1989	1.3	15.5	6	0.6	10176.3
501990	50	1990	1.3	15.5	6	0.6	10176.3
501991	50	1991	1.3	15.5	5	0.25	10176.3
501992	50	1992	1.3	15.5	5	0.25	10176.3
501993	50	1993	1.3	15.5	5	0.25	10176.3
501994	50	1994	1.3	15.5	5	0.1	10176.3
501995	50	1995	1.3	15.5	5	0.1	10176.3
501996	50	1996	1.3	15.5	5	0.1	10176.3
501997	50	1997	1.3	15.5	5	0.1	10176.3
501998	50	1998	1.3	15.5	5	0.1	10176.3
501999	50	1999	1.3	15.5	5	0.1	10176.3
502000	50	2000	1.3	15.5	5	0.1	10176.3
502001	50	2001	1.3	15.5	5	0.1	10176.3
502002	50	2002	1.3	15.5	5	0.1	10176.3
502003	50	2003	1.3	15.5	5	0.1	10176.3
502004	50	2004	0.5	15.5	2	0.1	10176.3
502005	50	2005	0.5	15.5	2	0.1	10176.3
502006	50	2006	0.5	15.5	2	0.1	10176.3
502007	50	2007	0.14	15.5	1.1	0.01	10176.3
502008	50	2008	0.14	15.5	1.1	0.01	10176.3
502009	50	2009	0.14	15.5	1.1	0.01	10176.3
502010	50	2010	0.14	15.5	0.2	0.01	10176.3
502011	50	2011	0.14	15.5	0.2	0.01	10176.3
502012	50	2012	0.14	15.5	0.2	0.01	10176.3
502013	50	2013	0.14	15.5	0.2	0.01	10176.3
502014	50	2014	0.14	15.5	0.2	0.01	10176.3
502015	50	2015	0.14	15.5	0.2	0.01	10176.3
502016	50	2016	0.14	15.5	0.2	0.01	10176.3
502017	50	2017	0.14	15.5	0.2	0.01	10176.3
502018	50	2018	0.14	15.5	0.2	0.01	10176.3
502019	50	2019	0.14	15.5	0.2	0.01	10176.3
502020	50	2020	0.14	15.5	0.2	0.01	10176.3
502021	50	2021	0.14	15.5	0.2	0.01	10176.3
502022	50	2022	0.14	15.5	0.2	0.01	10176.3
502023	50	2023	0.14	15.5	0.2	0.01	10176.3
502024	50	2024	0.14	15.5	0.2	0.01	10176.3
502025	50	2025	0.14	15.5	0.2	0.01	10176.3
502026	50	2026	0.14	15.5	0.2	0.01	10176.3
1201968	120	1968	1.3	15.5	6	0.6	10176.3
1201969	120	1969	1.3	15.5	6	0.6	10176.3
1201970	120	1970	1.3	15.5	6	0.6	10176.3
1201971	120	1971	1.3	15.5	6	0.6	10176.3
1201972	120	1972	1.3	15.5	6	0.6	10176.3
1201973	120	1973	1.3	15.5	6	0.6	10176.3
1201974	120	1974	1.3	15.5	6	0.6	10176.3
1201975	120	1975	1.3	15.5	6	0.6	10176.3
1201976	120	1976	1.3	15.5	6	0.6	10176.3
1201977	120	1977	1.3	15.5	6	0.6	10176.3
1201978	120	1978	1.3	15.5	6	0.6	10176.3
1201979	120	1979	1.3	15.5	6	0.6	10176.3
1201980	120	1980	1.3	15.5	6	0.6	10176.3
1201981	120	1981	1.3	15.5	6	0.6	10176.3
1201982	120	1982	1.3	15.5	6	0.6	10176.3
1201983	120	1983	1.3	15.5	6	0.6	10176.3
1201984	120	1984	1.3	15.5	6	0.6	10176.3
1201985	120	1985	1.3	15.5	6	0.6	10176.3
1201986	120	1986	1.3	15.5	6	0.6	10176.3
1201987	120	1987	1.3	15.5	6	0.6	10176.3
1201988	120	1988	1.3	15.5	6	0.6	10176.3
1201989	120	1989	1.3	15.5	6	0.6	10176.3
1201990	120	1990	1.3	15.5	6	0.6	10176.3
1201991	120	1991	1.3	15.5	5	0.25	10176.3
1201992	120	1992	1.3	15.5	5	0.25	10176.3
1201993	120	1993	1.3	15.5	5	0.25	10176.3
1201994	120	1994	1.3	15.5	5	0.1	10176.3
1201995	120	1995	1.3	15.5	5	0.1	10176.3
1201996	120	1996	1.3	15.5	5	0.1	10176.3
1201997	120	1997	1.3	15.5	5	0.1	10176.3
1201998	120	1998	1.3	15.5	5	0.1	10176.3
1201999	120	1999	1.3	15.5	5	0.1	10176.3
1202000	120	2000	1.3	15.5	5	0.1	10176.3
1202001	120	2001	1.3	15.5	5	0.1	10176.3
1202002	120	2002	1.3	15.5	5	0.1	10176.3
1202003	120	2003	1.3	15.5	5	0.1	10176.3
1202004	120	2004	0.5	15.5	2	0.1	10176.3
1202005	120	2005	0.5	15.5	2	0.1	10176.3
1202006	120	2006	0.5	15.5	2	0.1	10176.3
1202007	120	2007	0.14	15.5	1.1	0.01	10176.3

1202008	120	2008	0.14	15.5	1.1	0.01	10176.3
1202009	120	2009	0.14	15.5	1.1	0.01	10176.3
1202010	120	2010	0.14	15.5	0.2	0.01	10176.3
1202011	120	2011	0.14	15.5	0.2	0.01	10176.3
1202012	120	2012	0.14	15.5	0.2	0.01	10176.3
1202013	120	2013	0.14	15.5	0.2	0.01	10176.3
1202014	120	2014	0.14	15.5	0.2	0.01	10176.3
1202015	120	2015	0.14	15.5	0.2	0.01	10176.3
1202016	120	2016	0.14	15.5	0.2	0.01	10176.3
1202017	120	2017	0.14	15.5	0.2	0.01	10176.3
1202018	120	2018	0.14	15.5	0.2	0.01	10176.3
1202019	120	2019	0.14	15.5	0.2	0.01	10176.3
1202020	120	2020	0.14	15.5	0.2	0.01	10176.3
1202021	120	2021	0.14	15.5	0.2	0.01	10176.3
1202022	120	2022	0.14	15.5	0.2	0.01	10176.3
1202023	120	2023	0.14	15.5	0.2	0.01	10176.3
1202024	120	2024	0.14	15.5	0.2	0.01	10176.3
1202025	120	2025	0.14	15.5	0.2	0.01	10176.3
1202026	120	2026	0.14	15.5	0.2	0.01	10176.3
1751968	175	1968	1.3	15.5	6	0.6	10176.3
1751969	175	1969	1.3	15.5	6	0.6	10176.3
1751970	175	1970	1.3	15.5	6	0.6	10176.3
1751971	175	1971	1.3	15.5	6	0.6	10176.3
1751972	175	1972	1.3	15.5	6	0.6	10176.3
1751973	175	1973	1.3	15.5	6	0.6	10176.3
1751974	175	1974	1.3	15.5	6	0.6	10176.3
1751975	175	1975	1.3	15.5	6	0.6	10176.3
1751976	175	1976	1.3	15.5	6	0.6	10176.3
1751977	175	1977	1.3	15.5	6	0.6	10176.3
1751978	175	1978	1.3	15.5	6	0.6	10176.3
1751979	175	1979	1.3	15.5	6	0.6	10176.3
1751980	175	1980	1.3	15.5	6	0.6	10176.3
1751981	175	1981	1.3	15.5	6	0.6	10176.3
1751982	175	1982	1.3	15.5	6	0.6	10176.3
1751983	175	1983	1.3	15.5	6	0.6	10176.3
1751984	175	1984	1.3	15.5	6	0.6	10176.3
1751985	175	1985	1.3	15.5	6	0.6	10176.3
1751986	175	1986	1.3	15.5	6	0.6	10176.3
1751987	175	1987	1.3	15.5	6	0.6	10176.3
1751988	175	1988	1.3	15.5	6	0.6	10176.3
1751989	175	1989	1.3	15.5	6	0.6	10176.3
1751990	175	1990	1.3	15.5	6	0.6	10176.3
1751991	175	1991	1.3	15.5	5	0.25	10176.3
1751992	175	1992	1.3	15.5	5	0.25	10176.3
1751993	175	1993	1.3	15.5	5	0.25	10176.3
1751994	175	1994	1.3	15.5	5	0.1	10176.3
1751995	175	1995	1.3	15.5	5	0.1	10176.3
1751996	175	1996	1.3	15.5	5	0.1	10176.3
1751997	175	1997	1.3	15.5	5	0.1	10176.3
1751998	175	1998	1.3	15.5	5	0.1	10176.3
1751999	175	1999	1.3	15.5	5	0.1	10176.3
1752000	175	2000	1.3	15.5	5	0.1	10176.3
1752001	175	2001	1.3	15.5	5	0.1	10176.3
1752002	175	2002	1.3	15.5	5	0.1	10176.3
1752003	175	2003	1.3	15.5	5	0.1	10176.3
1752004	175	2004	0.5	15.5	2	0.1	10176.3
1752005	175	2005	0.5	15.5	2	0.1	10176.3
1752006	175	2006	0.5	15.5	2	0.1	10176.3
1752007	175	2007	0.14	15.5	1.1	0.01	10176.3
1752008	175	2008	0.14	15.5	1.1	0.01	10176.3
1752009	175	2009	0.14	15.5	1.1	0.01	10176.3
1752010	175	2010	0.14	15.5	0.2	0.01	10176.3
1752011	175	2011	0.14	15.5	0.2	0.01	10176.3
1752012	175	2012	0.14	15.5	0.2	0.01	10176.3
1752013	175	2013	0.14	15.5	0.2	0.01	10176.3
1752014	175	2014	0.14	15.5	0.2	0.01	10176.3
1752015	175	2015	0.14	15.5	0.2	0.01	10176.3
1752016	175	2016	0.14	15.5	0.2	0.01	10176.3
1752017	175	2017	0.14	15.5	0.2	0.01	10176.3
1752018	175	2018	0.14	15.5	0.2	0.01	10176.3
1752019	175	2019	0.14	15.5	0.2	0.01	10176.3
1752020	175	2020	0.14	15.5	0.2	0.01	10176.3
1752021	175	2021	0.14	15.5	0.2	0.01	10176.3
1752022	175	2022	0.14	15.5	0.2	0.01	10176.3
1752023	175	2023	0.14	15.5	0.2	0.01	10176.3
1752024	175	2024	0.14	15.5	0.2	0.01	10176.3
1752025	175	2025	0.14	15.5	0.2	0.01	10176.3
1752026	175	2026	0.14	15.5	0.2	0.01	10176.3
2501968	250	1968	1.3	15.5	6	0.6	10176.3
2501969	250	1969	1.3	15.5	6	0.6	10176.3
2501970	250	1970	1.3	15.5	6	0.6	10176.3

2501971	250	1971	1.3	15.5	6	0.6	10176.3
2501972	250	1972	1.3	15.5	6	0.6	10176.3
2501973	250	1973	1.3	15.5	6	0.6	10176.3
2501974	250	1974	1.3	15.5	6	0.6	10176.3
2501975	250	1975	1.3	15.5	6	0.6	10176.3
2501976	250	1976	1.3	15.5	6	0.6	10176.3
2501977	250	1977	1.3	15.5	6	0.6	10176.3
2501978	250	1978	1.3	15.5	6	0.6	10176.3
2501979	250	1979	1.3	15.5	6	0.6	10176.3
2501980	250	1980	1.3	15.5	6	0.6	10176.3
2501981	250	1981	1.3	15.5	6	0.6	10176.3
2501982	250	1982	1.3	15.5	6	0.6	10176.3
2501983	250	1983	1.3	15.5	6	0.6	10176.3
2501984	250	1984	1.3	15.5	6	0.6	10176.3
2501985	250	1985	1.3	15.5	6	0.6	10176.3
2501986	250	1986	1.3	15.5	6	0.6	10176.3
2501987	250	1987	1.3	15.5	6	0.6	10176.3
2501988	250	1988	1.3	15.5	6	0.6	10176.3
2501989	250	1989	1.3	15.5	6	0.6	10176.3
2501990	250	1990	1.3	15.5	6	0.6	10176.3
2501991	250	1991	1.3	15.5	5	0.25	10176.3
2501992	250	1992	1.3	15.5	5	0.25	10176.3
2501993	250	1993	1.3	15.5	5	0.25	10176.3
2501994	250	1994	1.3	15.5	5	0.1	10176.3
2501995	250	1995	1.3	15.5	5	0.1	10176.3
2501996	250	1996	1.3	15.5	5	0.1	10176.3
2501997	250	1997	1.3	15.5	5	0.1	10176.3
2501998	250	1998	1.3	15.5	5	0.1	10176.3
2501999	250	1999	1.3	15.5	5	0.1	10176.3
2502000	250	2000	1.3	15.5	5	0.1	10176.3
2502001	250	2001	1.3	15.5	5	0.1	10176.3
2502002	250	2002	1.3	15.5	5	0.1	10176.3
2502003	250	2003	1.3	15.5	5	0.1	10176.3
2502004	250	2004	0.5	15.5	2	0.1	10176.3
2502005	250	2005	0.5	15.5	2	0.1	10176.3
2502006	250	2006	0.5	15.5	2	0.1	10176.3
2502007	250	2007	0.14	15.5	1.1	0.01	10176.3
2502008	250	2008	0.14	15.5	1.1	0.01	10176.3
2502009	250	2009	0.14	15.5	1.1	0.01	10176.3
2502010	250	2010	0.14	15.5	0.2	0.01	10176.3
2502011	250	2011	0.14	15.5	0.2	0.01	10176.3
2502012	250	2012	0.14	15.5	0.2	0.01	10176.3
2502013	250	2013	0.14	15.5	0.2	0.01	10176.3
2502014	250	2014	0.14	15.5	0.2	0.01	10176.3
2502015	250	2015	0.14	15.5	0.2	0.01	10176.3
2502016	250	2016	0.14	15.5	0.2	0.01	10176.3
2502017	250	2017	0.14	15.5	0.2	0.01	10176.3
2502018	250	2018	0.14	15.5	0.2	0.01	10176.3
2502019	250	2019	0.14	15.5	0.2	0.01	10176.3
2502020	250	2020	0.14	15.5	0.2	0.01	10176.3
2502021	250	2021	0.14	15.5	0.2	0.01	10176.3
2502022	250	2022	0.14	15.5	0.2	0.01	10176.3
2502023	250	2023	0.14	15.5	0.2	0.01	10176.3
2502024	250	2024	0.14	15.5	0.2	0.01	10176.3
2502025	250	2025	0.14	15.5	0.2	0.01	10176.3
2502026	250	2026	0.14	15.5	0.2	0.01	10176.3
5001968	500	1968	1.3	15.5	6	0.6	10176.3
5001969	500	1969	1.3	15.5	6	0.6	10176.3
5001970	500	1970	1.3	15.5	6	0.6	10176.3
5001971	500	1971	1.3	15.5	6	0.6	10176.3
5001972	500	1972	1.3	15.5	6	0.6	10176.3
5001973	500	1973	1.3	15.5	6	0.6	10176.3
5001974	500	1974	1.3	15.5	6	0.6	10176.3
5001975	500	1975	1.3	15.5	6	0.6	10176.3
5001976	500	1976	1.3	15.5	6	0.6	10176.3
5001977	500	1977	1.3	15.5	6	0.6	10176.3
5001978	500	1978	1.3	15.5	6	0.6	10176.3
5001979	500	1979	1.3	15.5	6	0.6	10176.3
5001980	500	1980	1.3	15.5	6	0.6	10176.3
5001981	500	1981	1.3	15.5	6	0.6	10176.3
5001982	500	1982	1.3	15.5	6	0.6	10176.3
5001983	500	1983	1.3	15.5	6	0.6	10176.3
5001984	500	1984	1.3	15.5	6	0.6	10176.3
5001985	500	1985	1.3	15.5	6	0.6	10176.3
5001986	500	1986	1.3	15.5	6	0.6	10176.3
5001987	500	1987	1.3	15.5	6	0.6	10176.3
5001988	500	1988	1.3	15.5	6	0.6	10176.3
5001989	500	1989	1.3	15.5	6	0.6	10176.3
5001990	500	1990	1.3	15.5	6	0.6	10176.3
5001991	500	1991	1.3	15.5	5	0.25	10176.3
5001992	500	1992	1.3	15.5	5	0.25	10176.3

5001993	500	1993	1.3	15.5	5	0.25	10176.3
5001994	500	1994	1.3	15.5	5	0.1	10176.3
5001995	500	1995	1.3	15.5	5	0.1	10176.3
5001996	500	1996	1.3	15.5	5	0.1	10176.3
5001997	500	1997	1.3	15.5	5	0.1	10176.3
5001998	500	1998	1.3	15.5	5	0.1	10176.3
5001999	500	1999	1.3	15.5	5	0.1	10176.3
5002000	500	2000	1.3	15.5	5	0.1	10176.3
5002001	500	2001	1.3	15.5	5	0.1	10176.3
5002002	500	2002	1.3	15.5	5	0.1	10176.3
5002003	500	2003	1.3	15.5	5	0.1	10176.3
5002004	500	2004	0.5	15.5	2	0.1	10176.3
5002005	500	2005	0.5	15.5	2	0.1	10176.3
5002006	500	2006	0.5	15.5	2	0.1	10176.3
5002007	500	2007	0.14	15.5	1.1	0.01	10176.3
5002008	500	2008	0.14	15.5	1.1	0.01	10176.3
5002009	500	2009	0.14	15.5	1.1	0.01	10176.3
5002010	500	2010	0.14	15.5	0.2	0.01	10176.3
5002011	500	2011	0.14	15.5	0.2	0.01	10176.3
5002012	500	2012	0.14	15.5	0.2	0.01	10176.3
5002013	500	2013	0.14	15.5	0.2	0.01	10176.3
5002014	500	2014	0.14	15.5	0.2	0.01	10176.3
5002015	500	2015	0.14	15.5	0.2	0.01	10176.3
5002016	500	2016	0.14	15.5	0.2	0.01	10176.3
5002017	500	2017	0.14	15.5	0.2	0.01	10176.3
5002018	500	2018	0.14	15.5	0.2	0.01	10176.3
5002019	500	2019	0.14	15.5	0.2	0.01	10176.3
5002020	500	2020	0.14	15.5	0.2	0.01	10176.3
5002021	500	2021	0.14	15.5	0.2	0.01	10176.3
5002022	500	2022	0.14	15.5	0.2	0.01	10176.3
5002023	500	2023	0.14	15.5	0.2	0.01	10176.3
5002024	500	2024	0.14	15.5	0.2	0.01	10176.3
5002025	500	2025	0.14	15.5	0.2	0.01	10176.3
5002026	500	2026	0.14	15.5	0.2	0.01	10176.3
7501968	750	1968	1.3	15.5	6	0.6	10176.3
7501969	750	1969	1.3	15.5	6	0.6	10176.3
7501970	750	1970	1.3	15.5	6	0.6	10176.3
7501971	750	1971	1.3	15.5	6	0.6	10176.3
7501972	750	1972	1.3	15.5	6	0.6	10176.3
7501973	750	1973	1.3	15.5	6	0.6	10176.3
7501974	750	1974	1.3	15.5	6	0.6	10176.3
7501975	750	1975	1.3	15.5	6	0.6	10176.3
7501976	750	1976	1.3	15.5	6	0.6	10176.3
7501977	750	1977	1.3	15.5	6	0.6	10176.3
7501978	750	1978	1.3	15.5	6	0.6	10176.3
7501979	750	1979	1.3	15.5	6	0.6	10176.3
7501980	750	1980	1.3	15.5	6	0.6	10176.3
7501981	750	1981	1.3	15.5	6	0.6	10176.3
7501982	750	1982	1.3	15.5	6	0.6	10176.3
7501983	750	1983	1.3	15.5	6	0.6	10176.3
7501984	750	1984	1.3	15.5	6	0.6	10176.3
7501985	750	1985	1.3	15.5	6	0.6	10176.3
7501986	750	1986	1.3	15.5	6	0.6	10176.3
7501987	750	1987	1.3	15.5	6	0.6	10176.3
7501988	750	1988	1.3	15.5	6	0.6	10176.3
7501989	750	1989	1.3	15.5	6	0.6	10176.3
7501990	750	1990	1.3	15.5	6	0.6	10176.3
7501991	750	1991	1.3	15.5	5	0.25	10176.3
7501992	750	1992	1.3	15.5	5	0.25	10176.3
7501993	750	1993	1.3	15.5	5	0.25	10176.3
7501994	750	1994	1.3	15.5	5	0.1	10176.3
7501995	750	1995	1.3	15.5	5	0.1	10176.3
7501996	750	1996	1.3	15.5	5	0.1	10176.3
7501997	750	1997	1.3	15.5	5	0.1	10176.3
7501998	750	1998	1.3	15.5	5	0.1	10176.3
7501999	750	1999	1.3	15.5	5	0.1	10176.3
7502000	750	2000	1.3	15.5	5	0.1	10176.3
7502001	750	2001	1.3	15.5	5	0.1	10176.3
7502002	750	2002	1.3	15.5	5	0.1	10176.3
7502003	750	2003	1.3	15.5	5	0.1	10176.3
7502004	750	2004	0.5	15.5	2	0.1	10176.3
7502005	750	2005	0.5	15.5	2	0.1	10176.3
7502006	750	2006	0.5	15.5	2	0.1	10176.3
7502007	750	2007	0.14	15.5	1.1	0.01	10176.3
7502008	750	2008	0.14	15.5	1.1	0.01	10176.3
7502009	750	2009	0.14	15.5	1.1	0.01	10176.3
7502010	750	2010	0.14	15.5	0.2	0.01	10176.3
7502011	750	2011	0.14	15.5	0.2	0.01	10176.3
7502012	750	2012	0.14	15.5	0.2	0.01	10176.3
7502013	750	2013	0.14	15.5	0.2	0.01	10176.3
7502014	750	2014	0.14	15.5	0.2	0.01	10176.3

