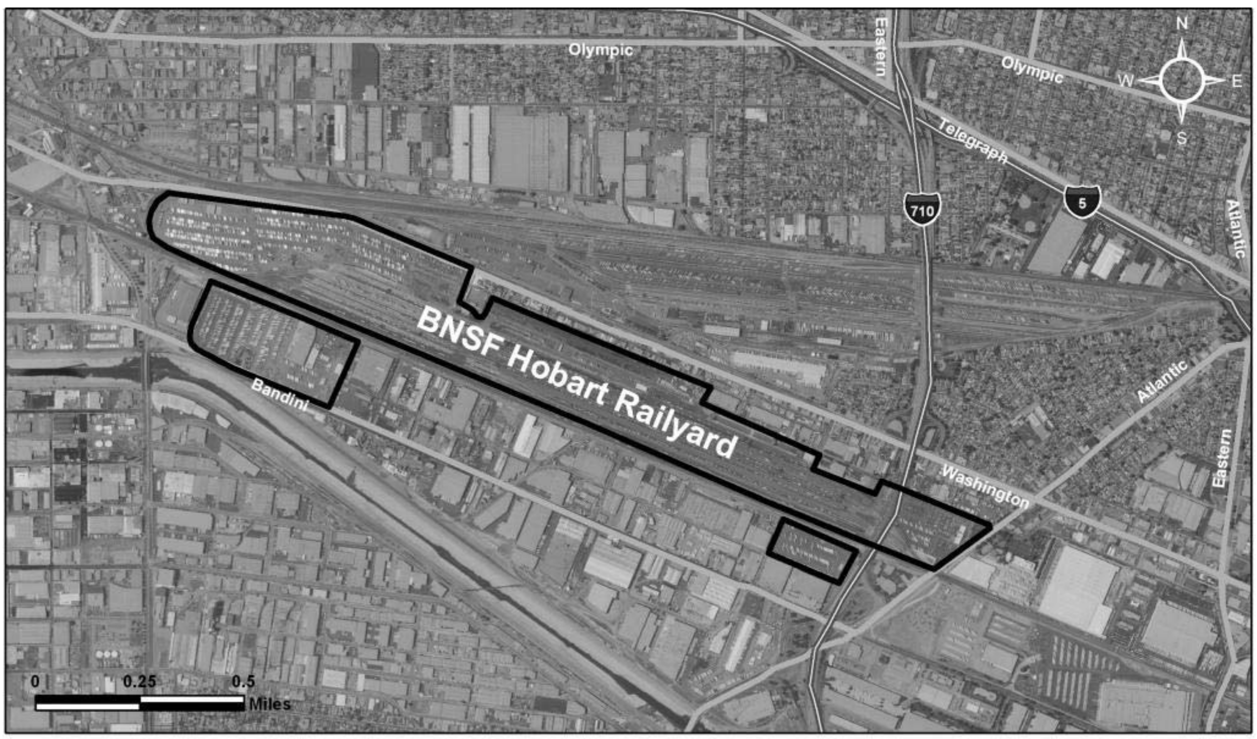
California Environmental Protection Agency

Air Resources Board

Health Risk Assessment for the BNSF Railway Hobart Railyard



Stationary Source Division

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California Environmental Protection Agency

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

APPENDICES

I. INTRODUCTION

The California Air Resources Board (ARB or Board) conducted a health risk assessment study to evaluate the health impacts associated with toxic air contaminants emitted in and around the BNSF Railway's (BNSF) Hobart Railyard located in Commerce, California. The study focused on the railyard property emissions from locomotives, on-road trucks, and off-road vehicles and equipment used to move bulk cargo. Also evaluated were mobile and stationary sources with significant emissions surrounding the BNSF Hobart Railyard. There are four railyards located in the city of Commerce (Union Pacific Commerce, BNSF Hobart, BNSF Commerce/Eastern, BNSF Sheila/Mechanical railyards). In order to cover the zone of significant health impacts associated with emissions from all of the four railyards in Commerce, ARB staff chose to analyze the significant emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards.

In addition, ARB staff prepared a separate report to provide the cumulative analysis for all of the four Commerce railyards.

A. Why is ARB concerned about diesel PM emissions?

In 1998, following a 10-year scientific assessment process, ARB identified particulate matter from diesel exhaust (diesel PM) as a toxic air contaminant based on its potential to cause cancer and other adverse health problems, including respiratory illnesses, and increased risk of heart disease. Population-based studies in numerous cities in the U.S. and around the world demonstrate a strong link between elevated particulate matter levels and premature deaths[*] (Pope et al., 1995, 2002 and 2004; Krewski et al., 2000), increased hospitalizations for respiratory and cardiovascular causes, asthma and other lower respiratory symptoms, acute bronchitis, work loss days, and minor restricted activity days. Many of these studies have linked the health effects to diesel PM either separately or as a component of ambient air (ARB, 2006a). Subsequent research has shown that diesel PM contributes to premature death. Diesel particles are very small. Approximately 94 percent of the mass of these particles are less than 2.5 microns in diameter ($PM_{2.5}$). Because of their tiny size, diesel PM is readily respirable and can penetrate deep into the lung and enter the bloodstream, carrying with them an array of toxins. Therefore, exposure to diesel PM is a health hazard, particularly to children whose lungs are still developing and the elderly who may have other serious health problems.

Diesel PM emissions typically are the dominant toxic air contaminant in and around a railyard facility. Diesel PM typically accounts for about 70% of the states' estimated potential ambient air toxic cancer risks. This estimate is based on data from ARB's ambient monitoring network in 2000 (ARB, 2000). These findings were consistent with that of the study conducted by South Coast Air Quality Management District: Multiple Air

[*] Premature Death: as defined by U.S. Center for Disease Control and Prevention's Years of Potential Life Lost, any life ended before age 75 is considered as premature death.

Toxics Exposure Study in the South Coast Air Basin (SCAQMD, 2000). Based on these scientific research findings, the health impacts in this study primarily focus on the risks from the diesel PM emissions.

B. Why evaluate diesel PM emissions at the BNSF Hobart Railyard?

In 2005, the ARB entered into a statewide railroad pollution reduction agreement (Agreement) with BNSF Railway Company (BNSF) and Union Pacific Railroad Company (UP) (ARB, 2005). This Agreement was developed to implement near term measures to reduce diesel PM emissions in and around California railyards by approximately 20 percent.

The Agreement requires that health risk assessments be prepared for each of the 17 major or designated railyards in the State. The Agreement requires the railyard HRAs to be prepared based on ARB's experience in preparing the UP Roseville Railyard HRA study in 2004, and the *ARB Health Risk Assessment Guidance for Railyard and Intermodal Facilities* that the ARB staff developed in 2006 (available at http://www.arb.ca.gov/railyard/hra/hra.htm) (ARB, 2006b). The BNSF Hobart Railyard is one of the designated railyards subject to the Agreement and the HRA requirements.

C. What are Health Risk Assessments?

A health risk assessment (HRA) uses mathematical models to evaluate the health impacts from exposure to certain chemical or toxic air contaminants released from a facility or found in the air. HRAs provide information to estimate potential long term cancer and non-cancer health risks. HRAs do not gather information or health data on specific individuals, but are estimates for the potential health impacts on a population at large.

An HRA consists of three major components: the air pollution emission inventory, the air dispersion modeling, and an assessment of associated health risks. The air pollution emission inventory provides an understanding of how the air toxics are generated and emitted. The air dispersion modeling takes the emission inventory and meteorology data such as temperature and wind speed/direction as its inputs, then uses a computer model to predict the distributions of air toxics in the air. Based on this information, an assessment of the potential health risks of the air toxics to an exposed population is performed. The results are expressed in a number of ways as summarized below.

- For potential cancer health effects, the risk is usually expressed as the number of chances in a population of a million people. The number may be stated as "10 in a million" or "10 chances per million". The methodology used to estimate the potential cancer risks is consistent with the Tier-1 analysis of *Air Toxics Hot Spots Program Risk Assessment Guidelines* (OEHHA, 2003). A Tier-1 analysis assumes that an individual is exposed to an annual average concentration of a given pollutant continuously for 70 years. The length of time that an individual is exposed to a given air concentration is proportional to the risk. Children, however, are impacted more during the childhood period. Exposure duration of 30 years or 9 years may also be evaluated as supplemental information to present the range of cancer risk based on residency period.

- For non-cancer health effects, a reference exposure level (REL)[†] is used to predict if there will be certain identified adverse health effects, such as lung irritation, liver damage, or birth defects. These adverse health effects may happen after chronic (long-term) or acute (short-term) exposure. To calculate a non-cancer health risk number, the reference exposure level is compared to the concentration that a person is exposed to and a "hazard index" (HI) is calculated. Typically, the greater the hazard index is above 1.0, the greater the potential for possible adverse health effects. If the hazard index is less than 1.0, then it is an indicator that adverse effects are less likely to happen.

- For premature deaths linked to diesel PM emissions in the South Coast Air Basin, ARB staff estimated about 1,300 premature deaths per year due to diesel exhaust exposure in 2000 (ARB Research Division, and Lloyd and Cackette, 2001). The total diesel PM emission from all sources in the South Coast Air Basin is about 7,750 tons per year in 2005 (ARB, 2006c). Diesel PM emissions in 2005 from the BNSF Hobart Railyard are estimated at about 23 tons per year, which is about 0.3% of total air basin emissions. For comparison with another major source of diesel PM emissions in the South Coast Air Basin, the combined diesel PM emissions from the Port of Los Angeles/Port of Long Beach were estimated to be about 1,760 tons per year, which resulted in an estimated 29 premature deaths per year (ARB, 2006d).

The potential cancer risk from a given carcinogen estimated from the health risk assessment is expressed as the incremental number of potential cancer cases that could be developed per million people, assuming the population is exposed to the carcinogen at a constant annual average concentration over a presumed 70-year lifetime. For example, if the cancer risk were estimated to be 100 chances per million, the probability of an individual developing cancer would not be expected to exceed 100 chances in a million. If a population (e.g., one million people) were exposed to the same potential cancer risk (e.g., 100 chances per million), then statistics would predict that no more than 100 of those million people exposed would be likely to develop cancer from a lifetime of exposure (i.e., 70 years) due to diesel PM emissions from a facility.

[†] The Reference Exposure Level (REL) for diesel PM is essentially the U.S. EPA Reference Concentration first developed in the early 1990s based on histological changes in the lungs of rats. Since the identification of diesel PM as a Toxic Air Contaminant (TAC), California has evaluated the latest literature on particulate matter health effects to set the Ambient Air Quality Standard. Diesel PM is a component of particulate matter. Health effects from particulate matter in humans include illness and death from cardiovascular and respiratory disease, and exacerbation of asthma and other respiratory illnesses. Additionally, a body of literature has been published, largely after the identification of diesel PM as a TAC and adoption of the REL, which shows that diesel PM can enhance allergic responses in humans and animals. Thus, it should be noted that the REL does not reflect adverse impacts of particulate matter on cardiovascular and respiratory disease and deaths, exacerbation of asthma, and enhancement of allergic response.