7502015	750	2015	0.14	15.5	0.2	0.01	10176.3
7502016	750	2016	0.14	15.5	0.2	0.01	10176.3
7502017	750	2017	0.14	15.5	0.2	0.01	10176.3
7502018	750	2018	0.14	15.5	0.2	0.01	10176.3
7502019	750	2019	0.14	15.5	0.2	0.01	10176.3
7502020	750	2020	0.14	15.5	0.2	0.01	10176.3
7502021	750	2021	0.14	15.5	0.2	0.01	10176.3
7502022	750	2022	0.14	15.5	0.2	0.01	10176.3
7502023	750	2023	0.14	15.5	0.2	0.01	10176.3
7502024	750	2024	0.14	15.5	0.2	0.01	10176.3
7502025	750	2025	0.14	15.5	0.2	0.01	10176.3
7502026	750	2026	0.14	15.5	0.2	0.01	10176.3
9991968	999	1968	1.3	15.5	6	0.6	10176.3
9991969	999	1969	1.3	15.5	6	0.6	10176.3
9991970	999	1970	1.3	15.5	6	0.6	10176.3
9991971	999	1971	1.3	15.5	6	0.6	10176.3
9991972	999	1972	1.3	15.5	6	0.6	10176.3
9991973	999	1973	1.3	15.5	6	0.6	10176.3
9991974	999	1974	1.3	15.5	6	0.6	10176.3
9991975	999	1975	1.3	15.5	6	0.6	10176.3
9991976	999	1976	1.3	15.5	6	0.6	10176.3
9991977	999	1977	1.3	15.5	6	0.6	10176.3
9991978	999	1978	1.3	15.5	6	0.6	10176.3
9991979	999	1979	1.3	15.5	6	0.6	10176.3
9991980	999	1980	1.3	15.5	6	0.6	10176.3
9991981	999	1981	1.3	15.5	6	0.6	10176.3
9991982	999	1982	1.3	15.5	6	0.6	10176.3
9991983	999	1983	1.3	15.5	6	0.6	10176.3
9991984	999	1984	1.3	15.5	6	0.6	10176.3
9991985	999	1985	1.3	15.5	6	0.6	10176.3
9991986	999	1986	1.3	15.5	6	0.6	10176.3
9991987	999	1987	1.3	15.5	6	0.6	10176.3
9991988	999	1988	1.3	15.5	6	0.6	10176.3
9991989	999	1989	1.3	15.5	6	0.6	10176.3
9991990	999	1990	1.3	15.5	6	0.6	10176.3
9991991	999	1991	1.3	15.5	5	0.25	10176.3
9991992	999	1992	1.3	15.5	5	0.25	10176.3
9991993	999	1993	1.3	15.5	5	0.25	10176.3
9991994	999	1994	1.3	15.5	5	0.1	10176.3
9991995	999	1995	1.3	15.5	5	0.1	10176.3
9991996	999	1996	1.3	15.5	5	0.1	10176.3
9991997	999	1997	1.3	15.5	5	0.1	10176.3
9991998	999	1998	1.3	15.5	5	0.1	10176.3
9991999	999	1999	1.3	15.5	5	0.1	10176.3
9992000	999	2000	1.3	15.5	5	0.1	10176.3
9992001	999	2001	1.3	15.5	5	0.1	10176.3
9992002	999	2002	1.3	15.5	5	0.1	10176.3
9992003	999	2003	1.3	15.5	5	0.1	10176.3
9992004	999	2004	0.5	15.5	2	0.1	10176.3
9992005	999	2005	0.5	15.5	2	0.1	10176.3
9992006	999	2006	0.5	15.5	2	0.1	10176.3
9992007	999	2007	0.14	15.5	1.1	0.01	10176.3
9992008	999	2008	0.14	15.5	1.1	0.01	10176.3
9992009	999	2009	0.14	15.5	1.1	0.01	10176.3
9992010	999	2010	0.14	15.5	0.2	0.01	10176.3
9992011	999	2011	0.14	15.5	0.2	0.01	10176.3
9992012	999	2012	0.14	15.5	0.2	0.01	10176.3
9992013	999	2013	0.14	15.5	0.2	0.01	10176.3
9992014	999	2014	0.14	15.5	0.2	0.01	10176.3
9992015	999	2015	0.14	15.5	0.2	0.01	10176.3
9992016	999	2016	0.14	15.5	0.2	0.01	10176.3
9992017	999	2017	0.14	15.5	0.2	0.01	10176.3
9992018	999	2018	0.14	15.5	0.2	0.01	10176.3
9992019	999	2019	0.14	15.5	0.2	0.01	10176.3
9992020	999	2020	0.14	15.5	0.2	0.01	10176.3
9992021	999	2021	0.14	15.5	0.2	0.01	10176.3
9992022	999	2022	0.14	15.5	0.2	0.01	10176.3
9992023	999	2023	0.14	15.5	0.2	0.01	10176.3
9992024	999	2024	0.14	15.5	0.2	0.01	10176.3
9992025	999	2025	0.14	15.5	0.2	0.01	10176.3
9992026	999	2026	0.14	15.5	0.2	0.01	10176.3

ARB Equipment	HP Bin	SOX (g SOX/hp-hr)
Excavator	50	0.0686448
Excavator	120	0.0622888
Excavator	175	0.0597464
Excavator	250	0.0597464
Excavator	500	0.0521192
Excavator	750	0.0533904
Crane	50	0.0686448
Crane	120	0.0622888
Crane	175	0.0597464
Crane	250	0.0597464
Crane	500	0.0521192
Crane	750	0.0533904
Crane	999	0.0533904
Forklift	50	0.0686448
Forklift	120	0.0622888
Forklift	175	0.0597464
Forklift	250	0.0597464
Forklift	500	0.0521192
Material Handling Equip	120	0.0597464
Other General Industrial Equip	50	0.0686448
Other General Industrial Equip	120	0.0622888
Other General Industrial Equip	175	0.0597464
Other General Industrial Equip	250	0.0597464
Other General Industrial Equip	500	0.0521192
Other General Industrial Equip	750	0.0533904
Other General Industrial Equip	999	0.0533904
Sweeper/Scrubber	50	0.0686448
Sweeper/Scrubber	120	0.0622888
Sweeper/Scrubber	175	0.0597464
Sweeper/Scrubber	250	0.0597464
Tractor/Loader/Backhoe	50	0.0686448
Tractor/Loader/Backhoe	120	0.0622888
Tractor/Loader/Backhoe	175	0.0597464
Tractor/Loader/Backhoe	250	0.0597464
Tractor/Loader/Backhoe	500	0.0597464
Tractor/Loader/Backhoe	750	0.0597464
Yard Tractor offroad engine	120	0.0622888
Yard Tractor offroad engine	175	0.0597464
Yard Tractor offroad engine	250	0.0597464
Yard Tractor offroad engine	750	0.0533904
Yard Tractor offroad engine	999	0.0533904
Yard Tractor onroad engine	120	0.0622888
Yard Tractor onroad engine	175	0.0597464
Yard Tractor onroad engine	250	0.0597464
Yard Tractor onroad engine	750	0.0533904
Yard Tractor onroad engine	999	0.0533904

Engine changes	Emission Changes %			
	HC	CO	NOx	PM
DOC	0.7	0.7	0	0.3
DPF (P)	0.9	0.9	0	0.85
DPF (A)	0	0	0	0.85
Emulsified Fuel	0	0	0.15	0.3
Emulsified Fuel+ DOC	0	0	0.2	0.5

Equipment Types	Code
Crane	1
Excavator	2
Forklift	3
Material Handling Equip	4
Other General Industrial Equ	5
Sweeper/Scrubber	6
Tractor/Loader/Backhoe	7
Yard Tractor offroad engine	8
Yard Tractor onroad engine	9

APPENDIX D

DEATILED EMISSION CALCULATIONS, EMISSION FACTOR DERIVATION, OFFROAD2007 OUTPUT, AND SPECIATION PROFILE FOR HEAVY EQUIPMENT

Summary of Emissions from Heavy Equipment
Dolores and ICTF Rail Yards, Long Beach, CA

									Hours of															
		Equipment				Fuel	No of	Rating	Operation	Load	2005 Emission Factors (g/bhp-hr)[3]						VOC Evaporative Emissions[4]		2005 Emission Estimates (tpy)					
Yard	Location	Type	Make	Model	Year	Type	Units	(hp)	(hr/yr)[1]	Factor[2]	ROG	CO	NOx	PM10	DPM	SOx	Part 1 (lb/hr)	Part 2 (lb/yr)	ROG	CO	NOx	PM10	DPM	SOx
ICTF	Car Dept.	Crane	Grove	RT600E	2004	Diesel	1	173	1095	0.43	0.32	2.83	4.61	0.18	0.18	0.05	-	-	0.03	0.25	0.41	0.02	0.02	0.00
ICTF	Crane Maint	Forklift	Taylor	850	2005	Diesel	2	155	7300	0.30	0.22	2.76	4.26	0.14	0.14	0.05	-	-	0.16	2.07	3.19	0.10	0.10	0.04
ICTF	Crane Maint	Forklift	Taylor	850	1998	Diesel	1	154	7300	0.30	1.33	3.66	8.59	0.62	0.62	0.05	-	-	0.49	1.36	3.19	0.23	0.23	0.02
ICTF	Crane Maint.	Man Lift	Unknown	Unknown	1985	Diesel	1	29	1825	0.46	5.11	10.26	7.51	1.02	1.02	0.06	-	-	0.14	0.28	0.20	0.03	0.03	0.00
Dolores	Locomotive Shop	Forklift	Yale	GP-060	ALL[5]	Propane	2	150	3285	0.30	0.11	23.38	7.30	0.06	0.00	0.00	-	-	0.04	7.62	2.38	0.02	0.00	0.00
Total							**7**												**0.86**	**11.58**	**9.38**	**0.40**	**0.38**	**0.07**

Notes
1. Hours of operation provided by UPRR personnel.
2. Default load factors from OFFROAD 2007 model.
3. Emission factors (g/bhp-hr) from the OFFROAD2007 model.
4. Evaporative emissions were calculated from the OFFROAD 2007 model and are negligible.
5. Dolores forklifts are modeled as the calendar year 2005 fleet average model year group from the OFFROAD2007 model.

Toxic Air Contaminant Emissions from the Propane-Fueled Forklifts
Dolores and ICTF Rail Yards, Long Beach, CA

Profile[1]	CAS	Chemical Name	Organic Fraction	Emissions (tpy)
719	95636	1,2,4-trimethylbenzene	0.00001	3.21E-07
719	75070	acetaldehyde	0.00003	9.63E-07
719	71432	benzene	0.00010	3.53E-06
719	110827	cyclohexane	0.00001	3.21E-07
719	100414	ethylbenzene	0.00001	3.21E-07
719	74851	ethylene	0.00058	2.02E-05
719	50000	formaldehyde	0.00074	2.60E-05
719	108383	m-xylene	0.00001	3.21E-07
719	110543	n-hexane	0.00002	6.42E-07
719	95476	o-xylene	0.00001	3.21E-07
719	115071	propylene	0.00154	5.42E-05
719	108883	toluene	0.00004	1.28E-06
719	1330207	xylene	0.00002	6.42E-07
Total				**1.09E-04**

Notes:
1. Organic fraction from ARBs SPECIATE database. Data is from "ICE-reciprocating - natural gas" option. The SPECIATE database does not include a profile for propane-fueled engines.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
3. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.0914)

OFFROAD 2007 Output
Dolores and ICTF Rail Yards

Yard	Location	Equipment Type	Make	Model	Year	Fuel Type	AVG Rating (hp)	No of Units	Operating Schedule (hr/day)	Operating Schedule (hr/yr)	Load Factor	Exhaust & Crankcase Emissions (lb/hp-hr) ROG	CO	NOX	SOX	PM10	Evap Part 1(lb/hr) ROG	Evap Part 2 (lb/yr) ROG
ICTF	Car Dept.	Crane	Grove	RT600E	2004	Diesel	173	1		1095	0.43000001	0.000714341	0.006248094	0.010159873	0.000120747	0.0003903	0	0
ICTF	Crane Maint	Forklift	Taylor	850	2005	Diesel	155	1		7300	0.3	0.000485603	0.006094147	0.009401028	0.000120747	0.0003092	0	0
ICTF	Crane Maint	Forklift	Taylor	850	2005	Diesel	155	1		7300	0.3	0.000485603	0.006094147	0.009401028	0.000120747	0.0003092	0	0
ICTF	Crane Maint	Forklift	Taylor	850	1998	Diesel	154	1		7300	0.3	0.002930775	0.008077516	0.018935238	0.000120747	0.0013639	0	0
ICTF	Crane Maint.	Man Lift	Unknown	Unknown	1985	Diesel	29	1		1825	0.46	0.011266342	0.022615559	0.016558722	0.00013873	0.0022549	0	0

Cnty	SCC	HP	MYr	ROG-Exhaust	CO-Exhaust	NOx-Exhaust	CO2-Exhaust	SO2-Exhaust	PM-Exhaust
Los Angeles	2270002045	175	2004	0.000736677	0.006443459	0.01047755	1.292062	0.000124522	0.000402465
Los Angeles	2270003020	175	2005	0.001858381	0.02332204	0.03597733	4.794742	0.000462093	0.001183285
Los Angeles	2270003020	175	2005	0.001858381	0.02332204	0.03597733	4.794742	0.000462093	0.001183285
Los Angeles	2270003020	175	1998	0.01351128	0.03723847	0.08729408	5.775983	0.00055666	0.006287591
Los Angeles	2270003010	50	1985	0.001313469	0.0026366	0.001930473	0.1460658	1.61737E-05	0.000262881

Crankcase	FuelCons.	Activity	LF	HPAvg	ROG/ROG	ROG (lb/hp-hr)	CO (lb/hp-hr)	NOx (lb/hp-hr)	SOx (lb/hp-hr)	PM (lb/hp-hr)
		32.19191	0.43	149	1	0.000714341	0.006248094	0.010159873	0.000120747	0.000390263
		171.2285	0.3	149	1	0.000485603	0.006094147	0.009401028	0.000120747	0.000309197
		171.2285	0.3	149	1	0.000485603	0.006094147	0.009401028	0.000120747	0.000309197
		206.2702	0.3	149	1	0.002930775	0.008077516	0.018935238	0.000120747	0.001363861
		14.90837	0.46	34	1	0.011266342	0.022615559	0.016558722	0.00013873	0.002254873

CY	Season	AvgDays	Code	Equipment	Fuel	MaxHP	Class	C/R	Pre	Hand	Port	County	Air Basin	Air Dist.	MY	Population	Activity	Consumption	ROG Exhaust	CO Exhaust	NOX Exhaust	CO2 Exhaust	SO2 Exhaust	PM Exhaust	N2O Exhaust	CH4 Exhaust
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	2005	10	34.54553	125.9969	0.000516736	0.006696458	0.01036286	1.386527	0.000133627	0.000335694	0	4.66243E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	2004	9	32.19191	117.5374	0.000736677	0.006443459	0.01047755	1.292062	0.000124522	0.000402465	0	6.64692E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	2003	9	29.59656	108.2279	0.001049214	0.006110834	0.01102094	1.187894	0.000114483	0.000503791	0	9.46689E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	2002	8	25.96358	95.29885	0.001804189	0.005524647	0.01321324	1.04208	0.00010043	0.000755064	0	0.000162789
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	2001	7	24.94098	91.59915	0.001816684	0.005464515	0.01302733	1.001037	9.64748E-05	0.000775358	0	0.000163917
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	2000	8	29.02304	106.6536	0.002211249	0.006542118	0.01554875	1.164875	0.000112265	0.000960482	0	0.000199518
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1999	9	29.9497	110.1235	0.002382187	0.006940084	0.01644689	1.202068	0.000115849	0.00105123	0	0.000214941
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1998	8	28.70633	105.6134	0.002379458	0.006833192	0.01614909	1.152163	0.00011104	0.001065174	0	0.000214695
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1997	8	25.91036	95.38268	0.002234506	0.006331232	0.0149237	1.039944	0.000100225	0.001013405	0	0.000201616
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1996	3	11.05967	40.73729	0.000990835	0.002772268	0.007567751	0.4438933	4.27802E-05	0.000414919	0	8.94015E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1995	2	7.369628	27.16125	0.000684934	0.001893833	0.005157323	0.2957891	2.85067E-05	0.000289971	0	6.18005E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1994	2	5.454278	20.11385	0.000525194	0.001436064	0.003901716	0.2189141	2.10978E-05	0.000224592	0	4.73874E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1993	1	3.054836	11.27196	0.000304385	0.000823599	0.002232755	0.1226096	1.18165E-05	0.000131381	0	2.74642E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1992	1	2.421051	8.938588	0.000249345	0.000668012	0.001807154	0.09717181	9.36492E-06	0.000108555	0	2.2498E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1991	1	1.729816	6.390258	0.00018395	0.000488209	0.001318078	0.06942827	6.69114E-06	8.07274E-05	0	1.65975E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1990	0	1.526088	5.640937	0.000167398	0.000440345	0.00118656	0.06125139	5.9031E-06	7.4013E-05	0	1.5104E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1989	0	0.915956	3.387659	0.000103541	0.000270077	0.000726408	0.03676303	3.54303E-06	4.60991E-05	0	9.34229E-06
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Construction and Mining Equipment	U	P	NHH	P	Los Angeles	SC	SC	1988	0	0.305319	1.129879	3.55364E-05	9.19535E-05	0.000246882	0.01225435	1.18101E-06	1.59252E-05	0	3.20639E-06
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2005	62	85.46236	76.29951	0.00068627	0.004532495	0.006947764	0.8373235	9.27157E-05	0.000469097	0	0.000061921
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2004	62	85.37475	76.53134	0.001263142	0.005181731	0.007213853	0.8364658	9.26207E-05	0.000550737	0	0.000113971
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2003	62	84.57448	76.68089	0.002948494	0.006743605	0.007849491	0.828625	9.17525E-05	0.000788789	0	0.000266038
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2002	61	83.2065	75.54327	0.0030604	0.006935768	0.007792558	0.8152217	9.02684E-05	0.000803445	0	0.000276135
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2001	60	82.14319	74.67932	0.00317885	0.007144532	0.007762119	0.8048042	8.91149E-05	0.000820243	0	0.000286823
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2000	73	99.33273	90.42956	0.004034595	0.008999243	0.009470048	0.9732198	0.000107763	0.001024618	0	0.000364035
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1999	71	97.38175	88.77364	0.004142139	0.009175053	0.009366013	0.9541047	0.000105647	0.001036579	0	0.000373739
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1998	69	95.07923	87.46679	0.005249329	0.01134927	0.01111315	0.9315457	0.000103149	0.001205873	0	0.000473639
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1997	68	93.13014	85.81564	0.005363803	0.01152844	0.01096298	0.9124493	0.000101034	0.001216616	0	0.000483967
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1996	67	92.39162	85.27595	0.005541594	0.0118456	0.01095308	0.9052141	0.000100233	0.001242151	0	0.000500009
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1995	59	80.54341	74.46293	0.005023011	0.01068269	0.009615611	0.78913	8.73793E-05	0.001113528	0	0.000453218
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1994	38	51.76703	47.93784	0.003351847	0.007094921	0.006223326	0.5071912	5.61606E-05	0.000735402	0	0.000302432
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1993	23	31.55954	29.27317	0.002118697	0.004464946	0.003820335	0.3092069	3.42381E-05	0.000460352	0	0.000191167
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1992	23	31.7035	29.45501	0.002203964	0.004625509	0.003864194	0.3106174	3.43942E-05	0.000474524	0	0.00019886
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1991	22	29.77579	27.70941	0.00214096	0.004475933	0.003654062	0.2917307	3.23029E-05	0.00045701	0	0.000193175
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1990	39	52.88683	49.29712	0.003928821	0.008183878	0.006534319	0.5181625	5.73754E-05	0.000831865	0	0.000354491
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1989	23	31.27517	29.2	0.002397928	0.004977921	0.003890211	0.3064207	3.39295E-05	0.000503841	0	0.000216361
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1988	15	21.22821	19.85203	0.001678231	0.003472669	0.002658204	0.207985	2.30299E-05	0.000350069	0	0.000151424
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1987	13	18.31136	17.1645	0.001524051	0.003076482	0.002340296	0.1794069	1.98655E-05	0.000308941	0	0.000137513
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1986	12	16.36679	15.36698	0.001402082	0.002822152	0.002105546	0.1603548	1.77559E-05	0.000282365	0	0.000126508
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1985	11	14.90837	14.02065	0.001313469	0.0026366	0.001930473	0.1460658	1.61737E-05	0.000262881	0	0.000118512
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1984	9	12.6397	11.90658	0.001144389	0.002291271	0.001647344	0.1238383	1.37125E-05	0.00022769	0	0.000103256
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1983	8	11.18127	10.55	0.001039588	0.002076339	0.001466678	0.1095493	1.21303E-05	0.000205676	0	9.38003E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1982	7	9.884899	9.342063	0.00094314	0.001879316	0.001304949	0.09684796	1.07238E-05	0.000185594	0	8.5098E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1981	6	8.426469	7.976731	0.00082452	0.001639303	0.001119509	0.08255893	9.14164E-06	0.00016142	0	7.43951E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1980	5	6.80599	6.453245	0.000682541	0.001354148	0.000909947	0.0666822	7.38363E-06	0.000132969	0	6.15846E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1979	4	5.509613	5.232558	0.000565957	0.00112058	0.000741262	0.05398083	5.97722E-06	0.00010974	0	5.10654E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1978	3	4.051186	3.85372	0.000426016	0.00084187	0.000548455	0.03969178	4.39502E-06	8.22336E-05	0	3.84387E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1977	2	3.240948	3.087977	0.000348709	0.000687828	0.000441492	0.03175343	3.51601E-06	6.7021E-05	0	3.14635E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1976	2	2.268664	2.165085	0.000249624	0.000491512	0.000310954	0.0222274	2.46121E-06	4.77786E-05	0	2.25232E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1975	1	1.215355	1.161742	0.000136688	0.000268684	0.000167606	0.01190753	1.31851E-06	2.60585E-05	0	1.23332E-05
2005	Annual	Mon-Sun	2270003010	Aerial Lifts	D	50	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1974	0	0.405119	0.3878727	4.65499E-05	9.13529E-05	5.62096E-05	0.003969179	4.39502E-07	8.84042E-06	0	4.20012E-06
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2005	35	171.2285	435.7593	0.001858381	0.02332204	0.03597733	4.794742	0.000462093	0.001183285	0	0.000167679
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2004	34	167.2895	426.2874	0.002885198	0.0238449	0.03846996	4.68444	0.000451463	0.001534349	0	0.000260327
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2003	34	170.0934	434.2094	0.004592219	0.0253217	0.04523864	4.762956	0.00045903	0.002180442	0	0.000414349
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2002	39	191.4349	490.6674	0.009966377	0.02971108	0.07071436	5.360561	0.000516624	0.004294575	0	0.00089925
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2001	38	189.1404	485.1955	0.0104825	0.03055274	0.07241131	5.296314	0.000510432	0.004623686	0	0.00094582
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2000	44	217.7717	559.1128	0.01280108	0.03655673	0.08630223	6.098045	0.000587699	0.005761792	0	0.001155021
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1999	43	211.1423	542.5491	0.01312091	0.03678098	0.08651554	5.912413	0.000569808	0.006011251	0	0.001183879
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1998	42	206.2702	530.4754	0.01351128	0.03723847	0.08729408	5.775983	0.00055666	0.006287591	0	0.001219101
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1997	40	197.1566	507.4633	0.01357681	0.03684166	0.08608944	5.52078	0.000532065	0.006406496	0	0.001225014
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1996	39	193.1432	497.5509	0.01394947	0.03731482	0.100914	5.4084	0.000521234	0.006080952	0	0.001258638
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1995	34	167.8423	432.7367	0.01268616	0.03348962	0.09031124	4.699923	0.000452955	0.00559252	0	0.001144652
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1994	28	135.644	350.0149	0.01070829	0.02792405	0.0751008	3.798303	0.000366061	0.004768699	0	0.000966192
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1993	8	37.38499	96.5489	0.003076953	0.00793293	0.02128145	1.046856	0.000100891	0.001382944	0	0.000277629
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1992	5	26.52966	68.57169	0.002272658	0.005797477	0.01551561	0.7428841	7.15954E-05	0.00103009	0	0.000205058
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1991	5	23.14514	59.87366	0.002060499	0.005204431	0.01389702	0.6481104	6.24616E-05	0.000941169	0	0.000185916
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1990	7	35.91994	92.99818	0.00331848	0.00830445	0.02212736	1.005831	9.69369E-05	0.001526587	0	0.000299421
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1989	6	28.38708	73.55666	0.002717944	0.006742667	0.01792952	0.7948955	7.6608E-05	0.001258559	0	0.000245236
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1988	5	24.8387	64.41578	0.002461668	0.006057129	0.01607555	0.6955339	6.7032E-05	0.001146842	0	0.000222112
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1987	4	20.10752	52.81194	0.002663763	0.00782337	0.01792899	0.5630512	5.4264E-05	0.001398464	0	0.000240347
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1986	3	14.58781	38.35958	0.001995871	0.005819392	0.01331293	0.4084881	3.9368E-05	0.001053386	0	0.000180084
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1985	2	10.84229	28.54267	0.001530491	0.004431962	0.0101219	0.3036059	2.926E-05	0.00081177	0	0.000138094
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1984	2	7.491032	19.7825	0.001164699	0.003215595	0.007150254	0.2097641	2.0216E-05	0.000580791	0	0.000105089
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1983	1	3.942652	10.42438	0.000631296	0.001732284	0.003845898	0.1104022	1.064E-05	0.00031617	0	5.69608E-05
2005	Annual	Mon-Sun	2270003020	Forklifts	D	175	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1982	0	1.314216	3.478969	0.000216531	0.000590715	0.001309499	0.03680073	3.54667E-06	0.000108887	0	1.95372E-05