HRA is a complex process that is based on current knowledge and a number of assumptions. However, there is a certain extent of uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas necessitating the use of assumptions. The assumptions used in the assessments are often designed to be conservative on the side of health protection in order to avoid underestimation of risk to the public. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities but more as a tool for comparison of the relative risk between one facility and another. In addition, the HRA results are best used to compare potential risks to target levels to determine the level of mitigation needed. They are also an effective tool for determining the impact a particular control strategy will have on reducing risks.

OEHHA is in the process of updating the current health risk assessment guidelines, and the ARB and UP and BNSF agreed to evaluate the non-cancer health impacts using an interim methodology. This was used in the Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach (ARB, 2006d) to estimate PM mortality. This will serve as a short-term and interim effort until OEHHA can complete its update of the Guidelines.

As soon as the HRAs are final, both the ARB and Railroads in cooperation with the SCAQMD staff, local citizens and others will begin a series of meetings to identify and implement measures to reduce emissions from railyard sources. Existing effects are detailed in Chapter III-C.

D. Who prepared the BNSF Hobart Railyard HRA?

Under the Agreement, ARB worked with the affected local air quality management districts, communities, cities, counties, and the two railroads to develop two guideline documents for performing the health risk assessments. The two documents, entitled *ARB Rail Yard Emissions Inventory Methodology* (ARB, 2006e), and *ARB Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b), provide guidelines for the identification, modeling, and evaluation of the toxic air contaminants from Designated Railyards throughout California.

Using the guidelines, the railroads and their designated consultants (i.e., ENVIRON International for the BNSF Hobart Railyard) developed the emission inventories and performed the air dispersion modeling for operations that occurred within each of the designated railyards. The base year of the analysis was 2005.

ARB staff was responsible for reviewing and approving the railroads' submittals, identifying significant sources of emissions near the railyards and modeling the impacts of those sources, and preparing the railyard health risk assessments. ARB staff was also responsible for releasing the draft HRAs to the public for comment and presenting them at community meetings. After reviewing public comments on the draft HRAs, ARB staff made revisions as necessary and appropriate, and is now presenting the HRAs in final form. Ultimately, the information derived from the railyard HRAs are to be used to help identify the most effective mitigation measures that could be implemented to further reduce railyard emissions and public health risks.

E. How is this report structured?

The next chapter provides a summary of the BNSF Hobart Railyard operations, emissions, air dispersion modeling, and health risk assessment results. Following the summary, the third chapter presents the details of the BNSF Hobart Railyard emission inventories. After that, the fourth chapter explains how the air dispersion modeling was conducted, and the fifth chapter provides the detailed health risk assessment for the BNSF Hobart Railyard. The appendices present the technical supporting documents for the analyses discussed in the main body of the report.

II. SUMMARY

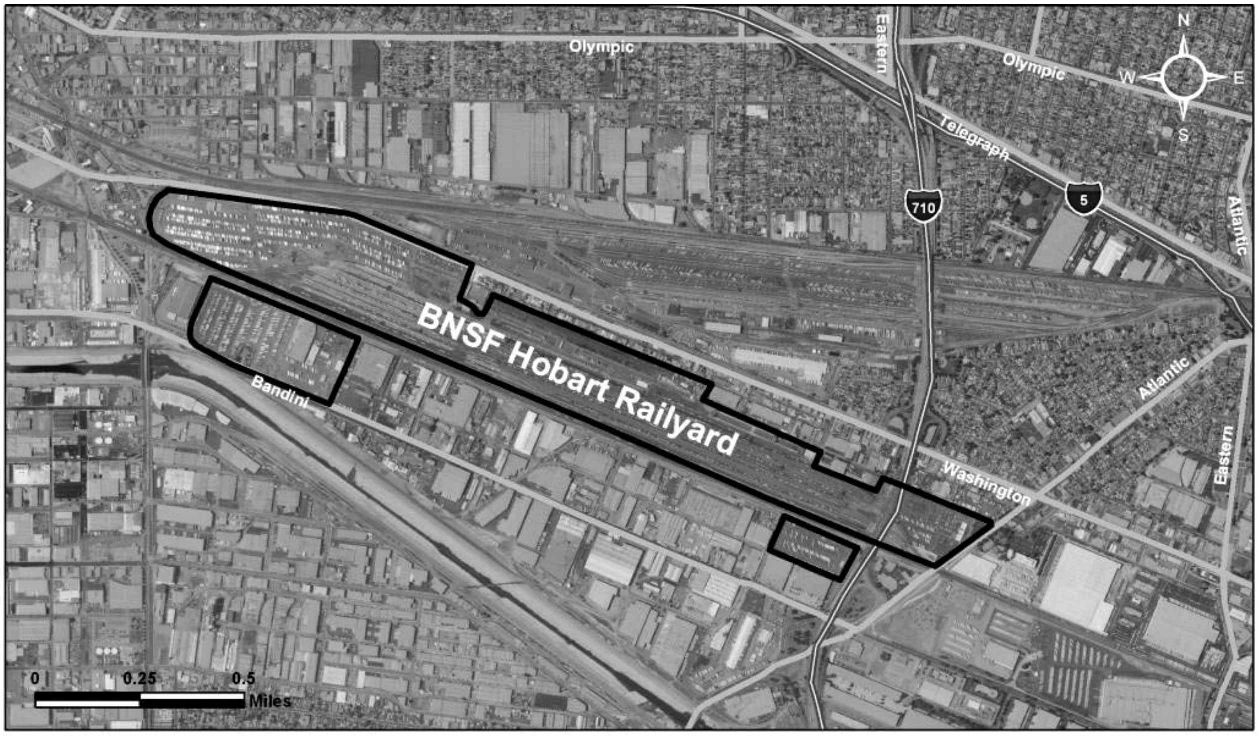
Below is a summary of the BNSF Hobart Railyard operations, emissions, air dispersion modeling, and health risk assessment results.

A. General Description of the BNSF Hobart Railyard and the Surrounding Areas

The BNSF Hobart Railyard is located at 3770 East Washington Boulevard in Commerce, California, approximately 4 miles southeast of downtown Los Angeles (see Figure II-1). It is located in a commercial and manufacturing area with several residential areas located within one mile. The BNSF Hobart Railyard is bordered by East Washington Boulevard and Sheila Street to the north, South Atlantic Boulevard to the east, the adjacent main line and East 26th Street to the south, and South Downey Road to the west. The eastern end of the BNSF Hobart Railyard is bisected by the I-710 freeway. Hobart is also located within three miles of five other major roadways, including: I-5 and Highway 60 to the north, I-110 to the west, and I-10 and Highway 101 to the northwest. The UP Commerce Railyard is located to the north of the BNSF Hobart Railyard on the other side of East Washington Boulevard.

The BNSF Hobart Railyard generally runs from the northwest to the southeast and consists of a locomotive classification yard, intermodal areas, and administration and equipment maintenance buildings. The railyard also includes two satellite areas used for container storage and located across East 26th Street at the southwest and southeast ends of the railyard, as shown in Figure II-1. The adjacent main line located just to the south of the BNSF Hobart Railyard is used for commuter rail (both Amtrak and Metrolink) and freight services. This segment of the adjacent main line is included in the emission inventory and air dispersion modeling analysis.

Figure II-1: BNSF Hobart Railyard and Surrounding Areas



B. What are the primary operations at the BNSF Hobart Railyard?

BNSF Hobart Railyard is the largest intermodal railyard in the United States, with a focus on the distribution of international containers. During the period between May 1, 2005 and April 30, 2006, BNSF Hobart Railyard processed approximately 1.2 million containers. Activities at the BNSF Hobart Railyard can be divided into the following operational areas: the adjacent main line, the classification yard, and the intermodal area. The adjacent main line includes arriving-departing line haul locomotives, passing line haul and passenger locomotives, boxcar transportation refrigeration units (TRUs), and track maintenance equipment activities. The classification yard includes locomotive switching, cargo handling equipment, portable engine operations, and track maintenance equipment activities. The intermodal areas includes cargo handling equipment, on-road container truck, on-road fleet vehicle, portable engine, container TRU, and permitted stationary source activities.

During the one-year period, the total number of BNSF line haul locomotives that arrived and departed from the BNSF Hobart Railyard was recorded as 41,945. Adjacent freight movement locomotives operating on the BNSF Hobart mainline were recorded at near 30,000 per year. Adjacent commuter rail operations include Amtrak and Metrolink. Amtrak operated 10,469 trains per year; Metrolink operated 7,280 trains per year, with activity occurring only during weekdays. The switching locomotive operations were estimated at 30,112 hours per year.

C. What are the diesel PM emissions in and around the BNSF Hobart Railyard?

In 2005, the combined diesel PM emissions from the BNSF Hobart railyard (on-site emissions) and other significant emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards (off-site emissions) are estimated at about 137 tons per year, excluding emissions occurring at the other three railyards in the Commerce area. Estimated off-site diesel PM emissions from mobile sources (not generally related to activities at the railyard) are about 113 tons per year, or about 83% of the total combined on-site and off-site diesel PM emissions. Off-site stationary sources contribute less than 400 pounds per year of the diesel PM emissions. The BNSF Hobart railyard diesel PM emissions are estimated at about 24 tons per year, which accounts for about 17% of the total combined on-site and off-site diesel PM emissions.

To provide a perspective on the railyards diesel PM emissions, Table II-1 lists the estimated diesel PM emissions (for the year of 2005) for eleven railyards whose HRAs are completed or planned to be completed at the beginning of 2007. The diesel PM emissions from the BNSF Hobart Railyard rank second among these eleven railyards.

Table II-1: Comparison of Diesel PM Emissions from Eleven Railyards (tons per year)

Railyard	Locomotive	Cargo Handling Equipment	On-Road Trucks	Others (Off-Road Equipment, TRUs, Stationary Sources, etc.)	Total§
UP Roseville*	25.1**	N/A‡	N/A‡	N/A‡	**25.1**
BNSF Hobart	5.9	4.2†	10.1	3.7	**23.9**
UP Commerce	4.9	4.8†	2.0	0.4	**12.1**
UP LATC	3.2	2.7†	1.0	0.5	**7.3**
UP Stockton	6.5	N/A‡	0.2	0.2	**6.9**
UP Mira Loma	4.4	N/A‡	0.2	0.2	**4.9**
BNSF Richmond	3.3	0.3	0.5	0.6	**4.7**
BNSF Stockton	3.6	N/A‡	N/A‡	0.02	**3.6**
BNSF Commerce Eastern	0.6	0.4	1.1	1.0	**3.1**
BNSF Sheila	2.2	N/A‡	N/A‡	0.4	**2.7**
BNSF Watson	1.9	N/A‡	<0.01	0.04	**1.9**

* The UP Roseville Health Risk Assessment (ARB, 2004a) was based on 1999-2000 emission estimate, only locomotive diesel PM emissions were reported in that study.
** The actual emissions were estimated at a range of 22.1 to 25.1 tons per year.
‡ Not applicable.
§ Numbers may not add precisely due to rounding.
† An error of cargo handling equipment emissions was found after the modeling was completed. The applicable change in emissions was believed to be de minimis; consequently, the modeling was notre-performed.

1. Railyard

The BNSF Hobart Railyard emission sources include, but are not limited to, locomotive switching, locomotive line haul, passenger locomotives, cargo handling equipment (CHE), track maintenance equipment, portable engines, on-road fleet vehicles, on-road container trucks, TRUs, and permitted stationary source activities. The facility operates 24 hours a day, 365 days a year. The BNSF Hobart Railyard emissions were calculated on a source-specific and facility-wide basis for the 2005 baseline year. The future growth in emissions at the BNSF Hobart facility is not incorporated in the HRA emission inventory, but will be included as part of the mitigation emission reduction efforts. The methodology used to calculate the diesel PM and other toxic air contaminant (TAC) emissions is based on *ARB Rail Yard Emissions Inventory Methodology* (ARB, 2006e).

As indicated in Table II-2, diesel-fueled on-road vehicles are the largest emission sources at the BNSF Hobart Railyard. Diesel PM emissions from on-road vehicles were estimated at approximately 10 tons per year, which accounted for 43% of the total railyard diesel PM emissions. Of the diesel PM emissions from on-road vehicles, BNSF container trucks contributed the largest amount, at about 9.4 tons per year. Locomotive operations were responsible for 5.9 tons per year of diesel PM emissions, with 3.7 tons generated by line haul locomotives and 2.2 tons generated by switching locomotives, consisting of about 24% of the total railyard diesel PM emissions. Of the diesel PM emissions from line haul locomotives, 2.2 tons were contributed by the BNSF arriving and departing locomotives, the remaining 1.5 tons were contributed by adjacent freight movements and adjacent commuter rail operations. Cargo handling equipment and other off-road equipment (TRUs and track maintenance equipment) produced 18% (4.2 tons per year) and 15% (3.6 tons per year) of the total railyard diesel PM emissions, respectively. Stationary sources generated less than 1% (0.1 tons) of the total railyard diesel PM emissions.

Diesel PM was not the only toxic air contaminant emitted in the BNSF Hobart Railyard. A relatively small amount of gasoline PM and toxic gases were generated from on-road fleet vehicles, portable engines, and track maintenance equipment. Toxic gases were also generated from the gasoline storage and dispensing facility. The gasoline PM emissions were estimated at about 0.007 tons or 14 pounds per year. Other top non-PM TACs (1,3-butadiene, benzene, formaldehyde, and acetaldehyde) emissions were about 0.02 tons or 40 pounds per year, which are much lower compared to the 24 tons per year of the diesel PM emissions in the railyard.

In addition, adjusting these emissions on a cancer potency weighted basis for their toxic potential (see a similar analysis for off-site air toxic contaminants on Table II-3), these non-diesel PM toxic air contaminants have less than a thousandth of the potency weighted emissions as compared to diesel PM (less than 0.01 vs. 24 tons per year). Hence, only diesel PM emissions are presented in the on-site emission analysis.

Table II-2: BNSF Hobart Railyard and Surrounding Areas Diesel PM Emissions

DIESEL PM EMISSION SOURCES	BNSF Hobart Railyard		Off-site Emissions *	
	Tons/Year	Percentage	Tons/Year	Percentage
ON-ROAD VEHICLES	**10.07**	**42%**	-	-
- On-site Container Trucks	9.36	39%		
- Off-site Container Trucks**	0.71	3%		
- Other On-Road Fleet	0.004	< 1%		
LOCOMOTIVES	**5.91**	**25%**	-	-
- Line Haul Locomotives	3.69	15%		
BNSF Arriving/Departing	*2.15*	*9%*	-	-
Adjacent Freight Movements	*1.03*	*4%*	-	-
Commuter Rail Operations	*0.51*	*2%*		
- Switching Locomotives (conducting yard operations)	2.22	9%	-	-
CARGO HANDLING EQUIPMENT	**4.20†**	**18%**	-	-
OTHER OFF-ROAD EQUIPMENT (TRUs and Track Maintenance*)*	**3.61**	**15%**	-	-
STATIONARY SOURCES	**0.10**	**< 1%**		
OFF-SITE MOBILE SOURCES (e.g., trucks, cars, etc.)			**113.2**	**100 %**
OFF-SITE STATIONARY SOURCES (e.g., industry, etc.)			**0.2**	**< 1%**
TOTAL	**23.9**	**100%**	**113.4**	**100%**

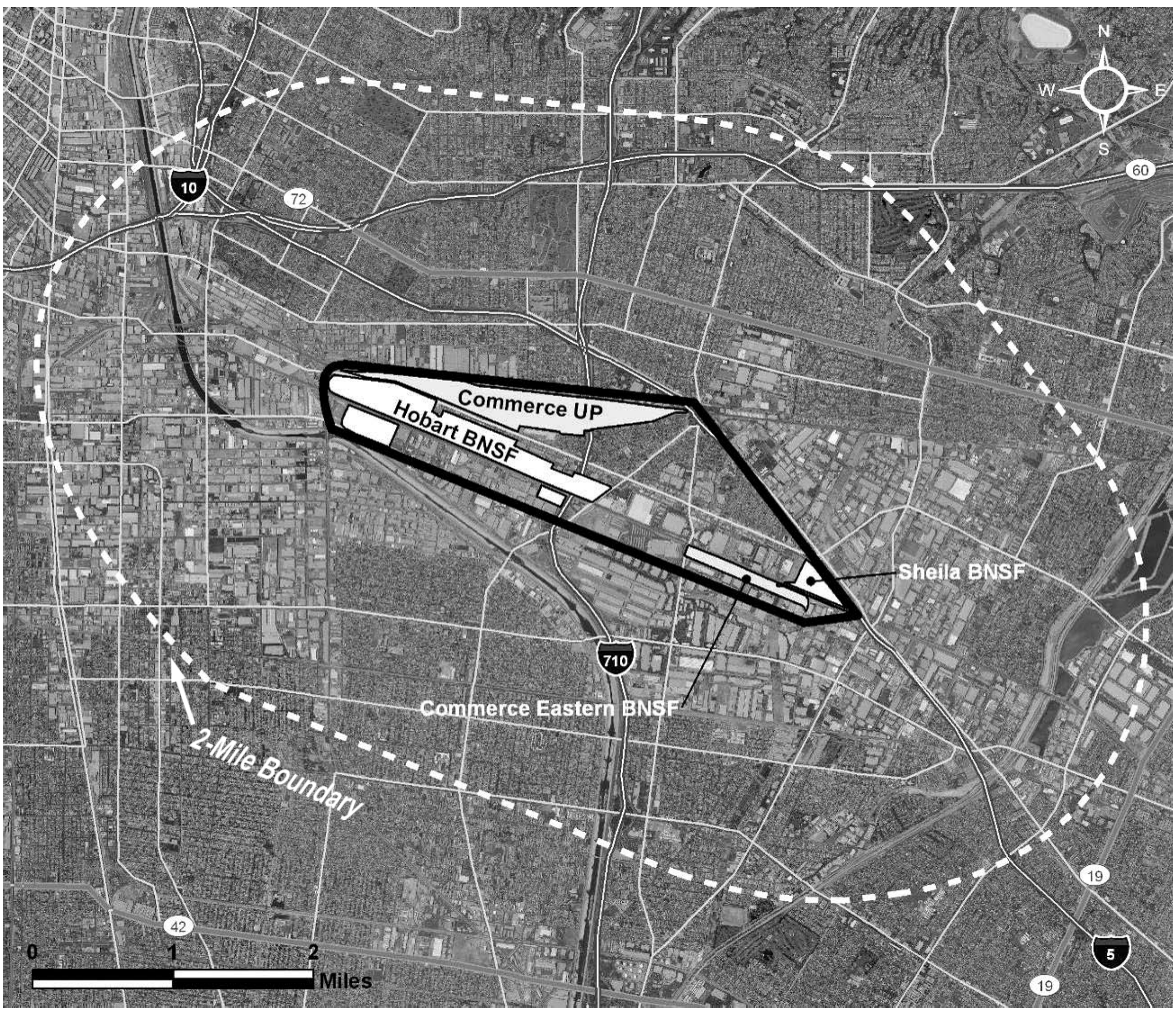
*: Exclude emissions occurring at the other three railyards in the Commerce area.
**: Heavy heavy duty trucks that move empty containers to off-site locations.
† : An error of cargo handling equipment emissions was found after the modeling was completed. The applicable change in emissions was believed to be de minimis; consequently, the modeling was not re-performed.

2. Surrounding Sources

ARB staff evaluated significant mobile and stationary sources of diesel PM emissions surrounding BNSF Hobart Railyard. The Health Risk Assessment study for UP Roseville Railyard (ARB, 2004a) indicated that cancer risk associated with on-site diesel PM emissions is substantially reduced beyond a one-mile distance from the railyard.

Therefore, in most of the railyard HRA studies, ARB staff analyzed the significant diesel PM emission sources within one-mile distance from the railyard property boundary, where on-site emissions have significant health impacts. However, there are four railyards located in the city of Commerce (UP Commerce, BNSF Hobart, BNSF Commerce/Eastern, and BNSF Sheila Mechanical railyards). To cover the zone of significant health impact associated with emissions from all of the four railyards in Commerce, ARB staff chose to analyze the significant emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards, as shown by the dashed outer line in Figure II-2. For the BNSF Hobart Railyard, off-site sources do not include emissions from the other three railyards in the Commerce area.

Figure II-2: Off-Site Two-Mile Joint Boundaries (Dashed Line) of the Four Commerce Railyards



ARB staff analyzed the significant off-site emission sources based on two categories: mobile and stationary. For the off-site mobile sources, the analysis focused on on-road heavy duty diesel trucks, as these are the primary source of diesel PM from the on-road vehicle fleet. ARB staff estimated mobile emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a two-mile distance from the joint boundaries of the four Commerce railyards are included in the analysis. The estimates do not include the diesel PM emissions generated from other modes such as extended idling, starts, and off-road equipment outside the rail yards. Individual sources such as local truck distribution centers and warehouses were not evaluated due to insufficient activity data, but truck traffic related to these facilities is reflected in the roadway link traffic activities. Because the off-site mobile sources have only focused on the on-road diesel emissions, the exclusion of extended idling and off-road equipment may result in an underestimation of off-site mobile sources emissions.

Roadway link: is defined as a discrete section of roadway with unique estimates for the fleet specific population and average speed and is classified as a freeway, ramp, major arterial, minor arterial, collector, or centroid connector.

Emissions from off-site stationary source facilities are identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts for stationary sources within their jurisdiction. The CEIDARS facilities whose locations fell within the two-mile distance from the joint boundaries of the four Commerce railyards are selected. Diesel PM emissions are estimated from stationary internal combustion (IC) engines burning diesel fuel, operating at stationary sources reported in CEIDARS.