OFFROAD Output for Propane-Fueled Fork Lifts

Cnty	SubR	SCC	HP	TechType	MYr	Population	ROG-Exhaust	CO-Exhaust	NOx-Exhaust	CO2-Exhaust	SO2-Exhaust	PM-Exhaust
Los Angeles	SC	2266003020	175		ALL		7.49E-03	1.63E+00	5.08E-01	4.69E+01	0.00E+00	4.17E-03
Los Angeles	SC	2266003020	175		>=2006		3.19E-03	6.80E-01	1.47E-01	1.62E+01	0.00E+00	1.45E-03
Los Angeles	SC	2266003020	175		>=2006		1.36E-03	2.76E-01	5.91E-02	5.95E+00	0.00E+00	5.29E-04
Los Angeles	SC	2266003020	175		>=2006		6.89E-04	1.30E-01	2.60E-02	2.61E+00	0.00E+00	2.32E-04
Los Angeles	SC	2266003020	175		>=2006		2.73E-04	4.48E-02	9.16E-03	8.43E-01	0.00E+00	7.50E-05

Crankcase	FuelCons.	Activity	LF	HPAvg	ROG/ROG	ROG (g/hp-hr)	CO (g/hp-hr)	NOx (g/hp-hr)	SOx (g/hp-hr)	PM (g/hp-hr)
		1.44E+03	0.3	146	1	0.107718497	23.3770918	7.29875177	0	0.059999991
		4.99E+02	0.3	146	1	0.13262965	28.22981102	6.112357281	0	0.059998108
		1.83E+02	0.3	146	1	0.154597113	31.29116273	6.709967865	0	0.060004578
		8.00E+01	0.3	146	1	0.178385095	33.6481004	6.72406002	0	0.060001163
		2.59E+01	0.3	146	1	0.218214866	35.85245788	7.324376197	0	0.059986439

APPENDIX E

DEATILED EMISSION CALCULATIONS, EMISSION FACTOR DERIVATION, AND OFFROAD2007 OUTPUT, FOR TRUs AND REEFER CARS

Summary of Emissions from Transport Refrigeration Units and Refrigerated Railcars
Dolores and ICTF Rail Yards, Long Beach, CA

TRU Equip Type	Average Rating (hp)[1]	Fuel Type	Average No. Units in Yard[2]	Hours of Operation (hr/day)[3]	Hours of Operation (hr/yr)[4]	Load Factor[5]	2005 Emission Factors (g/bhp-hr)[6] HC	CO	NOx	PM10	DPM	SOx	VOC Evaporative Emission Factors[7] Part 1 (lb/hr)	Part 2 (lb/yr)	2005 Emission Estimates (tons/yr) ROG	CO	NOx	PM10	DPM	SOx
Container	28.56	Diesel	70	4	1,460	0.56	2.85	6.78	6.43	0.71	0.71	0.07	-	-	5.12	12.16	11.53	1.28	1.28	0.12
Railcar	34	Diesel	10	4	1,460	0.53	3.23	7.49	6.71	0.79	0.79	0.07	-	-	0.94	2.17	1.95	0.23	0.23	0.02
Total			**80**		**2,920**										**6.06**	**14.33**	**13.47**	**1.51**	**1.51**	**0.14**

Notes:
1. Based on the average horsepower distribution in the OFFROAD 2007 model.
2. UPRR staff estimate that there are 35-37 TRUs and 2-5 reefer cars and in the Yard at any given time. To be conservative, these estimates were increased by 100%.
3. From CARB's Staff Report: ISOR, ATCM for TRUs, Section V.a.2.
4. It was assumed that the number of units and the annual hours of operations remains constant, with individual units cycling in and out of the yard.
5. Load factors are the default factors from the OFFROAD 2007 model.
6. Emission factors in g/bhp-hr are from OFFROAD 2006 model.
7. Evaporative emissions were calculated from the OFFROAD 2007 model and are negligible.

OFFROAD OUTPUT FOR TRUS AND REEFER CARS

CY	Season	AvgDays	Code	Equipment	Fuel	MaxHP	Class	C/R	Pre	Hand	Port	County	Air Basin	Air Dist.	Population
2005	Annual	Mon-Sun	2.27E+09	Transport F	D	15	Transport F	U	N	NHH	NP	Los Angele	SC	SC	1.15E+03
2005	Annual	Mon-Sun	2.27E+09	Transport F	D	25	Transport F	U	N	NHH	NP	Los Angele	SC	SC	4.49E+02
2005	Annual	Mon-Sun	2.27E+09	Transport F	D	50	Transport F	U	N	NHH	NP	Los Angele	SC	SC	8.18E+03

Activity	Consumpti	ROG Exha	CO Exhaus	NOX Exha	CO2 Exha	SO2 Exha	PM Exhaus	N2O Exha	CH4 Exhaust		
3.27E+03	1.20E+03	2.07E-02	8.80E-02	1.44E-01	1.31E+01	1.42E-03	9.22E-03	0.00E+00	1.86E-03		
1.28E+03	7.96E+02	1.32E-02	4.58E-02	8.56E-02	8.71E+00	9.47E-04	5.41E-03	0.00E+00	1.19E-03		
3.29E+04	3.98E+04	2.11E+00	4.89E+00	4.38E+00	4.26E+02	4.71E-02	5.13E-01	0.00E+00	1.90E-01		
		ROG Exha	CO Exhaus	NOX Exha	CO2 Exha	SO2 Exha	PM Exhaus	load	avg hp		container
0-15	lb/hr	1.26E-02	5.38E-02	8.79E-02	8.02E+00	8.71E-04	5.64E-03	0.64	10		0.17
15-25	lb/hr	2.06E-02	7.16E-02	1.34E-01	1.36E+01	1.48E-03	8.46E-03	0.64	17		0.08
25-50	lb/hr	1.28E-01	2.97E-01	2.67E-01	2.59E+01	2.87E-03	3.12E-02	0.53	34		0.75
container	lb/hr	0.100145	0.237934	0.225581	21.87653	0.002417	0.025064	0.5575	28.56		
rail	lb/hr	0.128463	0.297411	0.266559	25.89717	0.002868	0.031238	0.53	34		
container	lb/hp-hr	0.00629	0.014944	0.014168	1.373964	0.000152	0.001574				
rail	lb/hp-hr	0.007129	0.016504	0.014792	1.437135	0.000159	0.001733				
0-15	lb/hp-hr	0.001975	0.008409	0.013736	1.252887	0.000136	0.000882				
15-25	lb/hp-hr	0.001895	0.00658	0.012312	1.252886	0.000136	0.000777				
25-50	lb/hp-hr	0.007129	0.016504	0.014792	1.437135	0.000159	0.001733				

APPENDIX F

DEATILED EMISSION CALCULATIONS, EMISSION FACTOR DERIVATION AND EMFAC2007 OUTPUT FOR DIESEL-FUELED DELIVERY TRUCKS

Summary of Emissions from Intermodal HHD Diesel-Fueled Delivery Trucks
Dolores and ICTF Rail Yards, Long Beach, CA

Running Exhaust Emissions

Yard	Delivery Type	Truck Trips (trips/yr)[1,2,3]	VMT per Trip (mi/trip)[4]	VMT per Year	2005 Emission Factors (g/mi)[5,6] ROG	CO	NOx	PM10[7]	DPM[7]	SOx	2005 Emission Estimates (tons/yr) ROG	CO	NOx	PM10	DPM	SOx
Dolores	Diesel Fuel	2,625	0.06	157.50	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Dolores	Sand	156	2.2	343.20	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.01	0.01	0.00	0.00	0.00
Dolores	Oil	24	0.06	1.44	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Dolores	Soap	3	0.06	0.17	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
ICTF	Gasoline	11	0.5	5.43	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
ICTF	Diesel Fuel	22	0.5	10.75	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
ICTF	Oil	2	0.5	1.00	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Total		**2,842**		**519.49**							**0.00**	**0.01**	**0.02**	**0.00**	**0.001**	**0.00**

Idling Exhaust Emissions

Yard	Delivery Type	Number of Truck Trips	Idling (mins/trip)[8]	Idling (hr/yr)	2005 Emission Factors (g/hr)[9] ROG	CO	NOx	PM10	DPM	SOx	2005 Emission Estimates (tons/yr) ROG	CO	NOx	PM10	DPM	SOx
Dolores	Diesel Fuel	2,625	10	437.50	16.16	52.99	100.38	2.85	2.85	0.55	0.01	0.03	0.05	0.00	0.00	0.00
Dolores	Sand	156	30	78.00	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.01	0.00	0.00	0.00
Dolores	Oil	24	10	4.00	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Dolores	Soap	3	10	0.47	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
ICTF	Gasoline	11	10	1.81	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
ICTF	Diesel Fuel	22	10	3.58	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
ICTF	Oil	2	10	0.33	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Total				**525.70**							**0.01**	**0.03**	**0.06**	**0.00**	**0.002**	**0.00**

Notes:
1. Annual Diesel fuel delivery truck trips based on 1.76 million gallons of fuel delivered per month and 8,000 gallons per truck.
2. Annual gasoline fuel delivery truck trips based on 86,800 gallons of gasoline used per year and 8,000 gallons per truck.
3. Annual sand delivery truck trips are based on 3 trucks per week, per UPRR staff.
4. VMT per truck trip estimated from Google Earth, for onsite travel only.
5. Running exhaust emission factors (g/mi) from EMFAC 2007 using the BURDEN output option. The EMFAC default model year distribution for L.A. County was used.
6. Emission factor calculations assumed an average speed of 15 mph.
7. The PM10 emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.
8. Engineering estimate based on personal observation.
9. Idling exhaust emission factors from EMFAC 2007 using the EMFAC output option. The EMFAC default model year distribution for L.A. County was used.

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2006/12/14 07:57:01
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	27425
VMT/1000	5538
Trips	138783
Reactive Organic Gas Emissions	
Run Exh	39.07
Idle Exh	0.82
Start Ex	0

Total Ex	39.9
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	39.9
Carbon Monoxide Emissions	
Run Exh	105.2
Idle Exh	2.7
Start Ex	0

Total Ex	107.91
Oxides of Nitrogen Emissions	
Run Exh	175.11
Idle Exh	5.12
Start Ex	0

Total Ex	180.23
Carbon Dioxide Emissions (000)	
Run Exh	17.5
Idle Exh	0.34
Start Ex	0

Total Ex	17.84
PM10 Emissions	
Run Exh	15.05
Idle Exh	0.15
Start Ex	0

Total Ex	15.19
TireWear	0.22
BrakeWr	0.17

Total	15.59
Lead	0
SOx	1.48
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	1605.41

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2006/12/14 08:09:32
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1965 to 2005 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	16.163	15.188

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	52.988	49.792

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	100.382	94.327

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	6617.134	6192.269

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.55	0.517

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	2.845	2.674

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

APPENDIX G

DEATILED EMISSION CALCULATIONS, EMISSION FACTOR DERIVATION, EMFAC2007 OUTPUT, AND SPECIATION PROFILE FOR GASOLINE-FUELED YARD TRUCKS

Summary of Emissions from Yard Trucks
Dolores and ICTF Rail Yards, Long Beach, CA

Running Exhaust Emissions

Yard	Equipment Type	Equipment Owner/ID	Vehicle Class	Make	Model	Fuel Type	Model Year	Annual VMT (mi/yr)[1]	2005 Emission Factors (g/mi)[2,3]					2005 Emission Estimates (tons/yr)				
									ROG	CO	NOx	PM10	SOx	ROG	CO	NOx	PM10	SOx
ICTF	SUV	1915-53287	LDT	Jeep	Cherokee XHTH74	Gasoline	2000	73,000	0.07	3.00	0.22	0.04	0.01	0.01	0.24	0.02	0.00	0.00
ICTF	Pickup Truck	1915-55536	LDT	Chevy	Extended Cab	Gasoline	2003	73,000	0.05	1.97	0.16	0.03	0.01	0.00	0.16	0.01	0.00	0.00
ICTF	SUV	1915-19952	LDT	Chevy	Trailblazer 370	Gasoline	2003	73,000	0.05	1.97	0.16	0.03	0.01	0.00	0.16	0.01	0.00	0.00
ICTF	Pickup Truck	1915-19971	LDT	Chevy	Extended Cab	Gasoline	2004	73,000	0.04	1.51	0.12	0.03	0.01	0.00	0.12	0.01	0.00	0.00
ICTF	Van	1915-19975	LHDT 1	Chevy	15 Passenger Van	Gasoline	2004	73,000	0.03	0.35	0.12	0.03	0.00	0.00	0.03	0.01	0.00	0.00
Dolores	Service Truck	73152	MHD	Chevy	Chevy C4500	Gasoline	2003	12,644	0.88	11.41	2.19	0.02	0.00	0.01	0.16	0.03	0.00	0.00
Dolores	Mgr Truck	Unknown	LDT	Chevy	Trailblazer	Gasoline	2004	45,000	0.05	1.97	0.16	0.03	0.01	0.00	0.10	0.01	0.00	0.00
Dolores	Mgr Truck	73167	LDT	Chevy	Blazer	Gasoline	2004	36,608	0.05	1.97	0.16	0.03	0.01	0.00	0.08	0.01	0.00	0.00
Dolores	Pickup Truck	73396	LDT	Ford	F-150	Gasoline	2005	23,756	0.02	0.89	0.07	0.02	0.01	0.00	0.02	0.00	0.00	0.00
Total								**483,007**						**0.04**	**1.07**	**0.11**	**0.02**	**0.00**

Idling Exhaust Emissions

Yard	Equipment Type	Equip. Owner/ID	Vehicle Class	Make	Model	Fuel Type	Model Year	Idling[4] (hr/yr)	2005 Emission Factors (g/hr)[5,6]					2005 Emission Estimates (tons/yr)				
									ROG	CO	NOx	PM10	SOx	ROG	CO	NOx	PM10	SOx
ICTF	Van	1915-19975	LHDT 1	Chevy	15 Passenger Van	Gasoline	2004	91.25	23.10	141.99	1.56	0.00	0.05	0.00	0.01	0.00	0.00	0.00
Dolores	Service Truck	73152	MHD	Chevy	Chevy C4500	Gasoline	2003	91.25	23.10	141.99	1.56	0.00	0.05	0.00	0.01	0.00	0.00	0.00
Total														**0.00**	**0.03**	**0.00**	**0.00**	**0.00**

Notes:
1. Annual VMT estimated by UPRR personnel.
2. Running exhaust emissions calculated using the EMFAC2007 model with the BURDEN output option.
3. Running exhaust emission factor calculations assumed an average speed of 15 mph.
4. Idling time (hr/yr) is an engineering estimate.
5. Idling exhaust emissions factors for LHDT1 and MHD vehicles calculated using the EMFAC2007 model with the EMFAC output option.
6. Idling exhaust emissions from LDT vehicles are negligible.

Summary of TAC Emissions from Gasoline-Fueled Yard Trucks
Dolores and ICTF Rail Yards, Long Beach, CA

Profile[1]	CAS	Chemical Name	Organic Fraction	2005 Emissions (tpy) Dolores	ICTF	Total
2105	95636	1,2,4-trimethylbenzene	0.0120	2.33E-04	2.49E-04	4.82E-04
2105	106990	1,3-butadiene	0.0068	1.32E-04	1.41E-04	2.72E-04
2105	540841	2,2,4-trimethylpentane	0.0288	5.58E-04	5.96E-04	1.15E-03
2105	75070	acetaldehyde	0.0035	6.74E-05	7.20E-05	1.39E-04
2105	107028	acrolein (2-propenal)	0.0017	3.20E-05	3.42E-05	6.62E-05
2105	71432	benzene	0.0309	5.97E-04	6.38E-04	1.24E-03
2105	4170303	crotonaldehyde	0.0004	6.98E-06	7.46E-06	1.44E-05
2105	110827	cyclohexane	0.0077	1.48E-04	1.59E-04	3.07E-04
2105	100414	ethylbenzene	0.0131	2.53E-04	2.71E-04	5.24E-04
2105	74851	ethylene	0.0794	1.54E-03	1.64E-03	3.18E-03
2105	50000	formaldehyde	0.0197	3.81E-04	4.08E-04	7.89E-04
2105	78795	isoprene	0.0018	3.42E-05	3.66E-05	7.08E-05
2105	98828	isopropylbenzene (cumene)	0.0001	2.33E-06	2.49E-06	4.81E-06
2105	67561	methyl alcohol	0.0015	2.95E-05	3.15E-05	6.11E-05
2105	78933	methyl ethyl ketone (mek) (2-butanone)	0.0002	4.41E-06	4.71E-06	9.12E-06
2105	108383	m-xylene	0.0445	8.61E-04	9.20E-04	1.78E-03
2105	91203	naphthalene	0.0006	1.14E-05	1.22E-05	2.36E-05
2105	110543	n-hexane	0.0200	3.86E-04	4.13E-04	7.99E-04
2105	95476	o-xylene	0.0155	2.99E-04	3.20E-04	6.19E-04
2105	115071	propylene	0.0382	7.40E-04	7.90E-04	1.53E-03
2105	100425	styrene	0.0015	2.97E-05	3.17E-05	6.14E-05
2105	108883	toluene	0.0718	1.39E-03	1.49E-03	2.88E-03
Total				**7.73E-03**	**8.26E-03**	**1.60E-02**

Notes:
1. Organic fraction from ARBs SPECIATE database. Data is from "Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
3. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.8012).

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/22 11:59:54
Scen Year: 2005 -- Model year 2000 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Ar
Emissions: Tons Per Day
****

	LDT1-CAT
Vehicles	45056
VMT/1000	1700
Trips	291486
Reactive Organic Gas Emissions	
Run Exh	0.13
Idle Exh	0
Start Ex	0.08

Total Ex	0.2
Diurnal	0.01
Hot Soak	0.01
Running	0.04
Resting	0.01

Total	0.27
Carbon Monoxide Emissions	
Run Exh	5.62
Idle Exh	0
Start Ex	1.37

Total Ex	6.99
Oxides of Nitrogen Emissions	
Run Exh	0.42
Idle Exh	0
Start Ex	0.12

Total Ex	0.53
Carbon Dioxide Emissions (000)	
Run Exh	1.52
Idle Exh	0
Start Ex	0.03

Total Ex	1.55
PM10 Emissions	
Run Exh	0.04
Idle Exh	0
Start Ex	0

Total Ex	0.04
TireWear	0.01
BrakeWr	0.02

Total	0.08
Lead	0
SOx	0.02
Fuel Consumption (000 gallons)	
Gasoline	160.07
Diesel	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/22 12:00:45
Scen Year: 2005 -- Model year 2003 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	LDT1-CAT
Vehicles	27369
VMT/1000	1176
Trips	178428
Reactive Organic Gas Emissions	
Run Exh	0.06
Idle Exh	0
Start Ex	0.03

Total Ex	0.09
Diurnal	0
Hot Soak	0
Running	0.01
Resting	0

Total	0.11
Carbon Monoxide Emissions	
Run Exh	2.55
Idle Exh	0
Start Ex	0.51

Total Ex	3.05
Oxides of Nitrogen Emissions	
Run Exh	0.21
Idle Exh	0
Start Ex	0.05

Total Ex	0.26
Carbon Dioxide Emissions (000)	
Run Exh	1.05
Idle Exh	0
Start Ex	0.02

Total Ex	1.07
PM10 Emissions	
Run Exh	0.02
Idle Exh	0
Start Ex	0

Total Ex	0.02
TireWear	0.01
BrakeWr	0.02

Total	0.04
Lead	0
SOx	0.01
Fuel Consumption (000 gallons)	
Gasoline	110.3
Diesel	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/09/06 11:14:27
Scen Year: 2005 -- Model year 2003 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	MHDT-CAT
Vehicles	834
VMT/1000	62
Trips	38088
Reactive Organic Gas Emissions	
Run Exh	0.06
Idle Exh	0
Start Ex	0.04

Total Ex	0.1
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.1
Carbon Monoxide Emissions	
Run Exh	0.78
Idle Exh	0.01
Start Ex	0.68

Total Ex	1.47
Oxides of Nitrogen Emissions	
Run Exh	0.15
Idle Exh	0
Start Ex	0.09

Total Ex	0.24
Carbon Dioxide Emissions (000)	
Run Exh	0.1
Idle Exh	0
Start Ex	0

Total Ex	0.1
PM10 Emissions	
Run Exh	0
Idle Exh	0
Start Ex	0

Total Ex	0
TireWear	0
BrakeWr	0

Total	0
Lead	0
SOx	0
Fuel Consumption (000 gallons)	
Gasoline	10.28
Diesel	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2007/09/06 11:15:11
Scen Year: 2005 -- Model year 2003 selected
Season : Annual
Area : Statewide totals
****

Year: 2005 -- Model Years 2003 to 2003 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006

State Average State Average

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	23.103	3.173	6.012

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	141.992	26.3	42.777

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	1.561	75.051	64.584

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	4776.9	4098	4194.691

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0.049	0.358	0.314

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0.753	0.646

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Brake Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0	0

Pollutant Name: Gasoline - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0	0

Pollutant Name: Diesel - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/22 12:02:11
Scen Year: 2005 -- Model year 2004 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	LDT1-CAT	LHDT1-CAT
Vehicles	26388	4585
VMT/1000	1214	315
Trips	172560	151611
Reactive Organic Gas Emissions		
Run Exh	0.05	0.01
Idle Exh	0	0.01
Start Ex	0.02	0.02
	-------	-------
Total Ex	0.07	0.04
Diurnal	0	0
Hot Soak	0	0
Running	0.01	0
Resting	0	0
	-------	-------
Total	0.09	0.04
Carbon Monoxide Emissions		
Run Exh	2.02	0.12
Idle Exh	0	0.04
Start Ex	0.38	0.39
	-------	-------
Total Ex	2.4	0.55
Oxides of Nitrogen Emissions		
Run Exh	0.16	0.04
Idle Exh	0	0
Start Ex	0.03	0.25
	-------	-------
Total Ex	0.18	0.29
Carbon Dioxide Emissions (000)		
Run Exh	1.09	0.48
Idle Exh	0	0
Start Ex	0.02	0.01
	-------	-------
Total Ex	1.11	0.49
PM10 Emissions		
Run Exh	0.01	0
Idle Exh	0	0
Start Ex	0	0
	-------	-------
Total Ex	0.01	0
TireWear	0.01	0
BrakeWr	0.02	0
	-------	-------
Total	0.04	0.01
Lead	0	0
SOx	0.01	0
Fuel Consumption (000 gallons)		
Gasoline	113.65	50.53
Diesel	0	0

Title : Statewide totals Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2007/08/22 12:37:17
Scen Year: 2005 -- Model year 2004 selected
Season : Annual
Area : Statewide totals
****
Year: 2005 -- Model Years 2004 to 2004 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006

State Average State Average

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	23.103	3.173	10.704

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	141.992	26.3	70.016

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	1.561	75.051	47.281

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	4776.9	4098	4354.536

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0.049	0.358	0.241

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0.753	0.468

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: PM10 - Brake Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: Gasoline - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: Diesel - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/09/06 11:16:23
Scen Year: 2005 -- Model year 2005 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	LDT1-CAT
Vehicles	29451
VMT/1000	1509
Trips	193179
Reactive Organic Gas Emissions	
Run Exh	0.04
Idle Exh	0
Start Ex	0.01

Total Ex	0.05
Diurnal	0
Hot Soak	0
Running	0.01
Resting	0

Total	0.06
Carbon Monoxide Emissions	
Run Exh	1.48
Idle Exh	0
Start Ex	0.21

Total Ex	1.7
Oxides of Nitrogen Emissions	
Run Exh	0.11
Idle Exh	0
Start Ex	0.01

Total Ex	0.12
Carbon Dioxide Emissions (000)	
Run Exh	1.35
Idle Exh	0
Start Ex	0.02

Total Ex	1.37
PM10 Emissions	
Run Exh	0.01
Idle Exh	0
Start Ex	0

Total Ex	0.01
TireWear	0.01
BrakeWr	0.02

Total	0.04
Lead	0
SOx	0.01
Fuel Consumption (000 gallons)	
Gasoline	140.95
Diesel	0

APPENDIX H

DEATILED EMISSION CALCULATIONS FOR
DIESEL-FUELED IC ENGINES

Summary of Emissions from Diesel-Fueled Internal Combustion Engines
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Location	Equipment Type	Make	Fuel Type	Rating (hp)	Hours of Operation (hr/yr)[1,2]	2005 Emission Factors (g/bhp-hr)[3]						2005 Emission Estimates (tpy)					
							ROG	CO	NOx	PM10	DPM	SOx	ROG	CO	NOx	PM10	DPM	SOx
ICTF	Administrative Building	Emergency Generator	Cat 3208	Diesel	269	20	1.14	3.03	14.06	1.00	1.00	0.93	0.01	0.02	0.08	0.01	0.01	0.01
ICTF	Mechanical Department	Air Compressor	Ingersoll-Rand	Diesel	49	1000	1.14	3.03	14.06	1.00	1.00	0.93	0.06	0.16	0.76	0.05	0.05	0.05
Total													**0.07**	**0.18**	**0.84**	**0.06**	**0.06**	**0.06**

Notes:
1. Hours of operation for the emergency generator based on CARB's ATCM for Stationary Compression Ignition Engines. The ATCM limits non-emergency operation to 20 hours per year. UP personnel estimate that this engine is operated no more than 30 minutes/month. The 20 hours/yr estimate was used to be conservative.
2. Hours of operation for the air compressor is an engineering estimate.
3. Emission factors, in g/bhp-hr, from AP-42, Table 3.3-1, 10/96.