Within a two-mile distance from the joint boundaries of the four Commerce railyards, off-site diesel PM emissions are predominantly generated by mobile sources, which emit around 113 tons per year, as indicated by Table II-2. The majority of the off-site diesel PM emissions are from diesel-fueled heavy duty trucks traveling on I-5, I-710, CA-60, I-10 and major local streets. There are some stationary sources that generate less than 400 pounds per year of diesel PM emissions. Three major stationary sources, Los Angeles City Department of General Services, City of Vernon Light & Power Department, and Los Angeles County Sheriff's Department contribute almost 300 pounds per year of the off-site diesel PM emissions. Diesel PM emissions from sources in the BNSF Hobart Railyard and the sources within a two-mile distance from the joint boundaries of the four Commerce railyards are summarized in Table II-2.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the BNSF Hobart Railyard. There are 2,620 stationary toxic air contaminant sources identified within the two-mile distance from the joint boundaries of the four Commerce railyards. The total emissions of toxic air contaminants, other than diesel PM emitted from these stationary sources, were estimated at about 210 tons per year. Over 100 toxic air contaminant species are identified among these emissions, in which ammonia, toluene and methyl chloroform are the three major contributors with emissions estimated at 57, 25, and 24 tons per year, respectively. Not all of these toxic air contaminants are identified as carcinogens. According to ARB' *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000), diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, and formaldehyde are defined as the top 5 potential cancer risk contributors, based on ambient concentrations. These TACs account for 95% of the State's estimated potential cancer risk levels. This study also concluded that diesel PM contributes over 70% percent of the state's estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000). Among the off-site TACs emissions, the top 5 cancer risk contributors (without diesel PM) are estimated at about 1.6 tons per year.

Cancer potency factors (CPF) are expressed as the 95% upper confidence limit of excess cancer cases occurring in an exposed population assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of $(mg/kg\text{-}day)^{-1}$.

The Office of Environmental Health Hazard Assessment (OEHHA) has estimated an inhalation cancer potency factor (CPF) for individual chemicals and some chemical mixtures such as whole diesel exhaust. Diesel PM contains many individual cancer causing chemicals. The individual cancer causing chemicals from diesel exhaust are not separately evaluated so as to avoid double counting. The four compounds listed here are given a weighting factor by comparing each compound's CPF to the diesel PM CPF. This factor is multiplied by the estimated emissions for that compound, which gives the cancer potency weighted toxic emissions as shown in Table II-3. As can be seen in Table II-3, the potency weighted toxic emissions for these TACs are about 0.07 tons per year, which is substantially less than the diesel PM emissions.

Table II-3: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding the BNSF Hobart Railyard

Compound	Cancer Potency Factor	Weighting Factor	Estimated Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	113.2	**113.2**
1,3-Butadiene	0.6	0.55	0.007	**0.0037**
Benzene	0.1	0.09	0.435	**0.0392**
Carbon Tetrachloride[3]	0.15	0.14	0.001	**0.0001**
Formaldehyde	0.021	0.02	1.159	**0.0221**
Total (non-diesel PM)	**-**	**-**	**1.60***	**0.065***

*: Numbers may not add precisely due to rounding.

[3] Very small amount of carbon tetrachloride are emitted today. Ambient concentrations are highly influenced by past emissions due to the long atmospheric life time of this compound.

In addition, ARB staff evaluated the potential cancer risk levels caused by the use of gasoline in the South Coast Air Basin. Table II-4 shows the emissions of four major carcinogen compounds of gasoline exhausts in the South Coast Air Basin in the year of 2005 (ARB, 2006c). As indicated in Table II-4, the potency weighted emissions of these four toxic air contaminants from gasoline sources are estimated at about 816 tons per year, or about 11% of diesel PM emissions in the South Coast Air Basin. If only gasoline-powered vehicles are considered, the potency weighted emissions of these four TACs are estimated at about 438 tons per year, or about 6% of diesel PM emissions in the Basin. Hence, gasoline-powered vehicular sources are not included in the analysis.

Table II-4: Comparison of Major Gasoline-Use Related Toxic Air Contaminants with Diesel PM Emissions in the South Coast Air Basin

Compound	TACs Emissions (tons per year)			
	From All Sources	Potency Weighted*	From Gasoline Vehicles	Potency Weighted*
Diesel PM	7,446	**7,446**	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**17**	314	**3**
Total (non-diesel PM)	10,668	**816**	3,829	**438**

*: Based on cancer potency weighting factors.

D. What are the potential cancer risks from the BNSF Hobart Railyard?

The ARB has developed *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b) to help ensure that the methodologies used in each railyard HRA meet the requirements in the ARB / Railroad Statewide Agreement. The railyard HRA follows *The Air Toxics Hot Spots Program Risk Assessment Guidelines* (OEHHA, 2003) published by the Office of Environmental Health Hazard Assessment (OEHHA), and is consistent with the UP Roseville Railyard Study (ARB, 2004a) performed by ARB staff.

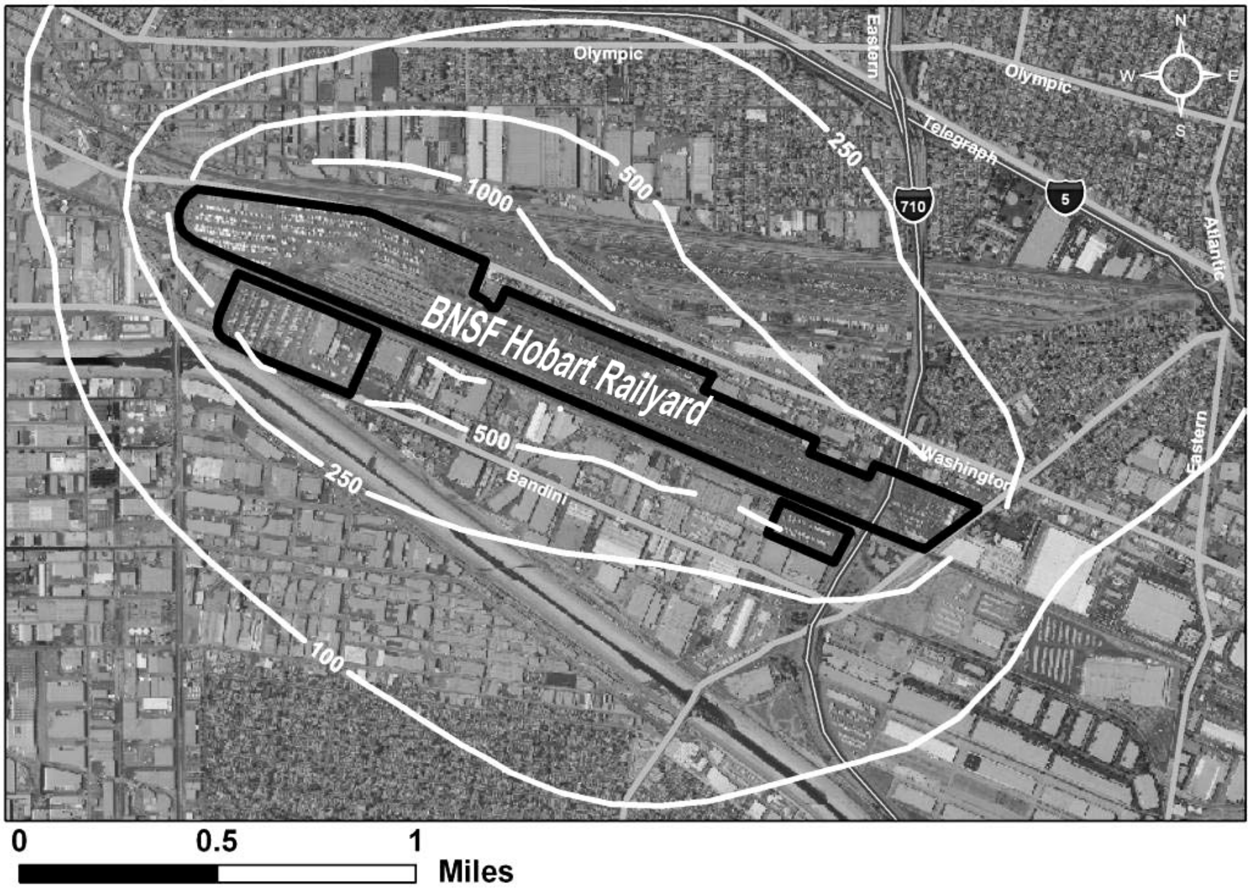
The United States Environmental Protection Agency (U.S. EPA) recently approved a new state-of-the-art air dispersion model called AERMOD (**A**merican Meteorological Society/**E**PA **R**egulatory Model Improvement Committee **MOD**EL). This model is used in the ARB railyard health risk assessments. One of the critical inputs required for the air dispersion modeling is the meteorology, such as wind direction and wind speed. These parameters determine where and how the pollutants will be transported. . Based on the U.S. EPA AERMOD meteorological data selection criteria, four meteorological stations around the BNSF Hobart Railyard were evaluated and the data from the most representative meteorology stations, Lynwood Station operated by South Coast Air Quality Management District (SCAQMD) and University of Southern California (USC) Station operated by National Weather Service (NWS), were selected for the modeling.

> An **isopleth** is a line drawn on a map through all points of equal value of some measurable quantity; in this case, cancer risk.

The potential cancer risk levels associated with the estimated diesel PM emissions at the BNSF Hobart Railyard are displayed by isopleths. In this study, ARB staff elected to present the cancer risk isopleths focusing on risk levels of 10, 25, 50, 100, 250, 500, and 1,000 in a million. Figure II-3 and Figure II-4 present these isopleths. Figure II-3 indicates the potential cancer risk levels of adjacent areas around the railyard and Figure II-4 shows the potential risk impacts over regional areas. In each figure, the risk isopleths are overlaid onto a satellite image of the Commerce area surrounding the BNSF Hobart Railyard, to better illustrate the land use (residential, commercial, industrial, or mixed use) of these impacted areas.

The OEHHA Guidelines specify that for health risk assessments, the cancer risk for the maximum exposure at the point of maximum impact be reported. The point of maximum impact (PMI), which is defined as a location or the receptor point with the highest cancer risk level outside of the railyard boundary, with or without residential exposure, is predicted to be located at the north side of the railyard fence line, near the on-road container truck operation area. This is directly downwind of high emission density areas for the prevailing southwesterly wind, where about 60 percent of facility-wide diesel PM emissions were generated (see the emission allocation in Appendix F). The cancer risk at the PMI is estimated to be about 3,000 chances in a million. The land use in the vicinity of the PMI is primarily zoned for transportation and industrial use. However, there may be residents living in this zoned area. In the residential zoned area, the potential cancer risk of maximally exposed individual resident (MEIR) or maximum individual cancer risk (MICR) is estimated at about 500 chances in a million. As indicated by Roseville Railyard Study (ARB, 2004a), the location of the PMI may vary depending upon the settings of the model inputs and parameters, such as meteorological data set or emission allocations in the railyard. Therefore, given the estimated emissions, modeling settings, and the assumptions applied to the risk assessment, there are great uncertainties associated with the estimation of point of maximum impact (PMI) and maximum individual cancer risk (MICR). These indications should not be interpreted as a literal prediction of disease incidence but more as a tool for comparison. In addition, the estimated point of maximum impact and maximum individual cancer risk may not be replicated by air monitoring.