APPENDIX I

TANKS OUTPUT, SPECIATION PROFILE, AND DETAILED EMISSION CALCULATIONS FOR STORAGE TANKS

Summary of Emissions and Equipment Specifications for Storage Tanks
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Tank No.	Tank Location	Material Stored	Tank Capacity	Tank Dimensions Length	Height	Diameter	Shell Color	Shell Condition	Annual Throughput (gal/yr)	Emissions (tpy)	Permitted?	Exemption Citation
ICTF	TNKD-9901	Crane Maintenance	Offroad Diesel	20,000	34.5		10	White	Good	120,000	0.004	Exempt	Rule 219(m)(4)
ICTF	TBA-1	Crane Maintenance	CARB Diesel	1,000	7		4	White	Good	52,000	0.001	Exempt	Rule 219(m)(4)
ICTF	TBA-2	Crane Maintenance	Gasoline	2,000	11.83	6.92	4.75	White	Good	86,808	0.71	Yes	NA
ICTF	TBA-3	Tractor Maintenance	SAE 15W-40 Motor	500	6		4	Dark Gray	Good	2000	0.0002	Exempt	Rule 219(m)(7)
ICTF	TBA-4	Crane Maintenance	Used Oil	300	4		4	Orange	Good	1800	neg.	Exempt	Rule 219(m)(7)
ICTF	TBA-5	Crane Maintenance	Motor Oil	243	2.5	3	4.3	White	Good	972	neg.	Exempt	Rule 219(m)(7)
ICTF	TBA-6	Crane Maintenance	Hydraulic Oil	300	6	2.5	3	White	Good	1200	neg.	Exempt	Rule 219(m)(7)
ICTF	TBA-7	Tractor Maintenance Area	Automatic Transmission Fluid	243	2.5	3	4.3	Black	Good	972	neg.	Exempt	Rule 219(m)(7)
ICTF	TBA-8	Tractor Maintenance	SAE 20W-50 Motor	202	3	3	3	White	Good	808	neg.	Exempt	Rule 219(m)(7)
ICTF	TBA-9	Tractor Maintenance	Used Motor Oil	300	4		2	Gray	Good	1200	neg.	Exempt	Rule 219(m)(7)
ICTF	TBA-10	Tractor Maintenance	Used Motor Oil	300	4		2	Gray	Good	1200	neg.	Exempt	Rule 219(m)(7)
ICTF	TBA-11	Tractor Maintenance	Hydraulic Oil	240	3	2.7	4.3	Dark Gray	Good	960	neg.	Exempt	Rule 219(m)(7)
Dolores	TNKD-0069	Tank Farm	Diesel	160,000		24.0	34.0	White	Good	10,500,000	0.10	Yes	NA
Dolores	TNKD-0068	Tank Farm	Diesel	160,000		24.0	34.0	White	Good	10,500,000	0.10	Yes	NA
Dolores	TNKO-0002	Tank Farm	Recovered Oil	10,000	16.0		10.0	White	Good	40000	0.002	Exempt	Rule 219(m)(7)
Dolores	TNKO-0003	Tank Farm	Drain Oil	12,000	20.5		10.0	White	Good	48000	0.002	Exempt	Rule 219(m)(7)
Dolores	TNKO-0004	Tank Farm	Journal Box Oil	8,000	21.3		8.0	White	Good	32000	0.001	Exempt	Rule 219(m)(7)
Dolores	TNKO-0001	Tank Farm	Lube Oil	12,000	20.5		10.0	Light Gray	Good	48000	0.004	Exempt	Rule 219(m)(7)
Dolores	TNKO-0184	Service Track	Recovered Oil	6,000	20.5		7.0	Light Gray	Good	24000	0.002	Exempt	Rule 219(m)(7)
Dolores	TNKS-0005	Tank Farm	Stormwater	25,000	30.0	12.0	12.0	White	Good	980,100	neg.	Yes	Part of WWTP
Dolores	TNKS-0006	Tank Farm	Stormwater	25,000	30.0	12.0	12.0	White	Good	980,100	neg.	Yes	Part of WWTP
Dolores	TNKS-0007	Tank Farm	Stormwater	25,000	30.0	12.0	12.0	White	Good	980,100	neg.	Yes	Part of WWTP
Dolores	TNKS-0008	Tank Farm	Stormwater	25,000	30.0	12.0	12.0	White	Good	980,100	neg.	Yes	Part of WWTP
Dolores	TNKS-0010	Tank Farm	Soap	8,000		8.0	8.0	White	Good	22,785	NA	Exempt	Rule 219(m)(6)
Dolores	NA	WWTP	Sludge	1,000	6.5	5.0	5.0	White	Good	NA	neg.	NA	Solids
Dolores	NA	WWTP	Nalco	380					Good	NA	neg.	NA	No Emissions
Total VOC											**0.93**		

Notes:
1. Annual throughput for non-exempt tanks provided by UPRR.
2. Annual throughput for exempt tanks based on the assumptions contained in the Trinity Reports.
3. Emissions calculations performed using the USEPA TANKS 4.0.9d program.
4. Emissions from small oil storage tanks, stormwater tanks, soap tank, sludge tanks and the Nalco tank were assumed to be negligible.
5. The VOC emissions for oil tanks were estimated by modeling the liquid conents as diesel fuel, resulting in conservative estimates.

Summary of TAC Emissions from Gasoline-Fueled Yard Trucks
Dolores and ICTF Rail Yards, Long Beach, CA

Profile[1]	CAS	Chemical Name	Organic Fraction	2005 Emissions (tpy) Dolores	ICTF	Total
2105	95636	1,2,4-trimethylbenzene	0.0120	2.33E-04	2.49E-04	4.82E-04
2105	106990	1,3-butadiene	0.0068	1.32E-04	1.41E-04	2.72E-04
2105	540841	2,2,4-trimethylpentane	0.0288	5.58E-04	5.96E-04	1.15E-03
2105	75070	acetaldehyde	0.0035	6.74E-05	7.20E-05	1.39E-04
2105	107028	acrolein (2-propenal)	0.0017	3.20E-05	3.42E-05	6.62E-05
2105	71432	benzene	0.0309	5.97E-04	6.38E-04	1.24E-03
2105	4170303	crotonaldehyde	0.0004	6.98E-06	7.46E-06	1.44E-05
2105	110827	cyclohexane	0.0077	1.48E-04	1.59E-04	3.07E-04
2105	100414	ethylbenzene	0.0131	2.53E-04	2.71E-04	5.24E-04
2105	74851	ethylene	0.0794	1.54E-03	1.64E-03	3.18E-03
2105	50000	formaldehyde	0.0197	3.81E-04	4.08E-04	7.89E-04
2105	78795	isoprene	0.0018	3.42E-05	3.66E-05	7.08E-05
2105	98828	isopropylbenzene (cumene)	0.0001	2.33E-06	2.49E-06	4.81E-06
2105	67561	methyl alcohol	0.0015	2.95E-05	3.15E-05	6.11E-05
2105	78933	methyl ethyl ketone (mek) (2-butanone)	0.0002	4.41E-06	4.71E-06	9.12E-06
2105	108383	m-xylene	0.0445	8.61E-04	9.20E-04	1.78E-03
2105	91203	naphthalene	0.0006	1.14E-05	1.22E-05	2.36E-05
2105	110543	n-hexane	0.0200	3.86E-04	4.13E-04	7.99E-04
2105	95476	o-xylene	0.0155	2.99E-04	3.20E-04	6.19E-04
2105	115071	propylene	0.0382	7.40E-04	7.90E-04	1.53E-03
2105	100425	styrene	0.0015	2.97E-05	3.17E-05	6.14E-05
2105	108883	toluene	0.0718	1.39E-03	1.49E-03	2.88E-03
Total				**7.73E-03**	**8.26E-03**	**1.60E-02**

Notes:
1. Organic fraction from ARBs SPECIATE database. Data is from "Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
3. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.8012).

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	TNKD-9901
City:	Long Beach
State:	California
Company:	UPRR
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):	34.50
Diameter (ft):	10.00
Volume (gallons):	20,000.00
Turnovers:	6.00
Net Throughput(gal/yr):	120,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TNKD-9901 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	66.43	60.99	71.87	64.33	0.0081	0.0067	0.0096	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009

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TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TNKD-9901 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations	
Standing Losses (lb):	4.3947
Vapor Space Volume (cu ft):	1,725.8749
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0374
Vented Vapor Saturation Factor:	0.9979
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,725.8749
Tank Diameter (ft):	10.0000
Effective Diameter (ft):	20.9640
Vapor Space Outage (ft):	5.0000
Tank Shell Length (ft):	34.5000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Daily Avg. Liquid Surface Temp. (deg. R):	526.1003
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	523.9983
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0374
Daily Vapor Temperature Range (deg. R):	21.7491
Daily Vapor Pressure Range (psia):	0.0028
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0067
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0096
Daily Avg. Liquid Surface Temp. (deg R):	526.1003
Daily Min. Liquid Surface Temp. (deg R):	520.6630
Daily Max. Liquid Surface Temp. (deg R):	531.5375
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9979
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0081
Vapor Space Outage (ft):	5.0000
Working Losses (lb):	3.0114
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Annual Net Throughput (gal/yr.):	120,000.0000

Annual Turnovers:	6.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000

Total Losses (lb):	7.4061

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TNKD-9901 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	3.01	4.39	7.41

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	ICTF - TBA-1
City:	Long Beach
State:	California
Company:	UPRR
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):		7.00
Diameter (ft):		5.00
Volume (gallons):		1,000.00
Turnovers:		52.00
Net Throughput(gal/yr):		52,000.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

ICTF - TBA-1 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	66.43	60.99	71.87	64.33	0.0081	0.0067	0.0096	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

ICTF - TBA-1 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations

Standing Losses (lb):	0.2232
Vapor Space Volume (cu ft):	87.5444
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0374
Vented Vapor Saturation Factor:	0.9989
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	87.5444
Tank Diameter (ft):	5.0000
Effective Diameter (ft):	6.6773
Vapor Space Outage (ft):	2.5000
Tank Shell Length (ft):	7.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Daily Avg. Liquid Surface Temp. (deg. R):	526.1003
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	523.9983
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0374
Daily Vapor Temperature Range (deg. R):	21.7491
Daily Vapor Pressure Range (psia):	0.0028
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0067
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0096
Daily Avg. Liquid Surface Temp. (deg R):	526.1003
Daily Min. Liquid Surface Temp. (deg R):	520.6630
Daily Max. Liquid Surface Temp. (deg R):	531.5375
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9989
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0081
Vapor Space Outage (ft):	2.5000
Working Losses (lb):	0.9703
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Annual Net Throughput (gal/yr.):	52,000.0000

Annual Turnovers:	52.0000
Turnover Factor:	0.7436
Tank Diameter (ft):	5.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	1.1935

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

ICTF - TBA-1 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	0.97	0.22	1.19

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TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	ICTF - TBA 2
City:	Long Beach
State:	California
Company:	UPRR
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):		12.00
Diameter (ft):		7.00
Volume (gallons):		2,000.00
Turnovers:		0.00
Net Throughput(gal/yr):		86,808.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

ICTF - TBA 2 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 10)	All	66.43	60.99	71.87	64.33	5.8655	5.2864	6.4943	66.0000			92.00	Option 4: RVP=10, ASTM Slope=3

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TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

ICTF - TBA 2 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations	
Standing Losses (lb):	603.7306
Vapor Space Volume (cu ft):	294.1491
Vapor Density (lb/cu ft):	0.0686
Vapor Space Expansion Factor:	0.1712
Vented Vapor Saturation Factor:	0.4789
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	294.1491
Tank Diameter (ft):	7.0000
Effective Diameter (ft):	10.3444
Vapor Space Outage (ft):	3.5000
Tank Shell Length (ft):	12.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0686
Vapor Molecular Weight (lb/lb-mole):	66.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.8655
Daily Avg. Liquid Surface Temp. (deg. R):	526.1003
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	523.9983
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.1712
Daily Vapor Temperature Range (deg. R):	21.7491
Daily Vapor Pressure Range (psia):	1.2079
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.8655
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	5.2864
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	6.4943
Daily Avg. Liquid Surface Temp. (deg R):	526.1003
Daily Min. Liquid Surface Temp. (deg R):	520.6630
Daily Max. Liquid Surface Temp. (deg R):	531.5375
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.4789
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	5.8655
Vapor Space Outage (ft):	3.5000
Working Losses (lb):	800.1295
Vapor Molecular Weight (lb/lb-mole):	66.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.8655
Annual Net Throughput (gal/yr.):	86,808.0000

Annual Turnovers:	0.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	7.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	1,403.8601

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

ICTF - TBA 2 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 10)	800.13	603.73	1,403.86

APP-184

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	ICTF - TBA-3
City:	Long Beach
State:	California
Company:	UPRR
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):		6.00
Diameter (ft):		4.00
Volume (gallons):		500.00
Turnovers:		4.00
Net Throughput(gal/yr):		2,000.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	

Paint Characteristics

Shell Color/Shade:	Gray/Medium
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

ICTF - TBA-3 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	74.48	63.43	85.52	67.39	0.0103	0.0074	0.0142	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012

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TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

ICTF - TBA-3 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations

Standing Losses (lb):	0.3250
Vapor Space Volume (cu ft):	48.0243
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0791
Vented Vapor Saturation Factor:	0.9989
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	48.0243
Tank Diameter (ft):	4.0000
Effective Diameter (ft):	5.5293
Vapor Space Outage (ft):	2.0000
Tank Shell Length (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0103
Daily Avg. Liquid Surface Temp. (deg. R):	534.1460
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	527.0583
Tank Paint Solar Absorptance (Shell):	0.6800
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0791
Daily Vapor Temperature Range (deg. R):	44.1922
Daily Vapor Pressure Range (psia):	0.0069
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0103
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0074
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0142
Daily Avg. Liquid Surface Temp. (deg R):	534.1460
Daily Min. Liquid Surface Temp. (deg R):	523.0980
Daily Max. Liquid Surface Temp. (deg R):	545.1941
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9989
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0103
Vapor Space Outage (ft):	2.0000
Working Losses (lb):	0.0640
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0103
Annual Net Throughput (gal/yr.):	2,000.0000

Annual Turnovers:	4.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	4.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	0.3890

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

ICTF - TBA-3 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	0.06	0.32	0.39

TANKS 4.0
Emissions Report - Detail Format
Tank Identification and Physical Characteristics

Identification

User Identification:	TNKD-0068
City:	Los Angeles C.O.
State:	California
Company:	UPRR
Type of Tank:	Vertical Fixed Roof Tank
Description:	Diesel Storage Tank - Dolores

Tank Dimensions

Shell Height (ft):	24.00
Diameter (ft):	34.00
Liquid Height (ft):	24.00
Avg. Liquid Height (ft):	12.00
Volume (gallons):	160,000.00
Turnovers:	65.63
Net Throughput (gal/yr):	10,500,000.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition:	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Cone
Height (ft):	0.00
Slope (ft/ft) (Cone Roof):	0.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig):	0.03

Meteorological Data used in Emissions Calculations: Los Angeles C.O., California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	68.08	62.92	73.24	65.99	0.0084	0.0071	0.0099	130.0000			188.00	Option 5: A=12.101, B=8907

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations	
Standing Losses (lb):	26.9533
Vapor Space Volume (cu ft):	10,895.0433
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0352
Vented Vapor Saturation Factor:	0.9947
Tank Vapor Space Volume	
Vapor Space Volume (cu ft):	10,895.0433
Tank Diameter (ft):	34.0000
Vapor Space Outage (ft):	12.0000
Tank Shell Height (ft):	24.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.0000
Roof Outage (Cone Roof)	
Roof Outage (ft):	0.0000
Roof Height (ft):	0.0000
Roof Slope (ft/ft):	0.0000
Shell Radius (ft):	17.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0084
Daily Avg. Liquid Surface Temp. (deg. R):	527.7526
Daily Average Ambient Temp. (deg. F):	65.9667
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	525.6567
Tank Paint Solar Absorptance (Shell):	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,567.1816
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0352
Daily Vapor Temperature Range (deg. R):	20.6478
Daily Vapor Pressure Range (psia):	0.0028
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0084
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0071
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0099
Daily Avg. Liquid Surface Temp. (deg R):	527.7526
Daily Min. Liquid Surface Temp. (deg R):	522.5906
Daily Max. Liquid Surface Temp. (deg R):	532.9145
Daily Ambient Temp. Range (deg. R):	18.3167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9947
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0084
Vapor Space Outage (ft):	12.0000

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)- (Continued)

Working Losses (lb):	170.8624
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0084
Annual Net Throughput (gal/yr.):	10,500,000.0000
Annual Turnovers:	65.6250
Turnover Factor:	0.6238
Maximum Liquid Volume (gal):	160,000.0000
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	34.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	197.8157

TANKS 4.0
Emissions Report - Detail Format
Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	170.86	26.95	197.82

TANKS 4.0
Emissions Report - Detail Format
Tank Identification and Physical Characteristics

Identification	
User Identification:	TNKD-0069
City:	Los Angeles C.O.
State:	California
Company:	UPRR
Type of Tank:	Vertical Fixed Roof Tank
Description:	Diesel Storage Tank - Dolores
Tank Dimensions	
Shell Height (ft):	24.00
Diameter (ft):	34.00
Liquid Height (ft):	24.00
Avg. Liquid Height (ft):	12.00
Volume (gallons):	160,000.00
Turnovers:	65.63
Net Throughput (gal/yr):	10,500,000.00
Is Tank Heated (y/n):	N
Paint Characteristics	
Shell Color/Shade:	White/White
Shell Condition:	Good
Roof Color/Shade:	White/White
Roof Condition:	Good
Roof Characteristics	
Type:	Cone
Height (ft):	0.00
Slope (ft/ft) (Cone Roof):	0.00
Breather Vent Settings	
Vacuum Settings (psig):	-0.03
Pressure Settings (psig):	0.03

Meteorological Data used in Emissions Calculations: Los Angeles C.O., California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	68.08	62.92	73.24	65.99	0.0084	0.0071	0.0099	130.0000			188.00	Option 5: A=12.101, B=8907

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations	
Standing Losses (lb):	26.9533
Vapor Space Volume (cu ft):	10,895.0433
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0352
Vented Vapor Saturation Factor:	0.9947
Tank Vapor Space Volume	
Vapor Space Volume (cu ft):	10,895.0433
Tank Diameter (ft):	34.0000
Vapor Space Outage (ft):	12.0000
Tank Shell Height (ft):	24.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.0000
Roof Outage (Cone Roof)	
Roof Outage (ft):	0.0000
Roof Height (ft):	0.0000
Roof Slope (ft/ft):	0.0000
Shell Radius (ft):	17.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0084
Daily Avg. Liquid Surface Temp. (deg. R):	527.7526
Daily Average Ambient Temp. (deg. F):	65.9667
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	525.6567
Tank Paint Solar Absorptance (Shell):	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,567.1816
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0352
Daily Vapor Temperature Range (deg. R):	20.6478
Daily Vapor Pressure Range (psia):	0.0028
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0084
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0071
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0099
Daily Avg. Liquid Surface Temp. (deg R):	527.7526
Daily Min. Liquid Surface Temp. (deg R):	522.5906
Daily Max. Liquid Surface Temp. (deg R):	532.9145
Daily Ambient Temp. Range (deg. R):	18.3167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9947
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0084
Vapor Space Outage (ft):	12.0000

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)- (Continued)

Working Losses (lb):	170.8624
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0084
Annual Net Throughput (gal/yr.):	10,500,000.0000
Annual Turnovers:	65.6250
Turnover Factor:	0.6238
Maximum Liquid Volume (gal):	160,000.0000
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	34.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	197.8157

TANKS 4.0
Emissions Report - Detail Format
Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	170.86	26.95	197.82

TANKS 4.0
Emissions Report - Detail Format
Total Emissions Summaries - All Tanks in Report

Annual Emissions Report

Tank Identification				Losses (lbs)
TNKD-0068	UPRR	Vertical Fixed Roof Tank	Los Angeles C.O., California	197.82
TNKD-0069	UPRR	Vertical Fixed Roof Tank	Los Angeles C.O., California	197.82
Total Emissions for all Tanks:				395.63

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	TNKO-0002
City:	Long Beach
State:	California
Company:	UPRR
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):		16.00
Diameter (ft):		10.00
Volume (gallons):		10,000.00
Turnovers:		4.00
Net Throughput(gal/yr):		40,000.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TNKO-0002 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	66.43	60.99	71.87	64.33	0.0081	0.0067	0.0096	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TNKO-0002 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations	
Standing Losses (lb):	2.0381
Vapor Space Volume (cu ft):	800.4058
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0374
Vented Vapor Saturation Factor:	0.9979
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	800.4058
Tank Diameter (ft):	10.0000
Effective Diameter (ft):	14.2766
Vapor Space Outage (ft):	5.0000
Tank Shell Length (ft):	16.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Daily Avg. Liquid Surface Temp. (deg. R):	526.1003
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	523.9983
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0374
Daily Vapor Temperature Range (deg. R):	21.7491
Daily Vapor Pressure Range (psia):	0.0028
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0067
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0096
Daily Avg. Liquid Surface Temp. (deg R):	526.1003
Daily Min. Liquid Surface Temp. (deg R):	520.6630
Daily Max. Liquid Surface Temp. (deg R):	531.5375
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9979
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0081
Vapor Space Outage (ft):	5.0000
Working Losses (lb):	1.0038
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Annual Net Throughput (gal/yr.):	40,000.0000

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Annual Turnovers:	4.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	3.0419

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TNKO-0002 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	1.00	2.04	3.04

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	TNKO-0003
City:	Long Beach
State:	California
Company:	UPRR
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):	20.50
Diameter (ft):	10.00
Volume (gallons):	12,000.00
Turnovers:	4.00
Net Throughput(gal/yr):	48,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

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TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TNKO-0003 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	66.43	60.99	71.87	64.33	0.0081	0.0067	0.0096	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TNKO-0003 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations

Standing Losses (lb):	2.6113
Vapor Space Volume (cu ft):	1,025.5199
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0374
Vented Vapor Saturation Factor:	0.9979
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,025.5199
Tank Diameter (ft):	10.0000
Effective Diameter (ft):	16.1600
Vapor Space Outage (ft):	5.0000
Tank Shell Length (ft):	20.5000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Daily Avg. Liquid Surface Temp. (deg. R):	526.1003
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	523.9983
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0374
Daily Vapor Temperature Range (deg. R):	21.7491
Daily Vapor Pressure Range (psia):	0.0028
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0067
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0096
Daily Avg. Liquid Surface Temp. (deg R):	526.1003
Daily Min. Liquid Surface Temp. (deg R):	520.6630
Daily Max. Liquid Surface Temp. (deg R):	531.5375
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9979
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0081
Vapor Space Outage (ft):	5.0000
Working Losses (lb):	1.2046
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Annual Net Throughput (gal/yr.):	48,000.0000