Figure II-3: Estimated Adjacent Area Potential Cancer Risks (Chances per Million) Associated with the Diesel PM Emissions from the BNSF Hobart Railyard

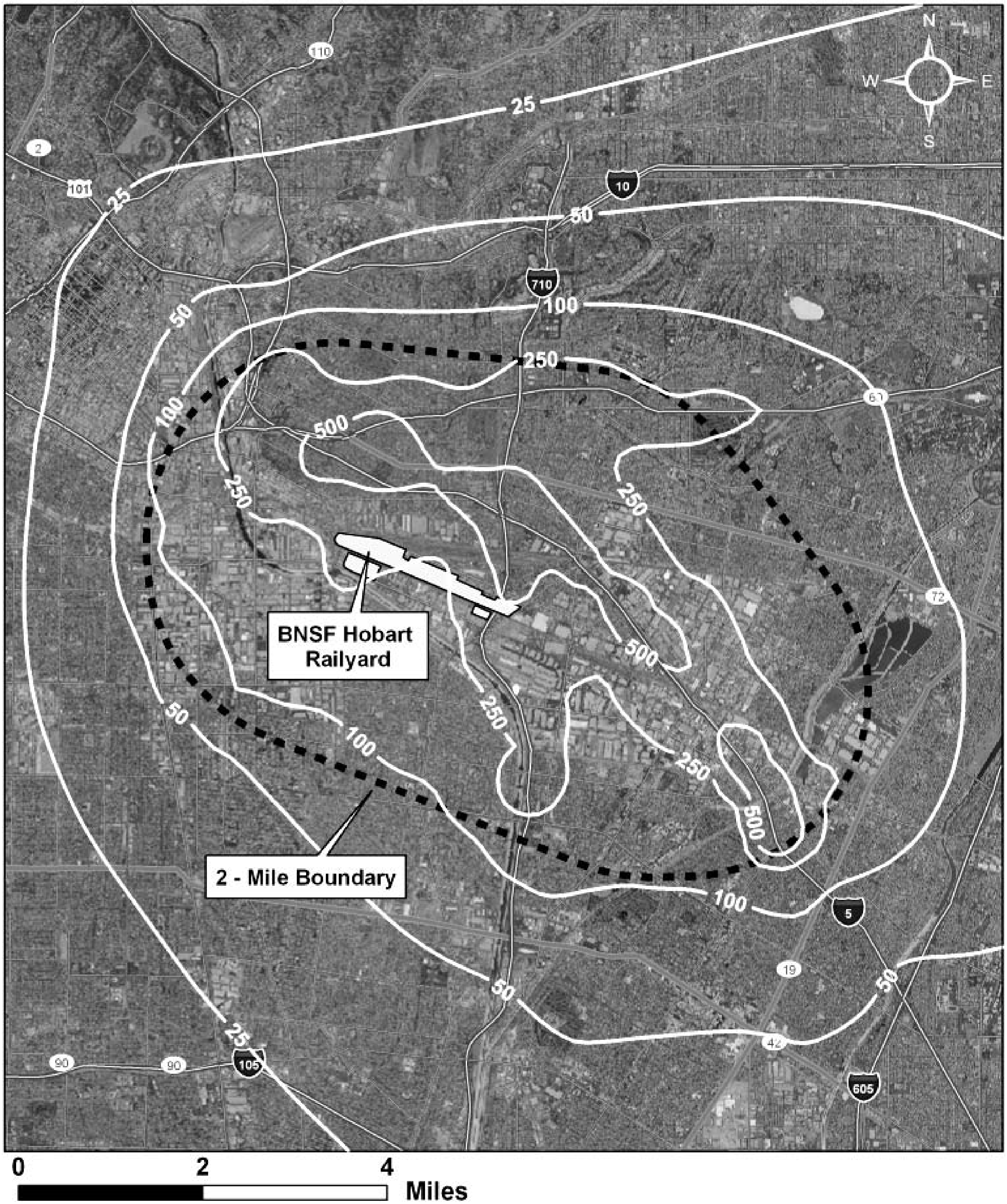


ARB staff also conducted a comparison of cancer risks estimated at the PMI versus MICR, and the differences of facility-wide diesel PM emissions between the UP and BNSF railyards. The ratios of cancer risks at the PMI or MICR to the diesel PM emissions do not suggest that one railroad's facilities have statistically higher cancer risks than the other railroad's or vice versa. Rather, the differences are primarily due to emission spatial distributions from individual operations among railyards.

As indicated in Figure II-3 and Figure II-4, the area with the greatest impact has an estimated potential cancer risk of over 1000 chances in a million, occurring in the area right next to the boundaries of the railyard fence line. The land use of this area is identified as industrial use. Because of the characteristics of meteorology, the ambient diesel PM concentrations become more dispersive northeast of the railyard. The estimated potential cancer risks are about 500 chances in a million at approximately 300 yards (up to 600 yards in the northeast) from the railyard boundaries. The land within this zone is mainly for industrial use; only about 100 residents live within this zone. The estimated potential cancer risks decrease to about 250 at approximately a half mile (up to one mile in the northeast) from the railyard boundaries. Some residential areas are located in the north part of this zone. At about one mile (up to two miles in the northeast) from the railyard boundaries, the estimated potential cancer risks decrease to about 100 chances per million. The estimated potential cancer risks further decrease to 50 in a million at about 1.5 miles (up to 3.5 miles in the northeast) from the railyard boundaries, then to 25 in a million at approximately 2.5 miles (up to 5 miles in the northeast) from the railyard boundaries. At about 4 miles (up to 8 miles in the northeast) from the railyard boundaries, the estimated potential cancer risks are at 10 in a million or lower.

Figure II-4: Estimated Regional Area Potential Cancer Risks (Chances per Million) Associated with the Diesel PM Emissions from the BNSF Hobart Railyard

Figure II-5: Estimated Potential Cancer Risk Levels (Chances per Million) Associated with the Off-Site Diesel PM Emissions



The OEHHA Guidelines recommend a 70-year lifetime exposure duration to evaluate the potential cancer risks for residents. Shorter exposure durations of 30 years and 9 years may be evaluated for residents and school-age children, respectively, as a supplement. These three exposure durations – 70 years, 30 years, and 9 years – all assume exposure for 24 hours a day, and 7 days a week. It is important to note that children, for physiological as well as behavioral reasons, have higher rates of exposure than adults on a per unit body weight basis (OEHHA, 2003).

To evaluate the potential cancer risks for off-site workers, the OEHHA Guidelines recommend that a 40-year exposure duration be used, assuming workers have a different breathing rate (149 L kg^{-1} day^{-1}) and exposure for an 8-hour workday, five days a week, 245 days a year.

Table II-5 shows the equivalent risk levels of 70- and 30-year exposure durations for exposed residents; and 40- and 9-year exposure durations for off-site workers and school-age children, respectively. As shown in Table II-5, the 10 in a million isopleth line in Figure II-4 would become 4 in a million for exposed population with a shorter residency of 30 years, 2.5 in a million for exposed school-age children, and 2 in a million for off-site workers.

To conservatively communicate the risks, ARB staff presents the estimated cancer risk isopleths all based on 70-year resident exposure duration, even for those impacted industrial areas where no resident lives.

Table II-5: Equivalent Potential Cancer Risk Levels for 70-, 40-, 30- and 9-Year Exposure Durations

Exposure Duration (years)	Equivalent Risk Level (chances in a million)					
70	10	25	50	100	250	500
30	4	11	21	43	107	214
9*	2.5	6.3	12.5	25	63	125
40‡	2	5	10	20	50	100

* Exposure duration for school-aged children.
‡ Exposure duration for off-site workers.

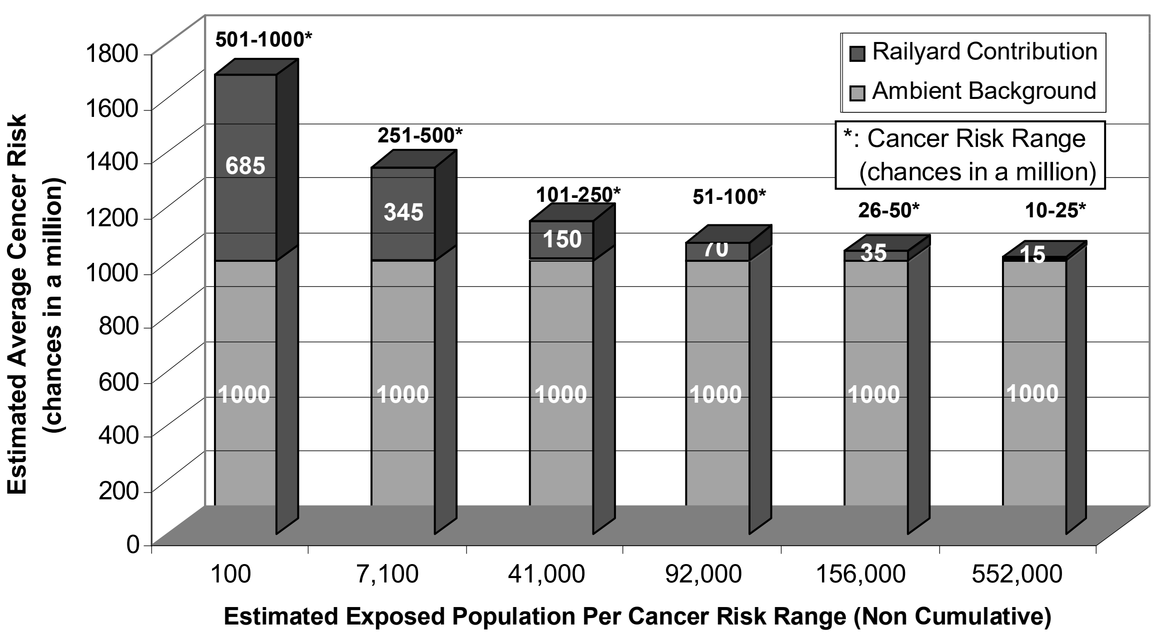
The more populated areas near the BNSF Hobart Railyard are located north and south of the railyard. There is a triangle residential area between the BNSF Hobart Railyard and UP Commerce Railyard. Most part of this triangle area has an estimated potential risk of over 100 chances in a million. Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated risks above 10 chances in a million levels encompasses approximately 51,000 acres where about 848,000 residents live. Table II-6 presents the exposed population and area coverage size for various impacted zones of potential cancer risks.

Table II-6: Impacted Areas and Exposed Population Estimated for the Diesel PM Emissions from the BNSF Hobart Railyard

Estimated Cancer Risk (chances per million)	Impacted Area (acres)	Estimated Population Exposed
10 - 25	33,000	552,000
26 - 50	10,000	156,000
51 - 100	4,700	92,000
101 - 250	2,500	41,000
251 - 500	700	7,100
501 - 1000	270	100
> 1000	70	0

It is important to understand that these risk levels represent the predicted risks (due to the BNSF Hobart Railyard diesel PM emissions) above the existing background risk levels. Although emissions from the railyard also contribute to the regional background, the measurable effect is small. For the broader South Coast Air Basin, the estimated regional background risk level is estimated to be about 1,000 in a million caused by all toxic air pollutants in the year of 2000 (ARB, 2006a). Figure II-6 provides a comparison of the predicted average potential cancer risks in various levels to the regional background risk level and estimated exposed population. For example, in the risk range between 250 and 500 in a million, the average potential cancer risk above the regional background is 345 in a million. Therefore, residents living in that area would have a potential cancer risk of over 1,300 in a million.

Figure II-6: Comparison of Estimated Potential Cancer Risks from the BNSF Hobart Railyard to the Regional Background Risk Levels



E. What are the estimated non-cancer health risks from the BNSF Hobart Railyard?

The potential non-cancer chronic health hazard index (HI) from diesel PM emissions for the residential area around the BNSF Hobart railyard are estimated to be less than 0.5, as shown in Figure II-7. According to OEHHA Guidelines (OEHHA, 2003), these levels indicate that the potential non-cancer chronic public health risks are less likely to happen. A small region right next to the northwest side of the BNSF Hobart Railyard fence line has a HI value over 1.0. The land use of this region is identified as industrial use. Figure II-7 presents the spatial distribution of non-cancer risks by health hazard index isopleths that range from 0.5 to 0.02 around the railyard facility.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute REL. It is only the specific compounds of diesel exhaust (e.g., acrolein) that independently have potential acute effects (such as irritation of the eyes and respiratory tract), and an assigned acute REL. However, acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other compounds in the diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. More importantly, given the multitude of activities ongoing at facilities as complex as railyards, there is a much higher level of uncertainty associated with maximum hourly-specific emission data, which is essential to assess acute risk. Therefore, non-cancer acute risk is not addressed quantitatively in this study. From a risk management perspective, ARB staff believes it is reasonable to focus on diesel PM cancer risk because it is the predominant risk driver and the most effective parameter to evaluate risk reduction actions. Further, actions to reduce diesel PM will also reduce non-cancer risks.

F. What are the estimated health risks from off-site emissions?

ARB staff evaluated the health impacts from off-site pollution sources near the BNSF Hobart railyard facility using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM emission sources located within a two-mile distance from the joint boundaries of the four Commerce railyards were included. Diesel PM off-site emissions used in the off-site modeling runs consisted of about 113.2 tons per year from roadways and about 0.2 tons per year from stationary facilities, representing emissions for 2005. The diesel PM emissions from the BNSF Hobart Railyard and the other three railyards operating in the city of Commerce are not analyzed in the off-site air dispersion modeling. The estimated potential cancer risks and non-cancer chronic health hazard index associated with off-site diesel PM emissions are illustrated in Figure II-5 and Figure II-8, respectively. As indicated in Figure II-5, the zone of impacts of estimated cancer risks associated with off-site diesel PM emissions is significantly larger than that of the BNSF Hobart Railyard. This result is expected because the diesel PM emissions from the significant off-site sources are equivalent to five times the BNSF Hobart Railyard diesel PM emissions.

Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated potential cancer risks above 100 cases in a million levels associated with off-site diesel PM emissions encompasses approximately 28,000 acres where about 430,000 residents live. For comparison with the BNSF Hobart Railyard health risks, the same level of potential cancer risks (100 cases in a million) associated with railyard diesel PM emissions covers about 3,700 acres with a population of approximately 48,000.

Table II-7 presents the exposed population and area coverage size for various impacted zones of cancer risks associated with off-site diesel PM emissions.

Table II-7: Impacted Areas and Exposed Population Estimated for the Off-Site Diesel PM Emissions

Estimated Cancer Risk (chances per million)	Impacted Area (acres)	Estimated Population Exposed
10 - 25	126,000*	650,000*
26 - 50	25,420*	529,000*
51 - 100	18,070*	303,000*
101 - 250	17,350	285,000
251 - 500	8,610	100,000
>500	2,330	45,000

*: Approximate estimates due to partial of these isopleths extend beyond the air dispersion model domain

Figure II-7: Estimated Potential Non-Cancer Chronic Health Risks (Indicated as Hazard Indices) Associated with the Diesel PM Emissions from the BNSF Hobart Railyard

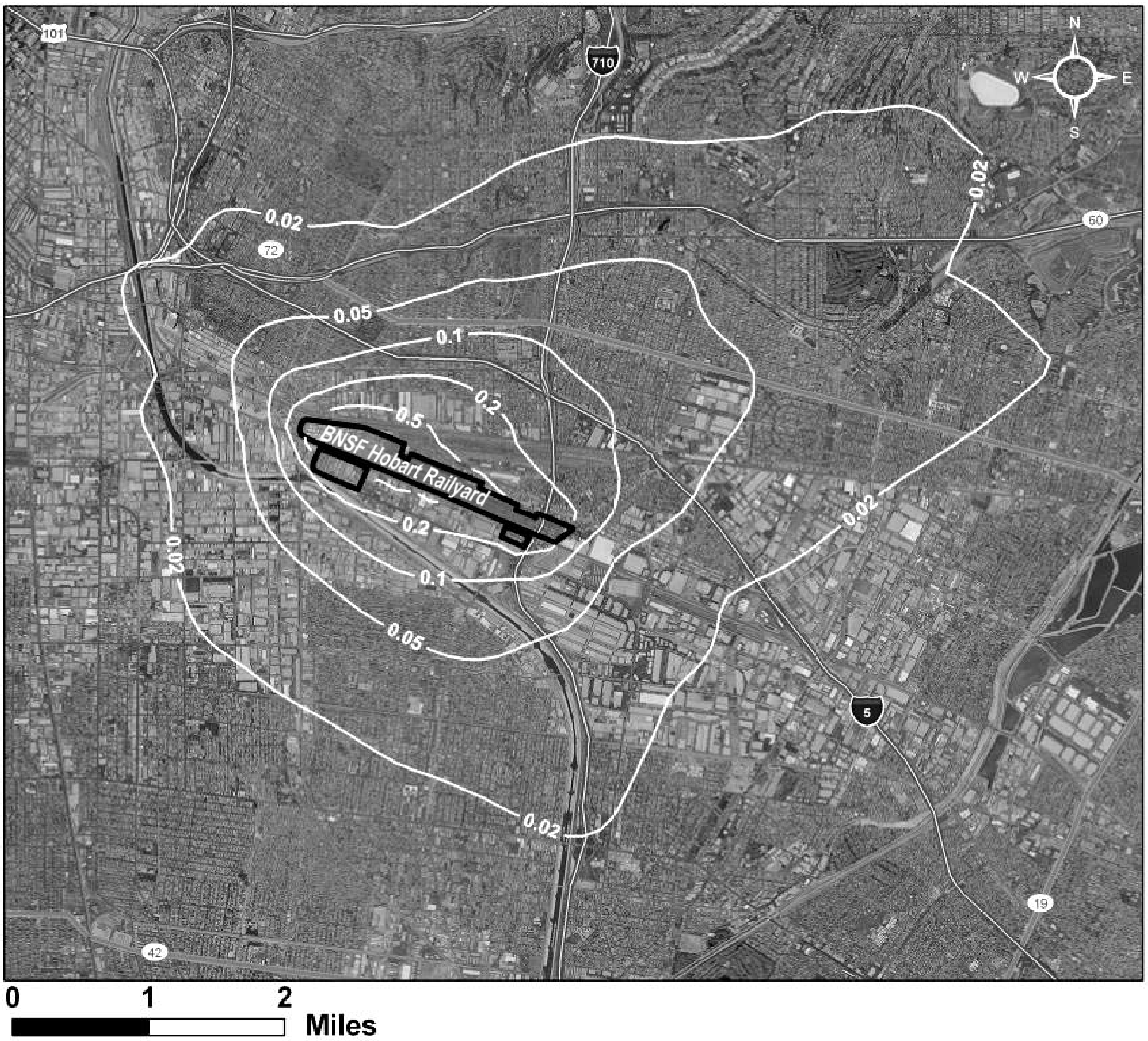
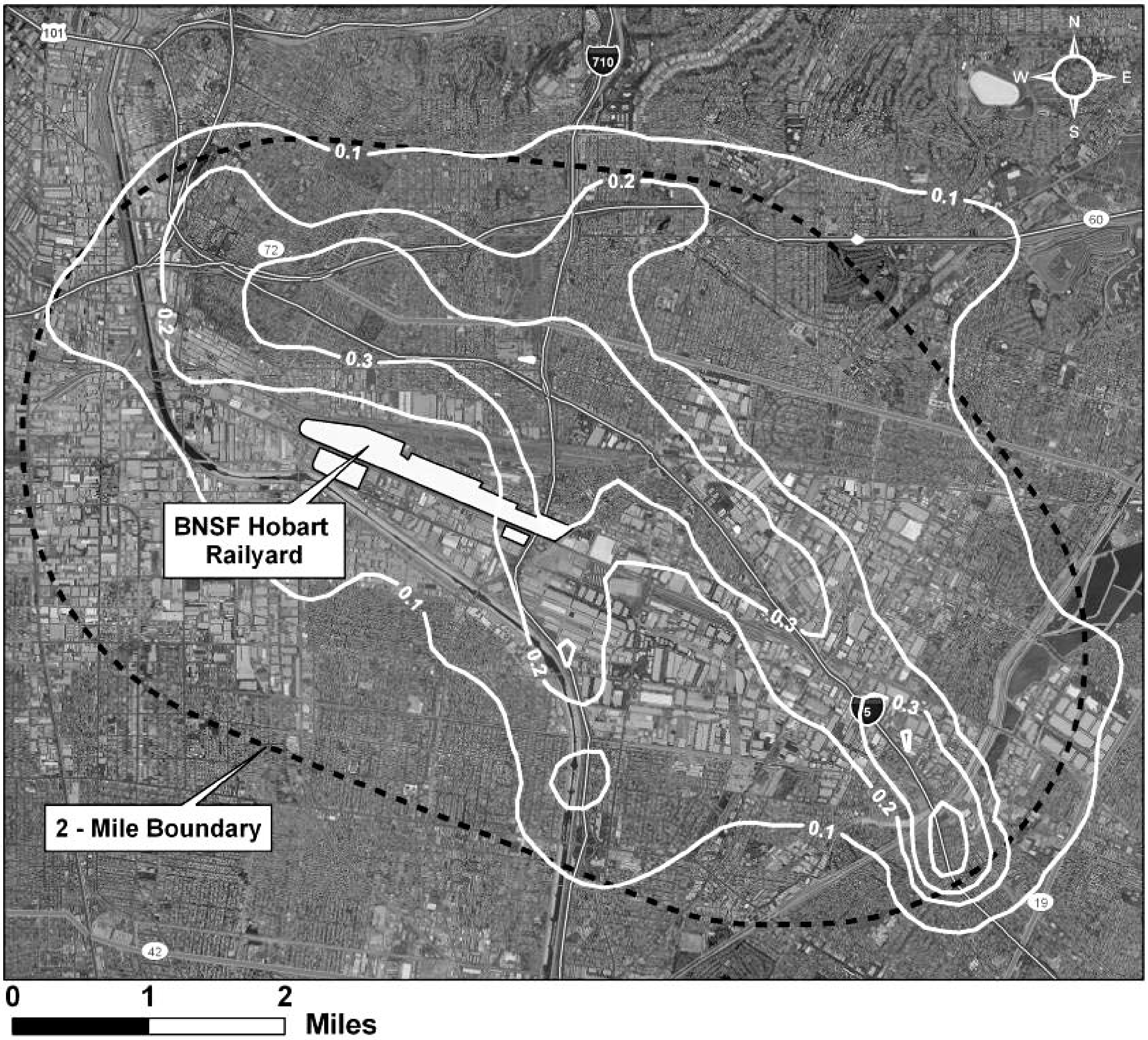


Figure II-8: Estimated Potential Non-Cancer Chronic Health Risks (Indicated as Hazard Indices) Associated with the Off-site Diesel PM Emissions



G. Can study estimates be verified by air monitoring?

Currently, there is no approved specific measurement technique for directly monitoring diesel PM emissions in the ambient air. This does not preclude the use of an ambient monitoring program to measure general air quality trends in a region. Since cancer risk is based on an annual average concentration, a minimum of a year of monitoring data would generally be needed.