Annual Turnovers:	4.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	3.8159

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TNKO-0003 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	1.20	2.61	3.82

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	TNKO-0004	
City:	Long Beach	
State:	California	
Company:	UPRR	
Type of Tank:	Horizontal Tank	
Description:		
Tank Dimensions		
Shell Length (ft):		21.30
Diameter (ft):		8.00
Volume (gallons):		8,000.00
Turnovers:		4.00
Net Throughput(gal/yr):		32,000.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	White/White	
Shell Condition	Good	
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TNKO-0004 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	66.43	60.99	71.87	64.33	0.0081	0.0067	0.0096	130.0000			188.00	Option 1: VP60 = .0065 VP70 = .009

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TNKO-0004 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations	
Standing Losses (lb):	1.7372
Vapor Space Volume (cu ft):	681.9457
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0374
Vented Vapor Saturation Factor:	0.9983
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	681.9457
Tank Diameter (ft):	8.0000
Effective Diameter (ft):	14.7333
Vapor Space Outage (ft):	4.0000
Tank Shell Length (ft):	21.3000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Daily Avg. Liquid Surface Temp. (deg. R):	526.1003
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	523.9983
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0374
Daily Vapor Temperature Range (deg. R):	21.7491
Daily Vapor Pressure Range (psia):	0.0028
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0067
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0096
Daily Avg. Liquid Surface Temp. (deg R):	526.1003
Daily Min. Liquid Surface Temp. (deg R):	520.6630
Daily Max. Liquid Surface Temp. (deg R):	531.5375
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9983
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0081
Vapor Space Outage (ft):	4.0000
Working Losses (lb):	0.8030
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0081
Annual Net Throughput (gal/yr.):	32,000.0000

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Annual Turnovers:	4.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	8.0000
Working Loss Product Factor:	1.0000

Total Losses (lb):	2.5403

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TNKO-0004 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	0.80	1.74	2.54

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	TNKO-0001	
City:	Long Beach	
State:	California	
Company:	UPRR	
Type of Tank:	Horizontal Tank	
Description:		

Tank Dimensions

Shell Length (ft):		20.50
Diameter (ft):		10.00
Volume (gallons):		12,000.00
Turnovers:		4.00
Net Throughput(gal/yr):		48,000.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	

Paint Characteristics

Shell Color/Shade:	Gray/Light	
Shell Condition	Good	

Breather Vent Settings

Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TNKO-0001 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	72.27	62.76	81.78	66.55	0.0097	0.0072	0.0127	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TNKO-0001 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations	
Standing Losses (lb):	5.5796
Vapor Space Volume (cu ft):	1,025.5199
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0678
Vented Vapor Saturation Factor:	0.9974
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,025.5199
Tank Diameter (ft):	10.0000
Effective Diameter (ft):	16.1600
Vapor Space Outage (ft):	5.0000
Tank Shell Length (ft):	20.5000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0097
Daily Avg. Liquid Surface Temp. (deg. R):	531.9374
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	526.2183
Tank Paint Solar Absorptance (Shell):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0678
Daily Vapor Temperature Range (deg. R):	38.0313
Daily Vapor Pressure Range (psia):	0.0055
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0097
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0072
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0127
Daily Avg. Liquid Surface Temp. (deg R):	531.9374
Daily Min. Liquid Surface Temp. (deg R):	522.4296
Daily Max. Liquid Surface Temp. (deg R):	541.4452
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9974
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0097
Vapor Space Outage (ft):	5.0000
Working Losses (lb):	1.4382
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0097
Annual Net Throughput (gal/yr.):	48,000.0000

Annual Turnovers:	4.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	10.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	7.0178

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TNKO-0001 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	1.44	5.58	7.02

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	TNKO-0184	
City:	Long Beach	
State:	California	
Company:	UPRR	
Type of Tank:	Horizontal Tank	
Description:		
Tank Dimensions		
Shell Length (ft):		20.50
Diameter (ft):		7.00
Volume (gallons):		6,000.00
Turnovers:		4.00
Net Throughput(gal/yr):		24,000.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Long Beach, California (Avg Atmospheric Pressure = 14.7 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

TNKO-0184 - Horizontal Tank
Long Beach, California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	72.27	62.76	81.78	66.55	0.0097	0.0072	0.0127	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

TNKO-0184 - Horizontal Tank
Long Beach, California

Annual Emission Calcaulations

Standing Losses (lb):	2.7361
Vapor Space Volume (cu ft):	502.5047
Vapor Density (lb/cu ft):	0.0002
Vapor Space Expansion Factor:	0.0678
Vented Vapor Saturation Factor:	0.9982
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	502.5047
Tank Diameter (ft):	7.0000
Effective Diameter (ft):	13.5204
Vapor Space Outage (ft):	3.5000
Tank Shell Length (ft):	20.5000
Vapor Density	
Vapor Density (lb/cu ft):	0.0002
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0097
Daily Avg. Liquid Surface Temp. (deg. R):	531.9374
Daily Average Ambient Temp. (deg. F):	64.3083
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	526.2183
Tank Paint Solar Absorptance (Shell):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,571.6498
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0678
Daily Vapor Temperature Range (deg. R):	38.0313
Daily Vapor Pressure Range (psia):	0.0055
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0097
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0072
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0127
Daily Avg. Liquid Surface Temp. (deg R):	531.9374
Daily Min. Liquid Surface Temp. (deg R):	522.4296
Daily Max. Liquid Surface Temp. (deg R):	541.4452
Daily Ambient Temp. Range (deg. R):	19.8167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9982
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0097
Vapor Space Outage (ft):	3.5000
Working Losses (lb):	0.7191
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0097
Annual Net Throughput (gal/yr.):	24,000.0000

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Annual Turnovers:	4.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	7.0000
Working Loss Product Factor:	1.0000

Total Losses (lb):	3.4552

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

TNKO-0184 - Horizontal Tank
Long Beach, California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	0.72	2.74	3.46

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APPENDIX J

REFUELING OPERATIONS

APPENDIX J-1

SCAQMD EMISSION FACTOR DOCUMENT

APPENDIX K - VOC EMISSIONS CALCULATIONS FOR FUEL DISPENSING AND SMALL LIQUID ORGANIC STORAGE TANKS (<10,000 GALLONS)

Small liquid storage tank is defined as a tank with **a *storage capacity of less than 10,000 gallons and operated at ambient temperature and pressure***. VOC emissions can be calculated using the following equation:

$$E = EF * Q$$

where:
- E = VOC emissions (lb/year)
- Q = annual throughput (Mgal/year or 1,000 gallons/year)
- EF = emission factor (lb/Mgal)

Throughput is the amount of the liquid loaded in the tank during the reporting period.

A. Fuel Dispensing and Storage Tanks (including non-retail service stations)

Gasoline (use Activity Code 2A)**:** EF = 1.8 lb/Mgal (controlled)
Diesel (use Activity Code 2B)**:** EF = 0.028 lb/Mgal

NOTE: Report BENZENE emission from gasoline tank loss on Form TAC using a default factor of 1% or 0.018 lb/Mgal of throughput. Diesel tank benzene loss is negligible and does not have to be reported.

B. Small Fuel and Other Liquid Organic Storage Tanks (< 10,000 gallons) (use Activity Code 2D)

Under-Ground tank: EF (lb/Mgal) = loss factor ***f***

Above-Ground tank

$$EF(lb / Mgal) = \frac{a * (C / Q)}{[1 + (b * H)]} + f$$

where:
- C = tank size or capacity (Mgal or 1,000 gallons)
- Q = annual throughput (Mgal/year or 1,000 gallons/year)
- H = tank height (feet)
- a,b,f = loss factors ***a, b, f*** (see attached table "Loss Factors for Small Storage Tanks")

NOTE: If you need assistance with tank calculation, please contact Help Hotline at (714) 596-7456.

* Gasoline (RVP 6) is the most common type of gasoline in SCAQMD jurisdiction.

TOXIC AIR CONTAMINANT (TAC) CALCULATION

Toxic air contaminant emissions associated with storage tanks must be calculated and reported. In general, the emission factor and emission rate for each component can be estimated by:

$$EF_{TAC} = Z_{TAC} * EF \qquad and \qquad E_{TAC} = Z_{TAC} * E_T$$

where:
- EF_{TAC} = emission factor for TAC component, lbs/1,000 gallons
- EF = VOC emission factor, lbs/1,000 gallons
- Z_{TAC} = weight fraction of TAC component
- E_{TAC} = emission rate of TAC component, lbs/yr
- E_T = total tank VOC emissions, lbs/yr

Emissions for each TAC component must be calculated and reported individually on Form TAC.

Loss Factors for Small Storage Tanks

Material	CAS#	a	b	f
Crude oil (RVP 5)		0.064	0.084	2.863
Distillate fuel oil no. 2		0.00015	0.00020	0.0241
Residual oil no. 6		0.000001	0.000001	0.000241
Jet naphtha (JP-4)		0.028	0.038	2.725
Jet kerosene		0.00019	0.00026	0.0306
Gasoline (RVP 6)*		0.089	0.087	5.423
Gasoline (RVP 7)		0.122	0.103	6.332
Gasoline (RVP 8)		0.156	0.119	7.334
Gasoline (RVP 9)		0.199	0.136	8.226
Gasoline (RVP 10)		0.235	0.152	9.099
Gasoline (RVP 11)		0.312	0.169	9.952
Gasoline (RVP 12)		0.387	0.186	10.783
Gasoline (RVP 13)		0.470	0.203	11.408
Acetaldehyde	75070	6.572	0.360	14.328
Acetic acid	64197	0.00201	0.00531	0.289
Acetic anhydride	108247	0.00102	0.00172	0.159
Acetonitrile	75058	0.013	0.034	1.277
Acrylamide	79061	0.000001	0.000003	0.0002
Acrylic acid	79107	0.00059	0.00143	0.0932
Acrylonitrile	107131	0.024	0.043	2.047
Allyl alcohol	107186	0.00347	0.00859	0.452
Allyl chloride	107051	0.291	0.143	9.929
Aniline	62533	0.00011	0.00021	0.0173
Benzene	71432	0.027	0.036	2.512
Butanol-(1)	71363	0.00082	0.00188	0.126
Butyl alcohol (-tert)	75650	0.00833	0.014	0.945
Butyl chloride (-n)	109693	0.040	0.041	3.399
Carbon disulfide	75150	0.280	0.143	9.826
Carbon tetrachloride	56235	0.069	0.044	6.091
Chlorobenzene	108907	0.00288	0.00418	0.426
Chloroform	67663	0.134	0.074	7.959
Chloroprene	126998	0.116	0.082	6.587
Cresol (-m)	108394	0.00003	0.00005	0.0047
Cresol (-o)	95487	0.00004	0.00006	0.0061
Cresol (-p)	106445	0.00001	0.00002	0.0022
Cyclohexane	110827	0.032	0.037	2.798
Cyclohexanol	108930	0.00004	0.00006	0.0058
Cyclohexanone	108941	0.00096	0.00169	0.150
Cyclohexene	110838	0.026	0.033	2.477
Cyclopentane	287923	0.198	0.125	7.925
Cyclopentanone	120923	0.00211	0.00412	0.314
Cyclopentene	142290	0.125	0.098	6.037
Decane (-n)	124185	0.00080	0.00099	0.128
Dichloroethane (1,1)	75343	0.156	0.088	7.924
Dichloroethane (1,2)	107062	0.030	0.029	2.589
Dichloroethylene (cis-1,2)	540590	0.130	0.081	7.130
Dichloroethylene (-trans-1,2)	156605	0.311	0.129	11.348
Diethoxymethane	462953	0.022	0.025	2.336
Diethyl (n,n) anilin	91667	0.00005	0.00006	0.0077
Diethyl ether	60297	0.712	0.211	14.158
Diethyl ketone	96220	0.00779	0.013	0.975
Diethyl sulfide	352932	0.016	0.021	1.749
Diethylamine	109897	0.129	0.089	5.906
Di-isopropyl ether	108203	0.090	0.065	5.974
Dimethyl formamide	68122	0.00055	0.00130	0.086
Dimethyl hydrazine (1,1)	57147	0.047	0.058	3.151
Dimethyl phthalate	131113	0.000000002	0.000000002	0.0000003
Dioxane (1,4)	123911	0.009	0.014	1.078
Dipropyl ether	111433	0.023	0.026	2.370
Di-t-butyl ether	6163662	0.020	0.020	2.321
Epichlorohydrin	106898	0.00354	0.00603	0.505

Material	CAS#	a	b	f
Ethanolamine (mono-)	141435	0.00003	0.00009	0.0048
Ethyl acetate	141786	0.031	0.035	2.768
Ethyl acrylate	140885	0.011	0.015	1.330
Ethyl alcohol	64175	0.00805	0.021	0.862
Ethyl chloride	75003	0.195	0.486	28.425
Ethylamine	75047	0.117	0.418	17.070
Ethylbenzene	100414	0.00219	0.00342	0.329
Ethylcyclopentane	1640897	0.011	0.015	1.296
Ethyleneoxide	75218	0.143	0.525	20.911
Fluorobenzene	462066	0.025	0.029	2.482
Formic acid	64186	0.00545	0.016	0.662
Freon 11	75694	6.863	0.321	39.980
Furan	110009	0.984	0.236	14.573
Furfural	96011	0.00025	0.00046	0.0404
Heptane (-n)	142825	0.013	0.017	1.534
Hexane (-n)	110543	0.063	0.058	4.501
Hexanol (-1)	111273	0.00014	0.00024	0.022
Hydrogen cyanide	74908	0.867	0.294	7.191
Iso-butyl alcohol	78831	0.00285	0.00588	0.395
Isooctane	26635643	0.017	0.018	1.908
Isopentane	78784	2.662	0.299	19.511
Isoprene	78795	0.917	0.230	14.176
Isopropyl alcohol	67630	0.007	0.015	0.830
Isopropyl benzene	98828	0.00114	0.00163	0.177
Methacrylonitrile	126987	0.016	0.027	1.634
Methyl acetate	79209	0.113	0.082	5.479
Methyl acrylate	96333	0.026	0.032	2.458
Methyl alcohol	67561	0.018	0.045	1.296
Methyl ethyl ketone	78933	0.022	0.033	2.173
Methyl isobutyl ketone	108101	0.00434	0.00667	0.605
Methyl methacrylate	80626	0.010	0.013	1.179
Methyl propyl ether	557175	0.351	0.179	12.029
Methyl styrene (alpha)	98839	0.00053	0.00079	0.084
Methylcyclohexane	108872	0.013	0.017	1.519
Methylcyclopentane	96377	0.051	0.052	3.992
Methyldichlorosilane	75547	0.724	0.170	19.816
Methylene chloride	75092	0.449	0.168	12.912
Methyl-tert-butyl ether (MTBE)	1634044	0.158	0.097	7.754
Mineral Spirits	8052413	0.00043	0.00061	0.069
Morpholine	110918	0.00181	0.00344	0.271
Nitrobenzene	98953	0.00005	0.00008	0.0087
Nitromethane	75525	0.00502	0.011	0.623
Nonane (-n)	111842	0.00145	0.00197	0.228
n-Propyl nitrate	627134	0.00574	0.00818	0.778
o-Chlorotoluene	95498	0.00089	0.00122	0.140
Octane (-n)	111659	0.00304	0.00442	0.457
Pentachloroethane	76017	0.00130	0.00112	0.206
Pentane (-n)	109660	0.612	0.202	13.213
Phosgene	75445	0.355	0.579	51.836
Picoline (-2)	108996	0.00219	0.00385	0.325
Propylamine (-n)	107108	0.170	0.125	6.673
Propylene glycol	57556	0.00001	0.00003	0.0023
Propylene oxide	75669	0.562	0.201	10.558
Pyridine	110861	0.00377	0.00729	0.522
Resorcinol	108463	0.000002	0.000003	0.0003
Styrene	100425	0.00138	0.00226	0.214
Tetrachloroethane (1,1,1,2)	630206	0.00428	0.00416	0.632
Tetrachloroethane (1,1,2,2)	79345	0.00136	0.00140	0.213
Tetrachloroethylene	127184	0.00686	0.00645	0.969
Tetrahydrofuran	109999	0.059	0.062	4.019
Toluene	108883	0.00644	0.01021	0.852
Trichloro(1,1,2)trifluoroethane	76131	0.597	0.130	22.145
Trichloroethane (1,1,1)	71556	0.074	0.050	6.048
Trichloroethane (1,1,2)	79005	0.00674	0.00766	0.925

Material	CAS#	a	b	f
Trichloroethylene	79016	0.030	0.025	2.996
Trichloropropane (1,2,3)	96184	3.639	3.975	530.740
Trimethylchorosilane	75774	0.168	0.091	8.918
Vinyl acetate	108054	0.039	0.043	3.320
Vinylidene chloride	75354	1.355	0.240	20.935
Xylene (-m)	1330207	0.00180	0.00285	0.274
Xylene (-o)	95476	0.00140	0.00225	0.216
1,1-Diethoxyethane	105577	0.010	0.012	1.306
1,1-Dimethylcyclopentane	1638262	0.022	0.028	2.243
1,2,4-Trimethylbenzene	95636	0.00045	0.00066	0.072
1,2-Dibromopropane	78751	0.00334	0.00278	0.509
1,2-Diethylbenzene		0.00023	0.00031	0.038
1,2-Dimethoxyethane	110714	0.081	0.065	5.291
1,2-Pentadiene		0.267	0.144	8.869
1,3-Dibromopropane	109648	0.00100	0.00087	0.160
1,3-Diethylbenzene		0.00025	0.00034	0.041
1,4-Diethylbenzene	105055	0.00024	0.00031	0.038
1,4-Pentadiene	591935	2.207	0.295	18.199
1,5-Hexadiene	592427	0.117	0.086	6.429
1-Chlorobutane	109639	0.036	0.038	3.207
1-Heptene		0.017	0.021	1.842
1-Methyl-2-isopropylbenzene	527844	0.00035	0.00046	0.056
1-Octanol	111875	0.00002	0.00003	0.0034
1-Pentene	109671	1.261	0.256	16.265
1-Pentyne	627190	0.390	0.169	10.408
1-Propanethiol	107039	0.057	0.059	4.040
1-Propanol	71238	0.003	0.007	0.371
2,2,3-Trimethylpentane		0.009	0.012	1.204
2,2,4-Trimethylpentane	540841	0.016	0.018	1.884
2,2-Dimethylpentane	590352	0.041	0.040	3.609
2,3,3-Trimethylpentane		0.00757	0.0098	1.011
2,3-Dimethylbutane	79298	0.135	0.091	7.124
2,3-Dimethylpentane	565593	0.022	0.026	2.324
2,3-Pentadiene		0.198	0.124	7.668
2,4-Dimethylpentane	108087	0.048	0.044	3.994
2-Chlorobutane	78864	0.072	0.060	5.055
2-Methyl-1-butene	563462	0.205	0.131	8.345
2-Methylhexane	591764	0.021	0.024	2.212
2-Methylpentane	107835	0.112	0.082	6.384
2-Propanethiol		0.165	0.107	7.410
3,3-Dimethylpentane	562492	0.029	0.031	2.828
3,4-Dichlorotoluene	95750	0.00009	0.0001	0.014
3-Ethylpentane		0.018	0.021	1.942
3-Methylhexane	589344	0.019	0.023	2.063
Trimethylphosphite		0.004	0.006	0.655
MAA	124583	0.0003	0.0005	0.047
Chloral	75876	0.0087	0.0107	1.429
Monomethylamine 50%		0.026	0.164	4.627
Dimethylamine 40%		0.016	0.066	2.700
Dichlorvos		0.00023	0.000186	0.0371
Dicrotophos	62737	0.0077	0.0058	1.2525
Metam Sodium		0.00002	0.00003	0.003
Dimethylchloroacetoacetate		0.010	0.0121	1.636
Dimethylformamide		0.0049	0.012	0.800
Nitrochlorobenzene		0.00002	0.00003	0.0038
Aromatic 150 Fluid	64742945	0.0102	0.01296	1.6665
Texanol	25265774	0.00004	0.00003	0.0068
Naphthalene	91203	0.008	0.00005	0.00007

*Most common type of gasoline in SCAQMD jurisdiction.

APPENDIX J-2

SPECIATION PROFILE AND DEATILED EMISSION CALCULATIONS FOR REFUELING OPERATIONS

Summary of Emissions from Refueling Operations
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Tank No.	Tank Location	Material Stored	2005 Throughput (gal/yr)	VOC Emission Factor (lb/1000 gal)[1]	2005 VOC Emissions (tpy)
ICTF	TNKD-9901	Crane Maintenance Area	Offroad Diesel	120,000	0.028	0.002
ICTF	TBA-1	Crane Maintenance Area	CARB Diesel	52,000	0.028	0.001
ICTF	TBA-2	Crane Maintenance Area	Gasoline	86,808	1.8	0.078
Dolores	TNKD-0069	Tank Farm	Diesel	10,500,000	0.028	0.147
Dolores	TNKD-0068	Tank Farm	Diesel	10,500,000	0.028	0.147
Total						**0.375**

Notes:
1. Emission factors from SCAQMD *General Instruction Book for the AQMD 2006-2007 Annual Emissions Reporting Program* , *Supplemental Instructions for Liquid Organic Storage Tanks and References.*

Toxic Air Contaminant Emissions from the Gasoline Refueling Operations
Dolores and ICTF Rail Yards, Long Beach, CA

Profile[1]	CAS	Chemical Name	Organic Fraction	Gasoline Refueling 2005 Emissions (tpy)
661	540841	2,2,4-trimethylpentane	0.0130	1.02E-03
661	71432	benzene	0.0036	2.82E-04
661	110827	cyclohexane	0.0103	8.06E-04
661	100414	ethylbenzene	0.0012	9.25E-05
661	78784	isopentane	0.3747	2.93E-02
661	98828	isopropylbenzene (cumene)	0.0001	8.63E-06
661	108383	m-xylene	0.0034	2.69E-04
661	110543	n-hexane	0.0155	1.21E-03
661	95476	o-xylene	0.0013	1.00E-04
661	106423	p-xylene	0.0011	8.39E-05
661	108883	toluene	0.0171	1.33E-03
Total				**3.45E-02**

Notes
1. Organic fraction from ARBs SPECIATE database. Data is from "Headspace vapors 1996 SSD etoh 2.0% (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
3. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.9963).