H. What activities are underway to reduce diesel PM emissions and public health risks?

The ARB has developed an integrated approach to reduce statewide locomotive and railyard emissions through a combination of voluntary agreements, ARB and U.S. EPA regulations, incentive funding programs, and early replacement of California's line haul and yard locomotive fleets. California's key locomotive and railyard air pollution control measures and strategies are summarized below:

South Coast Locomotive NOx Fleet Average Agreement (1998): Signed in 1998 between ARB and both Union Pacific Railroad (UP) and BNSF Railway (BNSF), it requires the locomotive fleets that operate in the South Coast Air Quality Management District (SCAQMD) to meet, on average, U.S. EPA's Tier 2 locomotive emissions standards by 2010. This measure will provide an estimated 65% reduction in oxides of nitrogen (NOx) and 50% reduction in locomotive particulate matter emissions in the South Coast Air Basin (SCAB) by 2010.

Statewide Railroad Agreement (2005): ARB and both UP and BNSF signed a voluntary statewide agreement in 2005. When fully implemented, the Agreement is expected to achieve a 20 percent reduction in locomotive diesel PM emissions in and around railyards through a required number of short-term and long-term measures. As of January 1, 2007, ARB staff estimated that the Agreement has reduced diesel PM emissions by 15% in and around the railyard.

ARB Diesel Fuel Regulations Extended to Intrastate Locomotives (2007): This regulation, approved in 2004, requires intrastate locomotives to use only California ultra low sulfur (15 parts per million) and aromatics diesel fuel. CARB diesel fuel can reduce intrastate locomotive diesel PM and NOx emissions by 14% and 6%, on average, respectively. ARB staff estimates there are over 250 intrastate locomotives currently operating in South Coast Air Basin, and CARB diesel will reduce these locomotive emissions by up to 30 tons per year for diesel PM and 300 tons per year for NO_x. The regulation took effect statewide for intrastate locomotives on January 1, 2007.

ARB Cargo Handling Equipment Regulations (2007): This regulation, approved in 2005, requires the control of emissions from more than 4,000 pieces of mobile cargo handling equipment statewide. Implementation of this regulation will reduce diesel PM emissions by approximately 40% in 2010 and 65% in 2015, and NO_x emissions by approximately 25% in 2010 and 50% in 2015. The regulation, when fully implemented, is expected to cumulatively reduce diesel PM and NO_x emissions from all cargo handling equipment in the State by up to 80 percent by 2020. At a railyard like BNSF Hobart, this regulation could reduce up to 3 tons per year of diesel PM emissions. The regulation took effect January 1, 2007.

<u>On-Road Heavy Duty Diesel Trucks Regulations</u>: In January of 2001, the U.S. EPA promulgated a Final Rule to reduce emission standards for 2007 and subsequent model year heavy-duty diesel engines (66 FR 5002, January 18, 2001). These emission standards represent a 90% reduction of NO_x emissions, 72% reduction of non-methane hydrocarbon emissions, and 90 percent reduction of PM emissions compared to the 2004 model year emission standards. The ARB adopted similar emission standards and test procedures to reduce emissions from 2007 and subsequent model year heavy-duty diesel engines and vehicles. This stringent emission standards will reduce NO_x and diesel PM emissions statewide from on-road heavy diesel trucks by approximately 50 and 3 tons per day, respectively, in 2010; by 140 and 6 tons per day, respectively, in 2015; and by 210 and 8 tons per day, respectively, in 2020.

<u>Transport Refrigeration Unit (TRU) Air Toxics Control Measure (ATCM):</u> This air toxics control measure is applicable to refrigeration systems powered by integral internal combustion engines designed to control the environment of temperature sensitive products that are transported in trucks, trailers, railcars, and shipping containers. Transport refrigeration units may be capable of both cooling and heating. Estimates show that diesel PM emission factors for transport refrigeration units and transport refrigeration unit Gen-set engines will be reduced by approximately 65 percent in 2010 and 92 percent in 2020. California's air quality will also experience benefits from reduced NOx emissions and reduced HC emissions. The transport refrigeration unit air toxics control measure is designed to use a phased approach over about 15 years to reduce the PM emissions from in-use transport refrigeration unit and transport refrigeration unit generator set engines that operate in California. The new rule became effective on December 10, 2004.

<u>Proposed On-Road In-Use Truck Regulations:</u> The ARB is developing a control measure to reduce diesel PM and oxides of nitrogen (NO_x) emissions from private fleets of on-road heavy-duty diesel-fueled vehicles. This measure includes, but is not limited to, long and short haul truck-tractors, construction related trucks, port hauling trucks, wholesale and retail goods transport trucks, tanker trucks, package and household goods transport trucks, and any other diesel-powered trucks with a gross vehicle weight rating of 14,000 pounds or greater. The proposed goals of the regulations are: (a) by 2014, emissions are to be no higher than a 2004 model year engine with a diesel particulate filter, and (b) by 2020, emissions are to be no higher than a 2007 model year engine.

<u>Proposed In-Use Port and Railyard Truck Mitigation Strategies:</u> The ARB is evaluating a port truck fleet modernization program that will substantially reduce diesel PM and NOx emissions by 2010, with additional reductions by 2020. There are an estimated 12,000 port trucks operating at the 3 major California ports which are a significant source of air pollution, about 7,075 tons per year of NOx and 564 tons per day of diesel PM in 2005, and operate in close proximity to communities. Strategies will include the retrofit or replacement of older trucks with the use of diesel particulate filters and a NOx reduction catalyst system. ARB staff will propose regulatory strategies for ARB Board consideration by the end of 2007 or early 2008.

ARB Tier 4 Off-Road Diesel-Fueled Emission Standards: On December 9, 2004, the Board adopted a fourth phase of emission standards (Tier 4) that are nearly identical to those finalized by the U.S. EPA on May 11, 2004, in its Clean Air Non-road Diesel Rule. As such, engine manufacturers are now required to meet aftertreatment-based exhaust standards for particulate matter (PM) and NOx starting in 2011 that are over 90 percent lower than current levels, putting off-road engines on a virtual emissions par with on-road heavy-duty diesel engines.

U.S. EPA Locomotive Emission Standards: Under the Federal 1990 Clean Air Act, U.S. EPA has sole authority to adopt and enforce locomotive emission standards. This federal preemption also extends to the remanufacturing of existing locomotives. The ARB has been encouraging the U.S. EPA to expeditiously require the introduction of Tier 4 locomotives built with diesel particulate filters and selective catalytic reduction. U.S. EPA released the notice of proposed regulation rulemaking (NPRM) for locomotives and marine vessels in the Federal Register on April 3, 2007. The NPRM proposed interim reduction in diesel PM emissions for locomotives from 2010-2013, but the final proposed standards would not be applicable to new locomotives until 2017. The final regulations are expected to be approved by early 2008.

ARB Goods Movement Emission Reduction Plan (GMERP): Approved in 2006, the GMERP provides goods movement emissions growth estimates and proposed strategies to reduce emissions from ships, trains, and trucks and to maintain and improve upon air quality. Based largely on the strategies discussed, one of the goals of the GMERP is to reduce locomotive NO_x and diesel PM emissions by up to 50 percent by 2015, and by up to 90 percent by 2020.

California Yard Locomotive Replacement Program: One locomotive strategy identified in the GMERP is to replace California's older switcher yard locomotives (currently about 800) that operate in and around railyards statewide. There are government incentive programs that may be able to assist in funding the replacement of some intrastate locomotives by 2010.

III. BNSF HOBART RAILYARD DIESEL PM EMISSIONS

This chapter provides a summary of the diesel PM emissions in and around the BNSF Hobart Railyard.

In 2005, the combined diesel PM emissions from the BNSF Hobart railyard (on-site emissions), and significant non-railyard emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards (off-site emissions), are estimated at about 136 tons per year, excluding emissions occurring at the other three railyards in the Commerce area. Estimated off-site diesel PM emissions from mobile sources (not generally related to activities at the railyard) are about 113 tons per year, or about 83% of the total combined on-site and off-site diesel PM emissions. Off-site stationary sources contribute less than 400 pounds per year of diesel PM emissions. The BNSF Hobart railyard diesel PM emissions are estimated at about 23 tons per year, which accounts for about 17% of the total combined on-site and off-site diesel PM emissions.

A. BNSF Hobart Railyard Emission Activities

The BNSF Hobart railyard activity data and emission inventories were provided by the BNSF and its consultant ENVIRON International. The methodology used to calculate the diesel PM and other toxic air contaminant (TAC) emissions is based on *ARB Rail Yard Emissions Inventory Methodology* (ARB, 2006e). Detailed calculation methodologies and resulting emission factors are included in the *Los Angeles – Hobart Railyard TAC Emission Inventory* (ENVIRON, 2006a) and *Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Hobart Railyard* (ENVIRON, 2006b) submitted by ENVIRON.

Activities at the BNSF Hobart Railyard include locomotive switching, locomotive line haul, passenger locomotives, cargo handling equipment, track maintenance equipment, portable engines, on-road fleet vehicles, on-road container trucks, transportation refrigeration units (TRUs), and permitted stationary source activities. The schematic locations of these activities at the railyard are shown in Figures III-1.

The BNSF Hobart emissions activities can be divided into the following operational areas: the adjacent main line located just south of the railyard, the classification yard located north of the adjacent main line, and the intermodal areas which cover the entire railyard. The emission activities categories occurring in these operational areas are summarized in Table III-1.