APPENDIX K

DEATILED EMISSION CALCULATIONS AND SPECIATION PROFILES FOR STEAM CLEANERS

Summary of Emissions from Steam Cleaners
Dolores and ICTF Rail Yards, Long Beach, CA

Emissions from Steam Cleaner Heaters

Yard	Location	Make	Model	Emission Unit	Fuel Type	Rating (MMBtu/hr)	Hours of Operation (hr/yr)[1]	Fuel Use (gal/yr)[2]	2005 Emission Factors (lb/mgal)[3]					2005 Emission Estimates (tons/yr)				
									VOC	CO	NOx	PM10	SOx[4]	ROG	CO	NOx	PM10	SOx
Dolores	Service Track	Hydroblaster	M5-5	Heater	Propane	0.35	1000	3844.142	0.5	1.9	14	0.4	0.002	9.61E-04	3.65E-03	2.69E-02	7.69E-04	2.88E-06
Dolores	Locomotive Shop	Hydroblaster	M5-5	Heater	Propane	0.35	1000	3844.142	0.5	1.9	14	0.4	0.002	9.61E-04	3.65E-03	2.69E-02	7.69E-04	2.88E-06
Dolores	Locomotive Shop	Hydroblaster	M5-5	Heater	Propane	0.35	1000	3844.142	0.5	1.9	14	0.4	0.002	9.61E-04	3.65E-03	2.69E-02	7.69E-04	2.88E-06
Dolores	Service Track	Hydroblaster	EH34	Heater	Propane	0.35	1000	3844.142	0.5	1.9	14	0.4	0.002	9.61E-04	3.65E-03	2.69E-02	7.69E-04	2.88E-06
Total														**0.004**	**0.015**	**0.108**	**0.003**	**0.000**

Emissions from Steam Cleaner Pumps

Yard	Location	Make	Model	Emission Unit	Fuel Type	Rating (hp)	Hours of Operation (hr/yr)[1]	Fuel Use (gal/yr)[5]	2005 Emission Factors (g/hp-hr)[6]					2005 Emission Estimates (tons/yr)				
									VOC	CO	NOx	PM10	SOx	ROG	CO	NOx	PM10	SOx
Dolores	Service Track	Hydroblaster	M5-5	Pump	Electric	NA	1000	0.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dolores	Locomotive Shop	Hydroblaster	M5-5	Pump	Electric	NA	1000	0.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dolores	Locomotive Shop	Hydroblaster	M5-5	Pump	Electric	NA	1000	0.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dolores	Service Track	Hydroblaster	EH34	Pump	Gasoline	11	1000	627.56	9.79	199.13	4.99	0.33	0.27	0.12	2.41	0.06	0.00	0.00
Total														**0.12**	**2.41**	**0.06**	**0.00**	**0.00**

Notes:
1. Hours of operation are an engineering estimate.
2. Based on a propane HHV of 3.824 MMBtu/barrel (from ARB Draft Emission Factors for Mandatory Reporting Programs, August 10, 2007) and 42 gallons per barrel.
3. Emission factors, in lb/mgal, from AP-42, Table 1.5-1, 10/96.
4. Based on a propane sulfur content of 185 ppm and a density of 4.24 lb propane per gallon.
5. Based on a BSFC of 7,000 Btu/hp-hr (from AP-42) and a gasoline HHV of of 122,697 Btu/gal (from Transportation Energy Data Book, Edition 26, US DOE, 2007).
6. Emission factors in lb/hp-hr from AP-42, Table 3.3-1, 10/96.

Toxic Air Contaminant Emissions from Steam Cleaners
Dolores and ICTF Rail Yards, Long Beach, CA

Propane Heaters

Profile[1]	CAS	Chemical Name	Organic Fraction	Emissions (tpy)
3	71432	benzene	0.0947	3.64E-04
3	110827	cyclohexane	0.0237	9.11E-05
3	50000	formaldehyde	0.1895	7.28E-04
3	108883	toluene	0.0474	1.82E-04
Total				**1.37E-03**

IC Engine

Profile[1]	CAS	Chemical Name	Organic Fraction	Emissions (tpy)
665	95636	1,2,4-trimethylbenzene	0.0140	1.67E-03
665	106990	1,3-butadiene	0.0091	1.08E-03
665	540841	2,2,4-trimethylpentane	0.0222	2.63E-03
665	75070	acetaldehyde	0.0106	1.26E-03
665	107028	acrolein (2-propenal)	0.0020	2.38E-04
665	71432	benzene	0.0368	4.37E-03
665	4170303	crotonaldehyde	0.0014	1.72E-04
665	110827	cyclohexane	0.0050	5.95E-04
665	100414	ethylbenzene	0.0167	1.98E-03
665	74851	ethylene	0.0996	1.18E-02
665	50000	formaldehyde	0.0327	3.88E-03
665	78795	isoprene	0.0016	1.85E-04
665	98828	isopropylbenzene (cumene)	0.0006	6.58E-05
665	67561	methyl alcohol	0.0038	4.53E-04
665	78933	methyl ethyl ketone (mek) (2-butanone)	0.0007	7.88E-05
665	108383	m-xylene	0.0496	5.89E-03
665	91203	naphthalene	0.0014	1.72E-04
665	110543	n-hexane	0.0146	1.73E-03
665	95476	o-xylene	0.0173	2.05E-03
665	115071	propylene	0.0546	6.48E-03
665	100425	styrene	0.0014	1.72E-04
665	108883	toluene	0.0756	8.98E-03
Total				**5.60E-02**

Notes:
1. Organic fraction from ARBs SPECIATE database.
2. Data for heaters is from "External combustion boiler - natural gas" option. SPECIATE database does not include an option for propane fueled boilers.
3. Data for the gasoline IC engine is from "Non-cat stabilized exhaust 1996 SSD 2.0% etoh (MTBE phaseout)" option
4. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
5. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (Profile 3 ratio = 0.4222; Profile 665 ratio = 0.9198)

APPENDIX L

DEATILED EMISSION CALCULATIONS AND SPECIATION PROFILE FOR THE NATURAL GAS-FIRED HEATER

Summary of Emissions from Natual Gas-Fired Heaters
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Location	Equipment Type	Fuel Type	Rating (MMBtu/hr)	Hours of Operation (hr/yr)[1]	Fuel Use		2005 Emission Factors (lb/mmcf)[3]						2005 Emission Estimates (tons/yr)					
						(MMBtu/yr)	(mmcf/yr)[2]	VOC	CO	NOx	PM10	DPM	SOx	ROG	CO	NOx	PM10	DPM	SOx
ICTF	Administrative Building	Heater	Nat. Gas	0.76	2190	1664.40	1.66	5.50	84.00	100.00	7.60	NA	0.60	0.00	0.07	0.08	0.01	NA	0.00

Notes:
1. Assumes operations equivalent to 3 months per year.
2. Annual fuel use based on a natural gas HHV of 1,000 Btu/scf.
3. Emission factors, in lb/mmcf, from AP-42, Table 1.4-1, 7/98.

Toxic Air Contaminant Emissions from the Propane-Fueled Forklifts
Dolores and ICTF Rail Yards, Long Beach, CA

Profile[1]	CAS	Chemical Name	Organic Fraction	Emissions (tpy)
719	95636	1,2,4-trimethylbenzene	0.00001	3.21E-07
719	75070	acetaldehyde	0.00003	9.63E-07
719	71432	benzene	0.00010	3.53E-06
719	110827	cyclohexane	0.00001	3.21E-07
719	100414	ethylbenzene	0.00001	3.21E-07
719	74851	ethylene	0.00058	2.02E-05
719	50000	formaldehyde	0.00074	2.60E-05
719	108383	m-xylene	0.00001	3.21E-07
719	110543	n-hexane	0.00002	6.42E-07
719	95476	o-xylene	0.00001	3.21E-07
719	115071	propylene	0.00154	5.42E-05
719	108883	toluene	0.00004	1.28E-06
719	1330207	xylene	0.00002	6.42E-07
Total				**1.09E-04**

Notes:

1. Organic fraction from ARBs SPECIATE database. Data is from "ICE-reciprocating - natural gas" option. The SPECIATE database does not include a profile for propane-fueled engines.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
3. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.0914)

APPENDIX M

DEATILED EMISSION CALCULATIONS AND SPECIATION PROFILE FOR THE PROPANE-FUELED WELDER

Summary of Emissions from Propane-Fueled Welders
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Location	Equipment Type	Make/Model	Fuel Type	Rating (hp)	Hours of Operation (hr/yr)[1]	Fuel Use[2]		2005 Emission Factors (lb/MMBtu)[3]					2005 Emission Estimates (tons/yr)				
							(MMBtu/yr)	(gal/yr)	VOC	CO	NOx	PM10	SOx	ROG	CO	NOx	PM10	SOx
Dolores	Service Track	Welder	Lincoln Ranger 9	Propane	18	1000	126	1,383.89	2.96E-02	3.51	2.27	9.50E-03	5.88E-04	0.002	0.221	0.143	0.001	0.000

Notes:
1. Hours of operation are an engineering estimate.
2. Fuel use based on a BSFC of 7,000 Btu/hp-hr, a propane HHV of 3.824 MMBtu/barrel (from ARB Draft Emission Factors for Mandatory Reporting Programs, August 10, 2007), and 42 gallons per barrel.
3. Emission factors, in lb/MMBtu, from AP-42, Table 3.2-3, 7/00.

Toxic Air Contaminant Emissions from Propane-Fueled Welders
Dolores and ICTF Rail Yards, Long Beach, CA

Profile[1]	CAS	Chemical Name	Organic Fraction	Emissions (tpy)
719	95636	1,2,4-trimethylbenzene	0.00001	1.70E-08
719	75070	acetaldehyde	0.00003	5.11E-08
719	71432	benzene	0.00010	1.87E-07
719	110827	cyclohexane	0.00001	1.70E-08
719	100414	ethylbenzene	0.00001	1.70E-08
719	74851	ethylene	0.00058	1.07E-06
719	50000	formaldehyde	0.00074	1.38E-06
719	108383	m-xylene	0.00001	1.70E-08
719	110543	n-hexane	0.00002	3.41E-08
719	95476	o-xylene	0.00001	1.70E-08
719	115071	propylene	0.00154	2.88E-06
719	108883	toluene	0.00004	6.82E-08
719	1330207	xylene	0.00002	3.41E-08
Total				**5.80E-06**

Notes:
1. Organic fraction from ARBs SPECIATE database. Data is from "ICE-reciprocating - natural gas" option. The SPECIATE database does not include a profile for propane-fueled engines.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
3. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.0914)

APPENDIX N

DEATILED EMISSION CALCULATIONS AND SPECIATION PROFILE
FOR MISCELLANEOUS GASOLINE-FUELED EQUIPMENT

Summary of Emissions from Miscellaneous Gasoline-Fueled Equipment
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Location	Equipment Type	Make/Model	Fuel Type	Rating (hp)	Hours of Operation (hr/yr)[1]	2005 Emission Factors (g/hp-hr)[2]					2005 Emission Estimates (tons/yr)				
							VOC	CO	NOx	PM10	SOx	ROG	CO	NOx	PM10	SOx
ICTF	WEBCO Area	Welder	Miller Power Arc 4000	Gasoline	8	1000	9.79	199.13	4.99	0.33	0.27	0.09	1.76	0.04	0.00	0.00
ICTF	Mechanical Department	Welder	Miller Blue Stars 6000	Gasoline	13	1000	9.79	199.13	4.99	0.33	0.27	0.14	2.85	0.07	0.00	0.00
ICTF	Mechanical Department	Welder	Miller Blue Stars 180	Gasoline	12.5	1000	9.79	199.13	4.99	0.33	0.27	0.13	2.74	0.07	0.00	0.00
ICTF	Mechanical Department	Welder	Miller Bobcat	Gasoline	18	1000	9.79	199.13	4.99	0.33	0.27	0.19	3.95	0.10	0.01	0.01
ICTF	Crane Maintenance	Welder	Contractor Owned	Gasoline	20	1000	9.79	199.13	4.99	0.33	0.27	0.22	4.39	0.11	0.01	0.01
ICTF	Crane Maintenance Area	Pressure Washer	Vanguard Model 350447	Gasoline	18	1000	9.79	199.13	4.99	0.33	0.27	0.19	3.95	0.10	0.01	0.01
ICTF	WEBCO Area	Air Compressor	Honda	Gasoline	5.5	1000	9.79	199.13	4.99	0.33	0.27	0.06	1.21	0.03	0.00	0.00
ICTF	Mechanical Department	Air Compressor	Ingersoll-Rand	Gasoline	30	1000	9.79	199.13	4.99	0.33	0.27	0.32	6.59	0.17	0.01	0.01
ICTF	Crane Maintenance Area	Generator		Gasoline	50	1000	9.79	199.13	4.99	0.33	0.27	0.54	10.98	0.28	0.02	0.01
Total												**1.89**	**38.41**	**0.96**	**0.06**	**0.05**

Notes:
1. Hours of operation are an engineering estimate.
2. Emission factors, in lb/hp-hr, from AP-42, Table 3.3-1, 10/96.

Toxic Air Contaminant Emissions from Miscellaneous Gasoline-Fueled Equipment
Dolores and ICTF Rail Yards, Long Beach, CA

			Organic	2005 Emission Estimates (tpy)									
Profile[1]	CAS	Chemical Name	Fraction	Welder - WEBCO	Welder-Mech.	Welder-Mech.	Welder-Mech.	Welder-Cr. Maint.	Pressure Washer	Air Comp. - WEBCO	Air Comp - Mech.	Generator	Total
665	95636	1,2,4-trimethylbenzene	0.0140	1.21E-03	1.97E-03	1.89E-03	2.73E-03	3.03E-03	2.73E-03	8.33E-04	4.55E-03	7.58E-03	2.65E-02
665	106990	1,3-butadiene	0.0091	7.82E-04	1.27E-03	1.22E-03	1.76E-03	1.96E-03	1.76E-03	5.38E-04	2.93E-03	4.89E-03	1.71E-02
665	540841	2,2,4-trimethylpentane	0.0222	1.91E-03	3.11E-03	2.99E-03	4.31E-03	4.79E-03	4.31E-03	1.32E-03	7.18E-03	1.20E-02	4.19E-02
665	75070	acetaldehyde	0.0106	9.16E-04	1.49E-03	1.43E-03	2.06E-03	2.29E-03	2.06E-03	6.30E-04	3.44E-03	5.73E-03	2.00E-02
665	107028	acrolein (2-propenal)	0.0020	1.73E-04	2.81E-04	2.70E-04	3.89E-04	4.32E-04	3.89E-04	1.19E-04	6.48E-04	1.08E-03	3.78E-03
665	71432	benzene	0.0368	3.18E-03	5.16E-03	4.96E-03	7.15E-03	7.94E-03	7.15E-03	2.18E-03	1.19E-02	1.99E-02	6.95E-02
665	4170303	crotonaldehyde	0.0014	1.25E-04	2.03E-04	1.95E-04	2.81E-04	3.12E-04	2.81E-04	8.59E-05	4.68E-04	7.80E-04	2.73E-03
665	110827	cyclohexane	0.0050	4.33E-04	7.03E-04	6.76E-04	9.74E-04	1.08E-03	9.74E-04	2.98E-04	1.62E-03	2.71E-03	9.47E-03
665	100414	ethylbenzene	0.0167	1.44E-03	2.35E-03	2.25E-03	3.25E-03	3.61E-03	3.25E-03	9.92E-04	5.41E-03	9.02E-03	3.16E-02
665	74851	ethylene	0.0996	8.60E-03	1.40E-02	1.34E-02	1.94E-02	2.15E-02	1.94E-02	5.91E-03	3.23E-02	5.38E-02	1.88E-01
665	50000	formaldehyde	0.0327	2.82E-03	4.58E-03	4.41E-03	6.35E-03	7.05E-03	6.35E-03	1.94E-03	1.06E-02	1.76E-02	6.17E-02
665	78795	isoprene	0.0016	1.34E-04	2.18E-04	2.10E-04	3.02E-04	3.36E-04	3.02E-04	9.23E-05	5.04E-04	8.39E-04	2.94E-03
665	98828	isopropylbenzene (cumene)	0.0006	4.79E-05	7.78E-05	7.48E-05	1.08E-04	1.20E-04	1.08E-04	3.29E-05	1.80E-04	2.99E-04	1.05E-03
665	67561	methyl alcohol	0.0038	3.30E-04	5.36E-04	5.15E-04	7.42E-04	8.24E-04	7.42E-04	2.27E-04	1.24E-03	2.06E-03	7.21E-03
665	78933	methyl ethyl ketone (mek) (2-butanone)	0.0007	5.73E-05	9.31E-05	8.95E-05	1.29E-04	1.43E-04	1.29E-04	3.94E-05	2.15E-04	3.58E-04	1.25E-03
665	108383	m-xylene	0.0496	4.28E-03	6.96E-03	6.69E-03	9.63E-03	1.07E-02	9.63E-03	2.94E-03	1.61E-02	2.68E-02	9.37E-02
665	91203	naphthalene	0.0014	1.25E-04	2.03E-04	1.95E-04	2.81E-04	3.12E-04	2.81E-04	8.59E-05	4.68E-04	7.80E-04	2.73E-03
665	110543	n-hexane	0.0146	1.26E-03	2.05E-03	1.97E-03	2.84E-03	3.15E-03	2.84E-03	8.66E-04	4.73E-03	7.88E-03	2.76E-02
665	95476	o-xylene	0.0173	1.49E-03	2.42E-03	2.33E-03	3.35E-03	3.73E-03	3.35E-03	1.03E-03	5.59E-03	9.32E-03	3.26E-02
665	115071	propylene	0.0546	4.71E-03	7.66E-03	7.37E-03	1.06E-02	1.18E-02	1.06E-02	3.24E-03	1.77E-02	2.95E-02	1.03E-01
665	100425	styrene	0.0014	1.25E-04	2.03E-04	1.95E-04	2.81E-04	3.12E-04	2.81E-04	8.59E-05	4.68E-04	7.80E-04	2.73E-03
665	108883	toluene	0.0756	6.53E-03	1.06E-02	1.02E-02	1.47E-02	1.63E-02	1.47E-02	4.49E-03	2.45E-02	4.08E-02	1.43E-01
Total				**4.07E-02**	**6.61E-02**	**6.36E-02**	**9.16E-02**	**1.02E-01**	**9.16E-02**	**2.80E-02**	**1.53E-01**	**2.54E-01**	**8.90E-01**

Notes:
1. Organic fraction from ARBs SPECIATE database. Data is from "Non-cat stabilized exhaust 1996 SSD 2.0% etoh (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
3. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.9198).

APPENDIX O

DEATILED EMISSION CALCULATIONS, EMISSION FACTOR DERIVATION, EMFAC2007 OUTPUT, AND SPECIATION PROFILE FOR WORKER VEHICLES

Summary of Emissions from Worker Vehicles
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Number of Trips (trips/yr)[1,2]	VMT per Trip[3]	VMT per Year	2005 Emission Factors (g/mi)[4]					2005 Emission Estimates (tpy)				
				ROG	CO	NOx	PM10	SOx	ROG	CO	NOx	PM10	SOx
Dolores-Onsite	32,850	0.5	16,425.00	0.36	0.63	0.59	0.04	0.00	0.01	0.01	0.01	0.00	0.00
ICTF - Onsite	152,935	2.5	382,337.50	0.36	0.63	0.59	0.04	0.00	0.15	0.27	0.25	0.02	0.00
Total	**185,785**		**398,762.50**						**0.16**	**0.28**	**0.26**	**0.02**	**0.00**

Notes:
1. Number of trips for Dolores from personal communication with M.J. Germer on August 24, 2007. Based on employee force counts, assumes no ride sharing, and assumes 365 days per year.
2. Number of trips for ICTF from personal communication with M.J. Germer on August 24, 2007. Based on employee force counts, assumes no ride sharing, and assumes 365 days per year.
3. VMT per truck trip from Trinity reports.
4. Running exhaust emission factors (g/mi) from EMFAC 2007 using the BURDEN output option. The EMFAC default model year distribution for L.A. County was used.
5. Assumed no idling for worker vehicles.

Emission Factors Worker Vehicles
Dolores and ICTF Rail Yards, Long Beach, CA

2005 MY Vehicle Class Population Distribution (<5151 LBS GVWR)			
	PC	LDT1	LDT2
Population counts	3,603,550	451,168	1,420,700
Fraction of LD/MD total	0.6581	0.0824	0.2595

Vehicle Class Weighted Average Emission Factors					
Emission Category	**Units**	**PC**	**LDT1**	**LDT2**	**AVERAGE**
ROG Exhaust	g/mi	0.346	0.539	0.329	0.358
CO Exhaust	g/mi	0.633	0.862	0.562	0.634
NOX Exhaust	g/mi	0.490	0.694	0.816	0.592
PM10 Total	g/mi	0.034	0.036	0.046	0.037
SOX	g/mi	0.004	0.006	0.005	0.005
Fuel Economy	mi/gal	20.356	16.796	16.834	19.149

Notes:
1. Emission factors calculated using EMFAC 2007.

Toxic Air Contaminant Emissions from Gasoline-Fueled Worker Vehicles
Dolores and ICTF Rail Yards, Long Beach, CA

			Organic	2005 Emissions (tpy)		
Profile[1]	CAS	Chemical Name	Fraction	Dolores	ICTF	Total
2105	95636	1,2,4-trimethylbenzene	0.0120	7.79E-05	1.81E-03	1.89E-03
2105	106990	1,3-butadiene	0.0068	4.41E-05	1.03E-03	1.07E-03
2105	540841	2,2,4-trimethylpentane	0.0288	1.87E-04	4.34E-03	4.53E-03
2105	75070	acetaldehyde	0.0035	2.26E-05	5.25E-04	5.48E-04
2105	107028	acrolein (2-propenal)	0.0017	1.07E-05	2.49E-04	2.60E-04
2105	71432	benzene	0.0309	2.00E-04	4.65E-03	4.85E-03
2105	4170303	crotonaldehyde	0.0004	2.34E-06	5.44E-05	5.67E-05
2105	110827	cyclohexane	0.0077	4.96E-05	1.16E-03	1.21E-03
2105	100414	ethylbenzene	0.0131	8.48E-05	1.97E-03	2.06E-03
2105	74851	ethylene	0.0794	5.14E-04	1.20E-02	1.25E-02
2105	50000	formaldehyde	0.0197	1.28E-04	2.97E-03	3.10E-03
2105	78795	isoprene	0.0018	1.14E-05	2.67E-04	2.78E-04
2105	98828	isopropylbenzene (cumene)	0.0001	7.78E-07	1.81E-05	1.89E-05
2105	67561	methyl alcohol	0.0015	9.88E-06	2.30E-04	2.40E-04
2105	78933	methyl ethyl ketone (mek) (2-butanone)	0.0002	1.48E-06	3.44E-05	3.58E-05
2105	108383	m-xylene	0.0445	2.88E-04	6.70E-03	6.99E-03
2105	91203	naphthalene	0.0006	3.81E-06	8.87E-05	9.25E-05
2105	110543	n-hexane	0.0200	1.29E-04	3.01E-03	3.14E-03
2105	95476	o-xylene	0.0155	1.00E-04	2.33E-03	2.43E-03
2105	115071	propylene	0.0382	2.47E-04	5.76E-03	6.01E-03
2105	100425	styrene	0.0015	9.93E-06	2.31E-04	2.41E-04
2105	108883	toluene	0.0718	4.65E-04	1.08E-02	1.13E-02
Total				**2.59E-03**	**6.02E-02**	**6.28E-02**

Notes:
1. Organic fraction from ARBs SPECIATE database. Data is from "Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.
3. Organic fraction reported on a ROG basis using ARB's Speciate ROG/TOG ratio (0.8012).

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2007/08/20 15:18:38
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	LDA-TOT	LDT1-TOT	LDT2-TOT
Vehicles	3603550	451168	1420700
VMT/1000	123280	16519	53929
Trips	22617700	2805710	9013310
Reactive Organic Gas Emissions			
Run Exh	27.06	7.35	11.54
Idle Exh	0	0	0
Start Ex	19.97	2.47	8.04
	-------	-------	-------
Total Ex	47.02	9.82	19.58
Diurnal	4.38	0.54	1.4
Hot Soak	6.2	0.87	1.89
Running	25.79	4.11	9.7
Resting	2.63	0.36	0.85
	-------	-------	-------
Total	86.03	15.69	33.43
Carbon Monoxide Emissions			
Run Exh	589.16	132.38	294.02
Idle Exh	0	0	0
Start Ex	201.07	26.93	90.19
	-------	-------	-------
Total Ex	790.22	159.31	384.21
Oxides of Nitrogen Emissions			
Run Exh	54.15	11.1	40.42
Idle Exh	0	0	0
Start Ex	12.5	1.52	8.1
	-------	-------	-------
Total Ex	66.65	12.63	48.52
Carbon Dioxide Emissions (000)			
Run Exh	55.87	9.06	29.72
Idle Exh	0	0	0
Start Ex	1.9	0.29	0.9
	-------	-------	-------
Total Ex	57.77	9.35	30.63
PM10 Emissions			
Run Exh	1.62	0.26	1.42
Idle Exh	0	0	0
Start Ex	0.15	0.02	0.12
	-------	-------	-------
Total Ex	1.77	0.28	1.54
TireWear	1.09	0.15	0.48
BrakeWr	1.7	0.23	0.75
	-------	-------	-------
Total	4.56	0.66	2.76
Lead	0	0	0
SOx	0.58	0.11	0.3
Fuel Consumption (000 gallons)			
Gasoline	6042.18	965.82	3199.62
Diesel	13.88	17.67	4.01

APPENDIX P

ROADWAY DUST

APPENDIX P-1

AP-42 SECTION 13.2 AND EXERPT FROM THE SCAQMD STAFF REPORT FOR RULE 1186

13.2.1 Paved Roads

13.2.1.1 General

Particulate emissions occur whenever vehicles travel over a paved surface such as a road or parking lot. Particulate emissions from paved roads are due to direct emissions from vehicles in the form of exhaust, brake wear and tire wear emissions and resuspension of loose material on the road surface. In general terms, resuspended particulate emissions from paved roads originate from, and result in the depletion of, the loose material present on the surface (i.e., the surface loading). In turn, that surface loading is continuously replenished by other sources. At industrial sites, surface loading is replenished by spillage of material and trackout from unpaved roads and staging areas. Figure 13.2.1-1 illustrates several transfer processes occurring on public streets.

Various field studies have found that public streets and highways, as well as roadways at industrial facilities, can be major sources of the atmospheric particulate matter within an area.[1-9] Of particular interest in many parts of the United States are the increased levels of emissions from public paved roads when the equilibrium between deposition and removal processes is upset. This situation can occur for various reasons, including application of granular materials for snow and ice control, mud/dirt carryout from construction activities in the area, and deposition from wind and/or water erosion of surrounding unstabilized areas. In the absence of continuous addition of fresh material (through localized trackout or application of antiskid material), paved road surface loading should reach an equilibrium value in which the amount of material resuspended matches the amount replenished. The equilibrium surface loading value depends upon numerous factors. It is believed that the most important factors are: mean speed of vehicles traveling the road; the average daily traffic (ADT); the number of lanes and ADT per lane; the fraction of heavy vehicles (buses and trucks); and the presence/absence of curbs, storm sewers and parking lanes.[10]

The particulate emission factors presented in the previous version of this section of AP-42, dated October 2002, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material. EPA included these sources in the emission factor equation for paved roads since the field testing data used to develop the equation included both the direct emissions from vehicles and emissions from resuspension of road dust.

This version of the paved road emission factor equation only estimates particulate emissions from resuspended road surface material [28]. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOBILE6.2 [27]. This approach eliminates the possibility of double counting emissions. Double counting results when employing the previous version of the emission factor equation in this section and MOBILE6.2 to estimate particulate emissions from vehicle traffic on paved roads. It also incorporates the decrease in exhaust emissions that has occurred since the paved road emission factor equation was developed. The previous version of the paved road emission factor equation includes estimates of emissions from exhaust, brake wear, and tire wear based on emission rates for vehicles in the 1980 calendar year fleet. The amount of PM released from vehicle exhaust has decreased since 1980 due to lower new vehicle emission standards and changes in fuel characteristics.

13.2.1.2 Emissions And Correction Parameters

Dust emissions from paved roads have been found to vary with what is termed the "silt loading" present on the road surface as well as the average weight of vehicles traveling the road. The term silt loading (sL) refers to the mass of silt-size material (equal to or less than 75 micrometers [μm] in physical diameter) per unit area of the travel surface. The total road surface dust loading consists of loose material that can be collected by broom sweeping and vacuuming of the traveled portion of the paved road. The silt fraction is determined by measuring the proportion of the loose dry surface dust that passes through a 200-mesh screen, using the ASTM-C-136 method. Silt loading is the product of the silt fraction and the total loading, and is abbreviated "sL". Additional details on the sampling and analysis of such material are provided in AP-42 Appendices C.1 and C.2.

The surface sL provides a reasonable means of characterizing seasonal variability in a paved road emission inventory. In many areas of the country, road surface loadings [11-21] are heaviest during the late winter and early spring months when the residual loading from snow/ice controls is greatest. As noted earlier, once replenishment of fresh material is eliminated, the road surface loading can be expected to reach an equilibrium value, which is substantially lower than the late winter/early spring values.

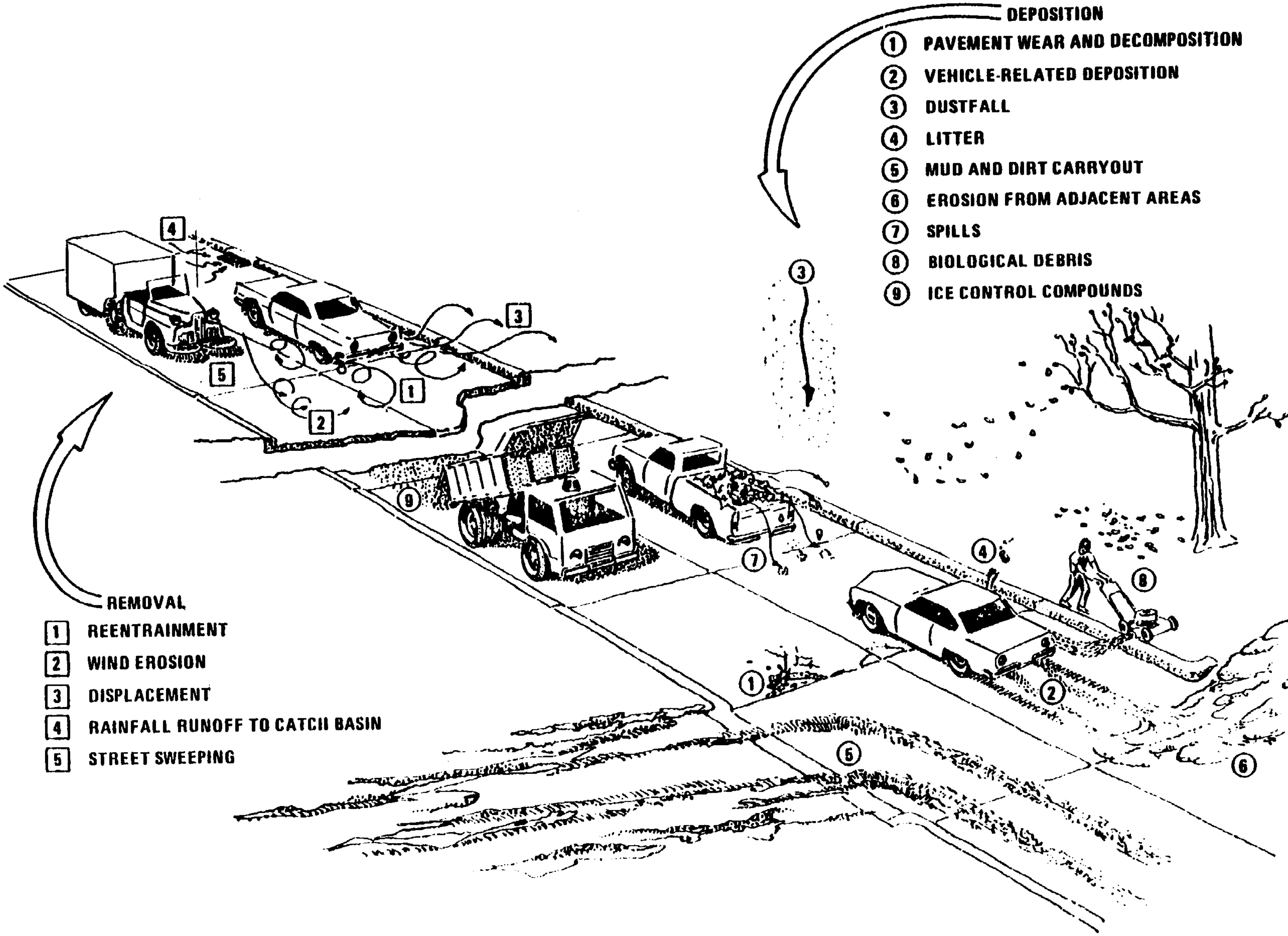

Figure 13.2.1-1. Deposition and removal processes.

13.2.1.3 Predictive Emission Factor Equations [10]

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road may be estimated using the following empirical expression:

$$E = k \left(\frac{sL}{2} \right)^{0.65} \times \left(\frac{W}{3} \right)^{1.5} - C \qquad (1)$$

where:
- E = particulate emission factor (having units matching the units of k),
- k = particle size multiplier for particle size range and units of interest (see below),
- sL = road surface silt loading (grams per square meter) (g/m^2),
- W = average weight (tons) of the vehicles traveling the road, and
- C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.

It is important to note that Equation 1 calls for the average weight of all vehicles traveling the road. For example, if 99 percent of traffic on the road are 2 ton cars/trucks while the remaining 1 percent consists of 20 ton trucks, then the mean weight "W" is 2.2 tons. More specifically, Equation 1 is *not* intended to be used to calculate a separate emission factor for each vehicle weight class. Instead, only one emission factor should be calculated to represent the "fleet" average weight of all vehicles traveling the road.

The particle size multiplier (*k*) above varies with aerodynamic size range as shown in Table 13.2.1-1. To determine particulate emissions for a specific particle size range, use the appropriate value of k shown in Table 13.2.1-1.

The emission factors for the exhaust, brake wear and tire wear of a 1980's vehicle fleet (*C*) was obtained from EPA's MOBILE6.2 model [28]. The emission factor also varies with aerodynamic size range as shown in Table 13.2.1-2.

Table 13.2-1.1. PARTICLE SIZE MULTIPLIERS FOR PAVED ROAD EQUATION

Size range[a]	Particle Size Multiplier k[b]		
	g/VKT	g/VMT	lb/VMT
PM-2.5[c]	0.66	1.1	0.0024
PM-10	4.6	7.3	0.016
PM-15	5.5	9.0	0.020
PM-30[d]	24	38	0.082

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The revised k-factors were based on the ratio of $PM_{2.5}$:PM_{10} in Table 1 of Reference 22 and are found in Table 2 of Reference 22. However, this ratio may not be used directly to estimate $PM_{2.5}$ from PM_{10} emissions. Equation (1) must be be computed separately for each size fraction because the relationship between $PM_{2.5}$ and PM_{10} emissions is not a simple ratio (i.e., the constant "C" in Equation (1) is not multiplied by the k-factor).

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Table 13.2.1-2. EMISSION FACTOR FOR 1980'S VEHICLE FLEET
EXHAUST, BRAKE WEAR AND TIRE WEAR

Particle Size Range[a]	*C*, Emission Factor for Exhaust, Brake Wear and Tire Wear[b]		
	g/VMT	g/VKT	lb/VMT
$PM_{2.5}$	0.1617	0.1005	0.00036
PM_{10}	0.2119	0.1317	0.00047
PM_{15}	0.2119	0.1317	0.00047
PM_{30}[c]	0.2119	0.1317	0.00047

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.
[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT).
[c] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Equation 1 is based on a regression analysis of numerous emission tests, including 65 tests for PM-10.[10] Sources tested include public paved roads, as well as controlled and uncontrolled industrial paved roads. All sources tested were of freely flowing vehicles traveling at constant speed on relatively level roads. No tests of "stop-and-go" traffic or vehicles under load were available for inclusion in the data base. The equations retain the quality rating of A (B for PM-2.5), if applied within the range of source conditions that were tested in developing the equation as follows:

Silt loading:	0.03 - 400 g/m^2 0.04 - 570 grains/square foot (ft^2)
Mean vehicle weight:	1.8 - 38 megagrams (Mg) 2.0 - 42 tons
Mean vehicle speed:	16 - 88 kilometers per hour (kph) 10 - 55 miles per hour (mph)

Note: There may be situations where low silt loading and/or low average weight will yield calculated negative emissions from equation 1. If this occurs, the emissions calculated from equation 1 should be set to zero.

Users are cautioned that application of equation 1 outside of the range of variables and operating conditions specified above, e.g., application to roadways or road networks with speeds below 10 mph and with stop-and-go traffic, will result in emission estimates with a higher level of uncertainty. In these situations, users are encouraged to consider alternative methods that are equally or more plausible in light of local emissions data and/or ambient concentration or compositional data.

To retain the quality rating for the emission factor equation when it is applied to a specific paved road, it is necessary that reliable correction parameter values for the specific road in question be determined. With the exception of limited access roadways, which are difficult to sample, the collection and use of site-specific silt loading (sL) data for public paved road emission inventories are strongly recommended. The field and laboratory procedures for determining surface material silt content and surface dust loading are summarized in Appendices C.1 and C.2. In the event that site-specific values cannot be obtained, an appropriate value for a paved public road may be selected from the values in Table 13.2.1-3, but the quality rating of the equation should be reduced by 2 levels. Also, recall that Equation 1 refers to emissions due to freely flowing (not stop-and-go) traffic at constant speed on level roads.

Equation 1 may be extrapolated to average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual (or other long-term) average emissions are inversely proportional to the frequency of measurable (> 0.254 mm [0.01 inch]) precipitation by application of a precipitation correction term. The precipitation correction term can be applied on a daily or an hourly basis [26].

For the daily basis, Equation 1 becomes:

$$E_{ext} = \left[k \left(\frac{sL}{2} \right)^{0.65} \left(\frac{W}{3} \right)^{1.5} - C \right] \left(1 - \frac{P}{4N} \right) \qquad (2)$$

where *k*, *sL*, *W*, *and C* are as defined in Equation 1 and

E_{ext} = annual or other long-term average emission factor in the same units as *k*,
P = number of “wet” days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Note that the assumption leading to Equation 2 is based on analogy with the approach used to develop long-term average unpaved road emission factors in Section 13.2.2. However, Equation 2 above incorporates an additional factor of "4" in the denominator to account for the fact that paved roads dry more quickly than unpaved roads and that the precipitation may not occur over the complete 24-hour day.

For the hourly basis, equation 1 becomes:

$$E_{ext} = \left[k \left(\frac{sL}{2} \right)^{0.65} \left(\frac{W}{3} \right)^{1.5} - C \right] \left(1 - \frac{1.2P}{N} \right) \qquad (3)$$

where k, sL, and W, and C are as defined in Equation 1 and

E_{ext} = annual or other long-term average emission factor in the same units as k,
P = number of hours with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of hours in the averaging period (e.g., 8760 for annual, 2124 for season 720 for monthly).

Note: In the hourly moisture correction term (1-1.2P/N) for equation 3, the 1.2 multiplier is applied to account for the residual mitigative effect of moisture. For most applications, this equation will produce satisfactory results. However, if the time interval for which the equation is applied is short, e.g., for one hour or one day, the application of this multiplier makes it possible for the moisture correction term to become negative. This will result in calculated negative emissions which is not realistic. Users should expand the time interval to include sufficient “dry” hours such that negative emissions are not calculated. For the special case where this equation is used to calculate emissions on an hour by hour basis, such as would be done in some emissions modeling situations, the moisture correction term should be modified so that the moisture correction “credit” is applied to the first hours following cessation of precipitation. In this special case, it is suggested that this 20% “credit” be applied on a basis of one hour credit for each hour of precipitation up to a maximum of 12 hours.

Note that the assumption leading to Equation 3 is based on analogy with the approach used to develop long-term average unpaved road emission factors in Section 13.2.2.

Figure 13.2.1-2 presents the geographical distribution of "wet" days on an annual basis for the United States. Maps showing this information on a monthly basis are available in the *Climatic Atlas of the United States*[23] . Alternative sources include other Department of Commerce publications (such as local climatological data summaries). The National Climatic Data Center (NCDC) offers several products that provide hourly precipitation data. In particular, NCDC offers *Solar and Meteorological Surface Observation Network 1961-1990* (SAMSON) CD-ROM, which contains 30 years worth of hourly meteorological data for first-order National Weather Service locations. Whatever meteorological data are used, the source of that data and the averaging period should be clearly specified.

It is emphasized that the simple assumption underlying Equations 2 and 3 has not been verified in any rigorous manner. For that reason, the quality ratings for Equations 2 and 3 should be downgraded one letter from the rating that would be applied to Equation 1.

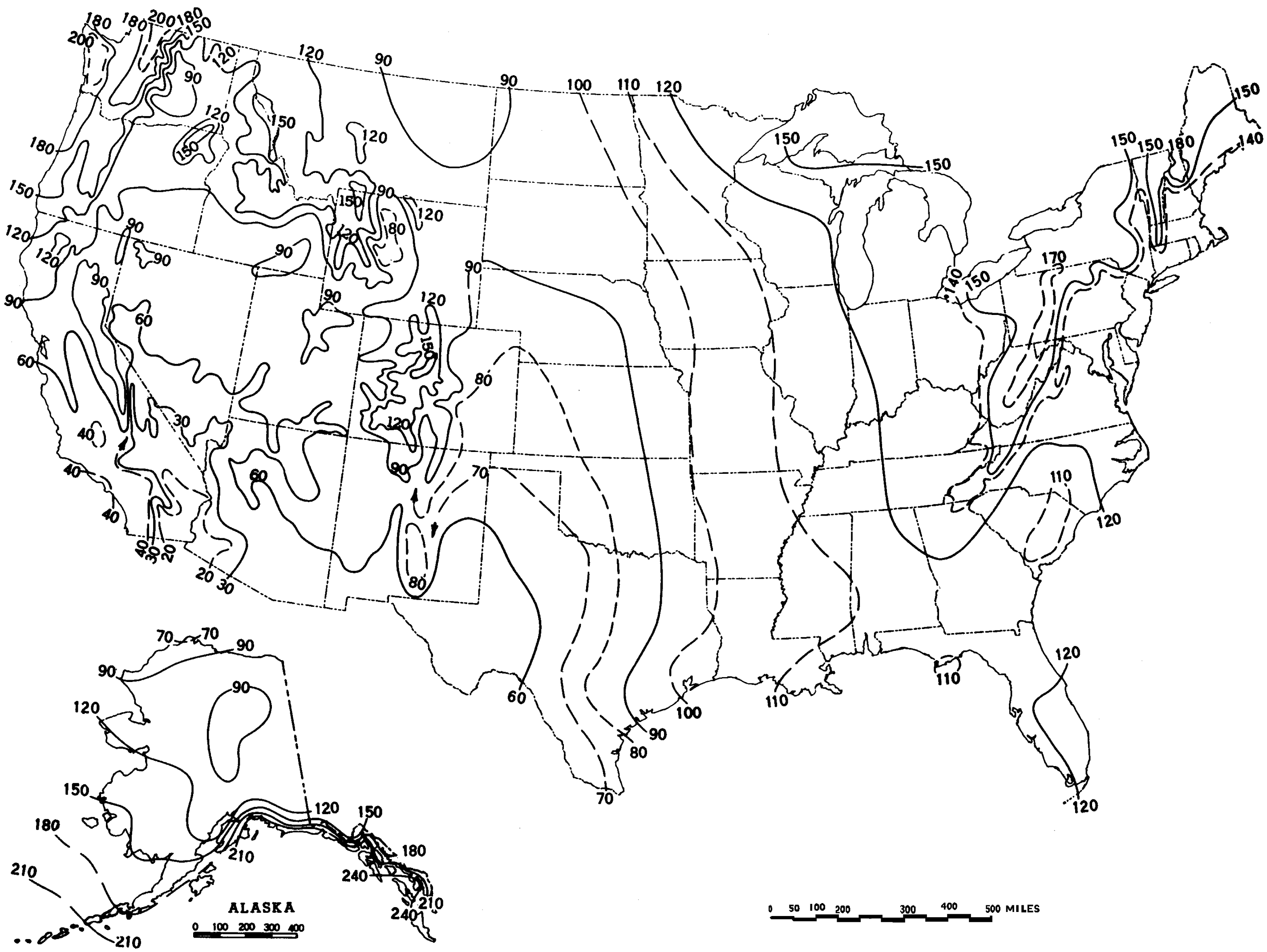

Figure 13.2.1-2. Mean number of days with 0.01 inch or more of precipitation in the United States.

Table 13.2.1-3 presents recommended default silt loadings for normal baseline conditions and for wintertime baseline conditions in areas that experience frozen precipitation with periodic application of antiskid material[24]. The winter baseline is represented as a multiple of the non-winter baseline, depending on the ADT value for the road in question. As shown, a multiplier of 4 is applied for low volume roads (< 500 ADT) to obtain a wintertime baseline silt loading of 4 X 0.6 = 2.4 g/m^2.

Table 13.2.1-3. Ubiquitous Silt Loading Default Values with Hot Spot Contributions from Anti-Skid Abrasives (g/m^2)

ADT Category	< 500	500-5,000	5,000-10,000	> 10,000
Ubiquitous Baseline g/m^2	0.6	0.2	0.06	0.03 0.015 limited access
Ubiquitous Winter Baseline Multiplier during months with frozen precipitation	X4	X3	X2	X1
Initial peak additive contribution from application of antiskid abrasive (g/m^2)	2	2	2	2
Days to return to baseline conditions (assume linear decay)	7	3	1	0.5

It is suggested that an additional (but temporary) silt loading contribution of 2 g/m^2 occurs with each application of antiskid abrasive for snow/ice control. This was determined based on a typical application rate of 500 lb per lane mile and an initial silt content of 1 % silt content. Ordinary rock salt and other chemical deicers add little to the silt loading, because most of the chemical dissolves during the snow/ice melting process.

To adjust the baseline silt loadings for mud/dirt trackout, the number of trackout points is required. It is recommended that in calculating PM-10 emissions, six additional miles of road be added for each active trackout point from an active construction site, to the paved road mileage of the specified category within the county. In calculating PM-2.5 emissions, it is recommended that three additional miles of road be added for each trackout point from an active construction site.

It is suggested the number of trackout points for activities other than road and building construction areas be related to land use. For example, in rural farming areas, each mile of paved road would have a specified number of trackout points at intersections with unpaved roads. This value could be estimated from the unpaved road density (mi/sq. mi.).

The use of a default value from Table 13.2.1-3 should be expected to yield only an order-of-magnitude estimate of the emission factor. Public paved road silt loadings are dependent upon: traffic characteristics (speed, ADT, and fraction of heavy vehicles); road characteristics (curbs, number of lanes, parking lanes); local land use (agriculture, new residential construction) and regional/seasonal factors (snow/ice controls, wind blown dust). As a result, the collection and use of site-specific silt loading data is highly recommended. In the event that default silt loading values are used, the quality ratings for the equation should be downgraded 2 levels.

Limited access roadways pose severe logistical difficulties in terms of surface sampling, and few silt loading data are available for such roads. Nevertheless, the available data do not suggest great variation in silt loading for limited access roadways from one part of the country to another. For annual conditions, a default value of 0.015 g/m^2 is recommended for limited access roadways.[9,22] Even fewer of the available data correspond to worst-case situations, and elevated loadings are observed to be quickly depleted because of high traffic speeds and high ADT rates. A default value of 0.2 g/m^2 is recommended for short periods of time following application of snow/ice controls to limited access roads.[22]

The limited data on silt loading values for industrial roads have shown as much variability as public roads. Because of the variations of traffic conditions and the use of preventive mitigative controls, the data probably do not reflect the full extent of the potential variation in silt loading on industrial roads. However, the collection of site specific silt loading data from industrial roads is easier and safer than for public roads. Therefore, the collection and use of site-specific silt loading data is preferred and is highly recommended. In the event that site-specific values cannot be obtained, an appropriate value for an industrial road may be selected from the mean values given in Table 13.2.1-4, but the quality rating of the equation should be reduced by 2 levels.

Table 13.2.1-4 (Metric And English Units). TYPICAL SILT CONTENT AND LOADING VALUES FOR PAVED ROADS AT INDUSTRIAL FACILITIES[a]

Industry	No. Of Sites	No. Of Samples	Silt Content (%)		No. Of Travel Lanes	Total Loading x 10^{-3}			Silt Loading (g/m^2)	
			Range	Mean		Range	Mean	Units[b]	Range	Mean
Copper smelting	1	3	15.4-21.7	19.0	2	12.9-19.5 45.8-69.2	15.9 55.4	kg/km lb/mi	188-400	292
Iron and steel production	9	48	1.1-35.7	12.5	2	0.006-4.77 0.020-16.9	0.495 1.75	kg/km lb/mi	0.09-79	9.7
Asphalt batching	1	3	2.6-4.6	3.3	1	12.1-18.0 43.0-64.0	14.9 52.8	kg/km lb/mi	76-193	120
Concrete batching	1	3	5.2-6.0	5.5	2	1.4-1.8 5.0-6.4	1.7 5.9	kg/km lb/mi	11-12	12
Sand and gravel processing	1	3	6.4-7.9	7.1	1	2.8-5.5 9.9-19.4	3.8 13.3	kg/km lb/mi	53-95	70
Municipal solid waste landfill	2	7	—	—	2	—	—	—	1.1-32.0	7.4
Quarry	1	6	—	—	2	—	—	—	2.4-14	8.2

[a] References 1-2,5-6,11-13. Values represent samples collected from *industrial* roads. Public road silt loading values are presented in Table-13.2.1-2. Dashes indicate information not available.

[b] Multiply entries by 1000 to obtain stated units; kilograms per kilometer (kg/km) and pounds per mile (lb/mi).

13.2.1.4 Controls[6,25]

Because of the importance of the silt loading, control techniques for paved roads attempt either to prevent material from being deposited onto the surface (preventive controls) or to remove from the travel lanes any material that has been deposited (mitigative controls). Covering of loads in trucks, and the paving of access areas to unpaved lots or construction sites, are examples of preventive measures. Examples of mitigative controls include vacuum sweeping, water flushing, and broom sweeping and flushing. Actual control efficiencies for any of these techniques can be highly variable. Locally measured silt loadings before and after the application of controls is the preferred method to evaluate controls. It is particularly important to note that street sweeping of gutters and curb areas may actually increase the silt loading on the traveled portion of the road. Redistribution of loose material onto the travel lanes will actually produce a short-term increase in the emissions.

In general, preventive controls are usually more cost effective than mitigative controls. The cost-effectiveness of mitigative controls falls off dramatically as the size of an area to be treated increases. The cost-effectiveness of mitigative measures is also unfavorable if only a short period of time is required for the road to return to equilibrium silt loading condition. That is to say, the number and length of public roads within most areas of interest preclude any widespread and routine use of mitigative controls. On the other hand, because of the more limited scope of roads at an industrial site, mitigative measures may be used quite successfully (especially in situations where truck spillage occurs). Note, however, that public agencies could make effective use of mitigative controls to remove sand/salt from roads after the winter ends.

Because available controls will affect the silt loading, controlled emission factors may be obtained by substituting controlled silt loading values into the equation. (Emission factors from controlled industrial roads were used in the development of the equation.) The collection of surface loading samples from treated, as well as baseline (untreated), roads provides a means to track effectiveness of the controls over time.

13.2.1.5 Changes since Fifth Edition

The following changes were made since the publication of the Fifth Edition of AP-42:

1) The particle size multiplier was reduced by approximately 55% as a result of emission testing specifically to evaluate the PM-2.5 component of the emissions.

2) Default silt loading values were included in Table 13.2.1-2 replacing the Tables and Figures containing silt loading statistical information.

3) Editorial changes within the text were made indicating the possible causes of variations in the silt loading between roads within and among different locations. The uncertainty of using the default silt loading value was discussed.

4) Section 13.2.1.1 was revised to clarify the role of dust loading in resuspension. Additional minor text changes were made.

5) Equations 2 and 3, Figure 13.2.1-2, and text were added to incorporate natural mitigation into annual or other long-term average emission factors.

6) The emission factor equation was adjusted to remove the component of particulate emissions from exhaust, brake wear, and tire wear. The parameter *C* in the new equation varies with aerodynamic size range of the particulate matter. Table 13.2.1-2 was added to present the new coefficients.

7) The default silt loading values in Table 13.2.1-3 were revised to incorporate the results from a recent analysis of silt loading data.

8) The PM-2.5 particle size multiplier was reduced by 40% as the result of wind tunnel studies of a variety of dust emitting surface materials.

9) References were rearranged and renumbered.

References For Section 13.2.1

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2. R. Bohn, *et al.*, *Fugitive Emissions From Integrated Iron And Steel Plants*, EPA-600/2-78-050, U. S. Environmental Protection Agency, Cincinnati, OH, March 1978.

3. C. Cowherd, Jr., *et al.*, *Iron And Steel Plant Open Dust Source Fugitive Emission Evaluation*, EPA-600/2-79-103, U. S. Environmental Protection Agency, Cincinnati, OH, May 1979.

4. C. Cowherd, Jr., *et al.*, *Quantification Of Dust Entrainment From Paved Roadways*, EPA-450/3-77-027, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1977.

5. *Size Specific Particulate Emission Factors For Uncontrolled Industrial And Rural Roads*, EPA Contract No. 68-02-3158, Midwest Research Institute, Kansas City, MO, September 1983.

6. T. Cuscino, Jr., *et al.*, *Iron And Steel Plant Open Source Fugitive Emission Control Evaluation*, EPA-600/2-83-110, U. S. Environmental Protection Agency, Cincinnati, OH, October 1983.

7. J. P. Reider, *Size-specific Particulate Emission Factors For Uncontrolled Industrial And Rural Roads*, EPA Contract 68-02-3158, Midwest Research Institute, Kansas City, MO, September 1983.

8. C. Cowherd, Jr., and P. J. Englehart, *Paved Road Particulate Emissions*, EPA-600/7-84-077, U. S. Environmental Protection Agency, Cincinnati, OH, July 1984.

9. C. Cowherd, Jr., and P. J. Englehart, *Size Specific Particulate Emission Factors For Industrial And Rural Roads*, EPA-600/7-85-038, U. S. Environmental Protection Agency, Cincinnati, OH, September 1985.

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11. *Evaluation Of Open Dust Sources In The Vicinity Of Buffalo, New York*, EPA Contract No. 68-02-2545, Midwest Research Institute, Kansas City, MO, March 1979.

12. *PM-10 Emission Inventory Of Landfills In The Lake Calumet Area*, EPA Contract No. 68-02-3891, Midwest Research Institute, Kansas City, MO, September 1987.

13. *Chicago Area Particulate Matter Emission Inventory — Sampling And Analysis*, Contract No. 68-02-4395, Midwest Research Institute, Kansas City, MO, May 1988.

14. *Montana Street Sampling Data*, Montana Department Of Health And Environmental Sciences, Helena, MT, July 1992.

15. *Street Sanding Emissions And Control Study*, PEI Associates, Inc., Cincinnati, OH, October 1989.

16. *Evaluation Of PM-10 Emission Factors For Paved Streets*, Harding Lawson Associates, Denver, CO, October 1991.

17. *Street Sanding Emissions And Control Study*, RTP Environmental Associates, Inc., Denver, CO, July 1990.

18. *Post-storm Measurement Results — Salt Lake County Road Dust Silt Loading Winter 1991/92 Measurement Program*, Aerovironment, Inc., Monrovia, CA, June 1992.

19. Written communication from Harold Glasser, Department of Health, Clark County (NV).

20. *PM-10 Emissions Inventory Data For The Maricopa And Pima Planning Areas*, EPA Contract No. 68-02-3888, Engineering-Science, Pasadena, CA, January 1987.

21. *Characterization Of PM-10 Emissions From Antiskid Materials Applied To Ice- And Snow-Covered Roadways*, EPA Contract No. 68-D0-0137, Midwest Research Institute, Kansas City, MO, October 1992.

22. C. Cowherd, *Background Document for Revisions to Fine Fraction Ratios &sed for AP-42 Fugitive Dust Emission Factors*. Prepared by Midwest Research Institute for Western Governors Association, Western Regional Air Partnership, Denver, CO, February 1, 2006.

23. *Climatic Atlas Of The United States*, U.S. Department of Commerce, Washington, D.C., June 1968.

24. C. Cowherd, Jr., *et al.*, *Improved Activity Levels for National Emission Inventories of Fugitive Dust from Paved and Unpaved Roads*, Presented at the 11th International Emission Inventory Conference, Atlanta, Georgia, April 2002.

25. C. Cowherd, Jr., *et al.*, *Control Of Open Fugitive Dust Sources*, EPA-450/3-88-008, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1988.

26. Written communication (Technical Memorandum) from G. Muleski, Midwest Research Institute, Kansas City, MO, to B. Kuykendal, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 27, 2001.

27. EPA, 2002b. MOBILE6 User Guide, United States Environmental Protection Agency, Office of Transportation and Air Quality. EPA420-R-02-028, October 2002.

28. Written communication (Technical Memorandum) from P. Hemmer, E.H. Pechan & Associates, Inc., Durham, NC to B. Kuykendal, U. S. Environmental Protection Agency, Research Triangle Park, NC, August, 21, 2003.

APPENDIX P-2

DEATILED EMISSION CALCULATIONS
FOR ROADWAY DUST

Summary of Particulate Matter Emissions from Paved Roadways
Dolores and ICTF Rail Yards, Long Beach, CA

Yard	Vehicle Type	Annual VMT (mi/yr)[1]	PM10 Emission Factor (g/VMT)[2]	Control Efficiency (%)[3]	2005 PM10 Emission Estimates (tpy)[3]
Dolores	Delivery Trucks	502.31	12.11	45%	0.00
Dolores	Yard Truck	118,007.00	12.11	45%	0.87
Dolores	Worker Vehicles	16,425.00	12.11	45%	0.12
ICTF	Intermodal Trucks	1,641,629.38	12.11	45%	12.06
ICTF	Delivery Trucks	17.18	12.11	45%	0.00
ICTF	Yard Truck	365,000.00	12.11	45%	2.68
ICTF	Worker Vehicles	382,337.50	12.11	45%	2.81
Total		**2,523,918.37**			**18.54**

Notes:
1. See intermodal truck, delivery truck, and worker vehicle subsheets for VMT calculations.
2. PM10 emission factor calculated using Equation 2 of AP-42 Section 13.2.1 (11/06) and the variables listed in the following table.

Variable	Unit	Annual PM10	Reference
k	g/VMT	7.3	AP-42, Table 13.2-1.1, 11/06
sL	g/m2	0.015	AP-42, Table 13.2.1-3, 11/06
W	tons	36.1	Trinity Report, Table 19-1
C	g/VMT	0.2119	AP-42, Table 13.2.1-2, 11/06
P	days	40	AP-42, Fig 13.2.1-2, 11/06
N	days	365	
$(sL/2)^{0.65}$		0.0416	AP-42, Equation 2, Section13.2.1, 11/6
$(W/3)^{1.5}$		41.7425	AP-42, Equation 2, Section13.2.1, 11/7
(P/4N)		0.0274	AP-42, Equation 2, Section13.2.1, 11/8
E	**g/VMT**	**12.11**	AP-42, Equation 2, Section13.2.1, 11/9

3. The control efficiency is calculated based on the equation in Attachment 1 of the SCAQMD staff report for Rule 1186 (1/97) and assumes street sweeping twice per week.

APPENDIX Q

SOURCE TREATMENT AND ASSUMPTIONS FOR AIR DISPERSION MODELING FOR NON-LOCOMOTIVE SOURCES

Appendix Q

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources

As shown in Figures 4-8, emissions were allocated spatially throughout the Yard in the areas where each source type operates or is most likely to operate. Emissions from mobile sources, low-level cargo handling equipment, heavy equipment, and moving locomotives were simulated as a series of volume sources along their corresponding travel routes and work areas. Yard hostlers, heavy-duty trucks, and other low-level emission sources were first allocated to the areas of the yard where their activity occurs, and were then allocated uniformly to a series of sources within the defined areas. Depending on their magnitude and proximity to yard boundaries, idling emissions for heavy-duty trucks may be treated as point sources rather than being included in the non-idling volume sources used to characterize moving vehicles. Idling of locomotives and elevated cargo handling equipment (cranes) were simulated as a series of point sources within the areas where these events occur. Large sources such as RTGs and cranes that are stationary or slow moving were treated as point sources with appropriate stack parameters.

Emissions from stationary sources, such as fuel tanks, were simulated as a point source corresponding to the actual equipment location within the Yard. Assumptions used spatially to allocate emissions for each source group are shown in the Table below. See Figures 2 and 3 for the source locations. See Appendix A-4 for assumptions regarding the spatial allocation of locomotive emissions.

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources ICTF and Dolores Rail Yards 2005 Baseline Year		
Source	Source Treatment	Assumptions for Spatial Allocation of Emissions
HHD Diesel-Fueled Drayage Trucks	Point (idling) Volume (traveling)	<u>Onsite</u> - Assumed 10% of the traveling emissions and 1/3 of the idling occurred at the intermodal gate. The remaining emissions (traveling and idling) were modeled in the trailer parking area. <u>Offsite</u> – emissions were placed along the various truck travel routes.
HHD Diesel-Fueled Delivery Trucks	Volume	Emissions from delivery trucks were allocated to the areas near the storage tanks served by the trucks. Due to the relatively small emission rates, emissions from idling and traveling were not separated.
Cargo Handling Equipment (low level)	Volume	<u>Top Picks</u> – all emissions were modeled in the chassis stacking area. <u>Yard Hostlers</u> – assumed 10% of the total emissions from yard hostlers occurred at the tractor maintenance area and the remaining emissions occurred in the trailer parking area.
Cargo Handling Equipment (RTGs)	Point	Assumed 10% of the total emissions from RTGs occurred at the crane maintenance area and the remaining emissions occurred in the areas around the unloading tracks.
Heavy Equipment (idling and traveling)	Point or Volume	<u>Taylor Forklifts</u> – assumed all operation occurred in the RTG maintenance area. <u>Man Lift</u> – assumed all operation occurred in the RTG maintenance area. <u>Grove Crane and Forklift – were modeled as yard-wide sources.</u>
TRUs and Reefer Cars	Volume	Assumed all emissions from TRUs and reefer cars occurred in the trailer parking area
Gasoline-Fueled Yard Trucks	Volume	Yard trucks were modeled as yard-wide sources.

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources ICTF and Dolores Rail Yards 2005 Baseline Year		
Source	Source Treatment	Assumptions for Spatial Allocation of Emissions
I.C. Engines	Point (Emer. Gen.) Volume (Air Comp.)	Emergency Generator – emissions from the emergency generator were modeled at the ICTF Administration Building Area. Air Compressor – was treated as a yard-wide source.
Storage Tanks	Point	Emissions from storage tanks were modeled at the actual tank locations.
Refueling Operations	Point	Emissions from refueling operations were modeled at the associated tank locations.
WWTP	Point	Emissions from the WWTP were modeled at the actual WWTP location.
Steam Cleaners	Volume	Emissions from steam cleaners were modeled in the area around the Dolores locomotive shop.
Natural Gas-Fired Heater	Point	Emissions from the heater were modeling at the ICTF Administration Building.
Propane Fueled Welder	Volume	Emissions from the propane-fueled welder were modeled at the Dolores locomotive shop.
Misc. Gasoline-Fueled Equipment	Volume	Emissions from one welder, the pressure washer, and the generator were modeled at the Crane Maintenance area. Emissions from the remaining 4 welders and 2 air compressors were modeled as ICTF yard-wide sources.
Worker Vehicles	Volume	Emissions from worker vehicles were modeled as yard-wide sources.

APPENDIX R

SEASONAL AND DIURNAL ACTIVITY PROFILES

Appendix R

Development of Temporal Activity Profiles for the UPRR ICTF and Dolores Yards

Locomotive activity can vary by time of day and season. For each yard, the number of trains arriving and departing from the yard in each month and each hour of the day was tabulated and used to develop temporal activity profiles for modeling. The number of locomotives released from service facilities in each month was also tabulated. The AERMOD EMISFACT SEASHR option was used to adjust emission rates by season and hour of the day, and the EMISFACT SEASON option was used where only seasonal adjustments were applied. Where .hour of day adjustments (but not seasonal) were applied, the EMISFACT HROFDY option was used.

Time of day profiles for train idling activity were developed assuming that departure events involved locomotive idling during the hour of departure and the preceding hour, and that arrival events involved locomotive idling during the hour of arrival. Thus, the hourly activity adjustment factor for hour *i* is given by

$$\frac{NA(j) + \sum_{j=i-1}^{i} ND(j)}{\sum_{j=1}^{24} (NA(j) + 2 \cdot ND(j))} \quad ,$$

where *NA(j)* and *ND(j)* are respectively the number of arriving and departing trains in hour *j*. These factors were applied to both idling on arriving and departing trains and idling in the service area (if applicable).

Similarly, time of day profiles for road power movements in the yard (arrivals, departures, and power moves) were developed without including arrivals in preceding hours and departures in subsequent hours. In this case, the hourly activity adjustment factor for hour *i* is given by

$$\frac{NA(i) + ND(i)}{\sum_{j=1}^{24} (NA(j) + ND(j))} \quad .$$

Seasonal adjustment factors are calculated as the sum of trains arriving and departing in each three month season, divided by the total number of arrivals and departures for the year. The hourly adjustment factors for each season are simply the product of the seasonal adjustment factor and the 24 hourly adjustment factors.

For yards with heavy duty truck and cargo handling activities related to rail traffic, seasonal train activity adjustments were applied, but not hour of day adjustments. Temporal profiles for yard switching operations were based on hourly (but not seasonal) factors developed from the operating shifts for the individual yard switching jobs. In some cases, locomotive load testing diurnal profiles were developed based on the specific times of day when load testing is conducted.

Table V-1 lists the hourly activity factors derived for train movements, train and service idling, and yard switching at the UPRR ICTF and Dolores Yards. Separate temporal profiles are listed for day and night moving emissions as different volume source parameters are used for day and night. Table V-2 lists the seasonal activity factors for train and service activity.

Table V-1. Hourly Activity Factors for Train Activity at the UPRR ICTF and Dolores Yards

Hour	Train and Service Idling	Train Movements (Daytime)	Train Movements (Nighttime)	Yard Switching (Daytime(	Yard Switching (Nighttime)
1	0.831	0.000	0.778	0.000	1.000
2	0.805	0.000	0.796	0.000	1.000
3	0.724	0.000	0.787	0.000	1.000
4	0.834	0.000	0.934	0.000	1.000
5	0.989	0.000	0.952	0.000	1.000
6	1.137	0.000	1.135	0.000	1.000
7	1.077	0.961	0.000	1.000	0.000
8	1.095	1.010	0.000	1.000	0.000
9	1.024	0.890	0.000	1.000	0.000
10	1.238	1.082	0.000	1.000	0.000
11	1.247	0.831	0.000	1.000	0.000
12	1.301	1.547	0.000	1.000	0.000
13	1.043	1.194	0.000	1.000	0.000
14	0.949	1.113	0.000	1.000	0.000
15	0.828	0.854	0.000	1.000	0.000
16	0.836	0.943	0.000	1.000	0.000
17	0.724	0.715	0.000	1.000	0.000
18	0.711	0.769	0.000	1.000	0.000
19	0.751	0.000	0.679	0.000	1.000
20	1.244	0.000	0.930	0.000	1.000
21	1.424	0.000	1.010	0.000	1.000
22	1.389	0.000	1.873	0.000	1.000
23	0.946	0.000	1.180	0.000	1.000
24	0.851	0.000	1.037	0.000	1.000

Table V-2. Seasonal Activity Factors for the UPRR ICTF and Dolores Yards

Activity Type	Winter	Spring	Summer	Fall
Trains	0.914	1.047	1.052	0.987
Service	1.122	1.101	0.918	0.860

APPENDIX S

SELECTION OF POPULATION FOR THE URBAN OPTION INPUT IN AERMOD AIR DISPERSION MODELING ANALYSIS

Appendix S

Selection of Population for the Urban Option Input in AERMOD Air Dispersion Modeling Analysis

Urban heat islands and the thermal domes generated by them extend over an entire urbanized area[1]. Hot spots within the urban heat island are associated with roads and roofs, which surround each Union Pacific (UP) rail yard in high density. Following guidance cited by the ARB ("*For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source.*"), it is the entire metropolitan area that contributes to the urban heat island plume affecting the rail yard. For metropolitan areas containing substantial amounts of open water, the area of water should not be included.

To simulate the effect of the urban heat island on turbulence in the boundary layer, especially at night, when the effect is substantial, AERMOD adjusts the height of the nighttime urban boundary layer for the heat flux emitted into the boundary layer by the urban surface, which is warmer than surrounding rural areas[2,3]. The difference between the urban and rural boundary layer temperatures is proportional to the maximum temperature difference of 12 Celsius degrees observed in a study of several Canadian cities, and directly related to the logarithm of the ratio of the urban population to a reference population of 2,000,000 (i.e., Montreal, the Canadian city with the maximum urban-rural temperature difference)[4].

The adjusted height of the nocturnal urban boundary layer is proportional to the one-fourth power of the ratio of the population of the city of interest to the reference population, based on the observation that the convective boundary layer depth is proportional to the square root of the city size, and city size is roughly proportional to the square root of its population, assuming constant population density[5]. Regardless of wind direction during any specific hour used by AERMOD, it is the entire metropolitan area, minus bodies of water, which moves additional heat flux into the atmosphere and affects its dispersive properties, not just the 400 km^2 area of the air dispersion modeling domain that surrounds the each rail yard, which was chosen purely for modeling convenience.

Continuing to follow the guidance cited by the ARB ("*If this approach results in the identification of clearly defined MSAs, then census data may be used as above to determine the appropriate population for input to AERMOD"),* the population of each Metropolitan Statistical Area is being used in the modeling run for each rail yard.

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[1] USEPA. *Thermally-Sensed Image of Houston*, http://www.epa.gov/heatisland/pilot/houston_thermal.htm, included in Heat Island Effect website, http://www.epa.gov/heatisland/about/index.html, accessed November 8, 2006.
[2] USEPA. *AERMOD: Description of Model Formulation,* Section 5.8 – Adjustments for the Urban Boundary Layer, pages 66-67, EPA-454/R-03-004, September 2004, accessed at http://www.epa.gov/scram001/7thconf/aermod/aermod_mfd.pdf on November 9,
[3] Oke, T.R. *City Size and the Urban Heat Island,* Atmospheric Environment, Volume 7, pp. 769-779, 1973.
[4] Ibid for References 3 and 4.
[5] Ibid.

APPENDIX T

DEMOGRAPHIC DATA

Appendix T

Population Shape Files for UPRR Rail Yards

The accompanying shape files include census boundaries as polygons and the corresponding residential populations from the 2000 U.S. Census. Separate shape files are included at the tract, block group, and block levels. The primary ID for each polygon begins with *ssccctttttt*, where *ss* is the FIPS state code (06 for California), *cc* is the county code, and *tttttt* is the tract code. The primary IDs for block groups have a single additional digit which is the block group number within each tract. Those for blocks have four additional digits identifying the block number. The population for each polygon are included as both the secondary ID and as attribute 1. Polygon coordinates are UTM zone 10 (Oakland and Stockton) or 11 (southern California yards), NAD83, in meters. The files contain entire tracts, block groups, or blocks that are completely contained within a specified area. For all yards except Stockton, the area included extends 10 kilometers beyond the 20 x 20 kilometer modeling domains. For Stockton, this area was extended to 20 kilometers beyond the modeling domain boundaries to avoid excluding some very large blocks.

In merging the population data[1] with the corresponding boundaries[2], it was noted that at all locations, there are defined census areas (primarily blocks, but in some cases block groups and tracts) for which there are no population records listed in the population files. Overlaying these boundaries on georeferenced aerial photos indicates that these are areas that likely have no residential populations (e.g., industrial areas and parks). The defined areas without population data have been excluded from these files. Areas with an identified population of zero have been included. It was also observed that some blocks, block groups and tracts with residential populations cover both residential areas and significant portions of the rail yards themselves. For this reason, any analysis of population exposures based on dispersion modeling should exclude receptors that are within the yard boundaries or within 20 meters of any modeled emission source locations.

To facilitate the exclusion of non-representative receptors, separate shape files have been generated that define the area within 20 meters of the yard boundaries for each yard. These files are also included with the accompanying population files. It should also be noted that the spatial extent of individual polygons can vary widely, even within the same type. For example, single blocks may be as small as 20 meters or as large as 10,000 meters or more in length. To estimate populations contained within specific areas, it may prove most useful to generate populations on a regular grid (e.g., 250 x 250 m cells) rather than attempting to process irregularly shaped polygons.

[1] Population data were extracted from the *Census 2000 Summary File 1* DVD, issued by the U.S. Department of Commerce, September 2001.
[2] Boundaries were extracted from ESRI shapefiles (*.shp) created from the U.S. Census TIGER Line Files downloaded from ESRI (*http://arcdata.esri.com/data/tiger2000/tiger_download.cfm*).