Table III-1: BNSF Hobart Railyard Activities

Operational Area	Emission Activities
Adjacent Main Line	Arriving-Departing Line Haul Locomotives Passing Line Haul Locomotives Passenger Locomotives Passing the BNSF Hobart Railyard Boxcar TRUs
Track Maintenance Classification Yard	Switching Locomotives Cargo Handling Equipment Track Maintenance Equipment Portable Engines
Intermodal Areas	Cargo Handling Equipment On-Road Container Trucks On-Road Fleet Vehicles Container TRUs Portable Engines Permitted Stationary Sources

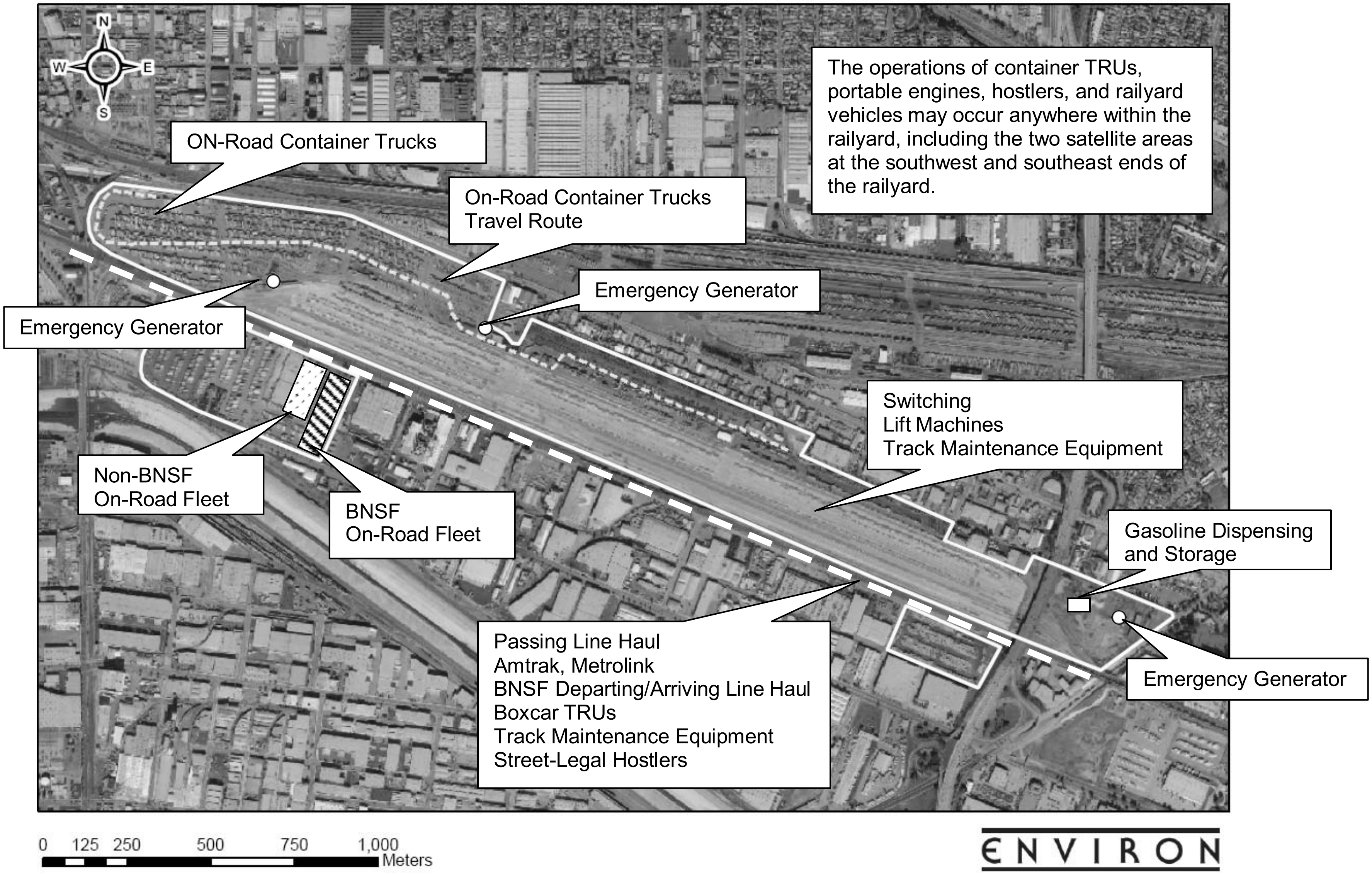
The adjacent main line includes arriving-departing line haul locomotives, passing line haul and passenger locomotives, boxcar TRUs, and track maintenance equipment activities. The adjacent main line consists of four parallel rail lines and runs immediately south of the southern boundary of the railyard. The adjacent main line considered for this project is approximately two miles in length and runs from the southwest to the southeast along the railyard boundary.

The classification yard includes locomotive switching, cargo handling equipment, portable engine operations, and track maintenance equipment activities. The classification yard is located north of the adjacent main line and consists of six rail lines that run in parallel for approximately two miles, from the I-710 overpass at the east end of the railyard to the west end of the railyard where they converge. All locomotive switching and lift machine activities occur within the classification yard.

The intermodal areas includes cargo handling equipment, on-road container truck, on-road fleet vehicle, portable engine, container TRU, and permitted stationary source activities. Cargo handling equipment is used to handle intermodal freight at the BNSF Hobart Railyard and includes lift machines, hostlers and railyard vehicles. As discussed above, lift machine activities are limited to the switching area. Hostler and railyard vehicle activities may occur anywhere in the railyard, including the two satellite areas at the southwest and southeast ends of the railyard. On-road container trucks (i.e., tractor-trailer trucks) enter the intermodal area at the ingress at the western end of Sheila Street and then travel to the western end of the railyard, and depart from the northwest corner of the railyard. Street-legal hostlers, which transport containers between the main railyard and the two satellite areas, were also categorized as on-road container trucks. Street-legal hostlers enter and exit the railyard at a gate near the southwest corner of the railyard and travel along East 26th Street to the two satellite areas. BNSF and non-BNSF on-road fleet vehicle activities are confined to the eastern portion of the satellite area adjacent to the southwest corner of the railyard (shown in Figure III-1). Portable engine and container TRU activities may occur anywhere in the main railyard and the satellite areas.

Several stationary sources are located at the railyard, including a gasoline dispensing and storage facility and three emergency generators. The gasoline dispensing and storage facility is located in the center of the portion of the railyard east of the I-710 overpass. The emergency generators are located at the western edge of the switching area, in the north central area of the railyard near the corner of Sheila Street and South Indiana Street, and near the northeast corner of the railyard as shown in Figure III-1.

Figure III-1: The BNSF Hobart Railyard Emission Source Locations



B. BNSF Hobart Railyard Diesel PM Emissions Summary

Using the data provided by BNSF and the methodology described in the emission inventory report (ENVIRON, 2006b), the diesel PM emissions from the BNSF Hobart Railyard sources are estimated to be approximately 23.4 tons per year. The diesel PM emissions from each individual activities are provided in Table III-2.

Table III-2: Summary of BNSF Hobart Railyard Diesel PM Emissions

DIESEL PM EMISSION SOURCES	BNSF Hobart Railyard	
	Tons/Year	Percentage
DIESEL-FUELED VEHICLES *	**10.07**	**42%**
- On-site Container Trucks	9.36	39%
- Off-site Container Trucks**	0.71	3%
- Other On-Road Fleet	< 0.01	< 1%
LOCOMOTIVES	**5.91**	**25%**
- Line Haul Locomotives	3.69	15%
BNSF Arriving/Departing	*2.15*	*9%*
Adjacent Freight Movements	*1.03*	*4%*
Adjacent Commuter Rail Operations	*0.51*	*2%*
-Switching Locomotives	2.22	9%
CARGO HANDLING EQUIPMENT	**4.20†**	**18%**
OTHER OFF-ROAD EQUIPMENT (TRUs and Track Maintenance)	**3.61**	**15%**
STATIONARY SOURCES	**0.10**	**< 1%**
TOTAL	**23.9**	**100%**

*: For further detail on railyard diesel-fueled vehicles versus off-site on-road truck emissions, see Section III-C.
**: Heavy heavy duty trucks that move empty containers to off-site locations.
† : An error of cargo handling equipment emissions was found after the modeling was completed. The applicable change in emissions was believed to be de minimis; consequently, the modeling was not re-performed.

Diesel PM was not the only toxic air contaminant emitted in the BNSF Hobart Railyard. A relatively small amount of gasoline PM and toxic gases were generated from on-road fleet vehicles, portable engines, and track maintenance equipment. Toxic gases were also generated from the gasoline storage and dispensing facility. The gasoline PM emissions were estimated at about 0.007 tons or 14 pounds per year. Other top non-PM TACs (1,3-butadiene, benzene, formaldehyde, and acetaldehyde) emissions were about 0.02 tons or 40 pounds per year, which are much lower compared to the 24 tons per year of the diesel PM emissions in the railyard.

In addition, adjusting these emissions on a cancer potency weighted basis for their toxic potential (see a similar analysis for off-site air toxic contaminants on Table II-3), these non-diesel PM toxic air contaminants have less than a thousandth of the potency weighted emissions as compared to diesel PM (less than 0.01 vs. 24 tons per year). Hence, only diesel PM emissions are presented in the on-site emission analysis.

1. Diesel-Fueled Vehicles

Diesel-fueled vehicles are the largest diesel PM emission sources at the BNSF Hobart Railyard. Diesel-Fueled vehicles contribute about 43% of the total railyard diesel PM emissions at about 10 tons per year.

The BNSF Hobart Railyard is characterized by container service and trailer on rail service. Container service is primarily responsible for receiving or delivering containers to the container yard. Trailer on rail service is responsible for delivering or shipping the entire trailer on a rail car. During the period between May 1, 2005 and April 30, 2006, BNSF container trucks generated about 3,530 trips a day (1,289,000 trips per year). As shown in Table III-3, 93% of the on-road vehicle diesel PM emissions came from BNSF on-road container truck operations, which were estimated as 9.36 tons per year. In addition, BNSF on-site contractors operate a fleet of on-road trucks to move empty containers to off-site lots and other facilities. These vehicles make approximately 1,300 trips a day (474,500 trips per year) from the contractor gate separate from the other entrance and exit gate for other container trucks. Diesel PM emissions from the contractor trucks were estimated at about 0.7 tons per year, which account for about 7% of the total diesel PM emitted from diesel-fueled vehicles.

A total of 22 diesel-fueled on-road fleet vehicles owned by BNSF's contractor also contribute a small portion (less than 1%) of diesel PM emissions at the BNSF Hobart Railyard. The vehicles are parked at different locations on the site and therefore have different travel distances.

In January of 2001, the U.S. EPA promulgated a Final Rule for emission standards for 2007 and subsequent model year heavy-duty diesel engines (66 FR 5002, January 18, 2001). These emission standards represent a 90 percent reduction of oxides of nitrogen emissions, 72 percent reduction of non-methane hydrocarbon emissions, and 90 percent reduction of particulate matter emissions compared to the 2004 model year emission standards. Therefore starting in 2007, the BNSF Hobart Railyard will benefit from these mitigation measures since diesel PM emissions from heavy-duty diesel fueled trucks are gradually reduced as the truck fleets turnover.

Table III-3: On-Road Truck and Vehicle Diesel PM Emissions

Activity	Diesel PM Emissions	
	Tons per year	Percent of Total
On-site Container Trucks	9.36	93%
Off-site Container Trucks*	0.71	7%
Other On-Road Fleet	< 0.01	< 1%
TOTAL	**10.07**	**100%**

*: Heavy heavy duty trucks that move empty containers to off-site locations.

2. Locomotives

Locomotives are the second largest diesel PM emission source at the BNSF Hobart Railyard. The locomotives contribute about 5.9 tons per year or about 25% of the total diesel PM emissions. The locomotives are divided into two major categories: line haul locomotives and switching locomotives (i.e., moving rail cars within the yard). The line haul locomotives include the BNSF arriving-departing locomotives, adjacent freight movements, and adjacent commuter rail operations. The locomotive operations were further divided into activity subcategories to describe the emission modes and spatial allocation, such as locomotive movements, idling, etc.

Line haul locomotives include hauling through trains on the main line, pulling arriving trains into the yard, and departing trains out of the yard. A total number of line haul locomotives that arrive and depart from the BNSF Hobart Railyard was recorded as 41,945 with 13,700 long-term (greater than 1 hour) between May 1, 2005 and April 30, 2006. The total switching engine activity consists of 5 locomotive engines operating three shifts per day, 7 days a week. Switching engines operate on average 5.5 hours per shift. This resulted in an estimate of 30,112 hours per year for switching activity. Two subcategories of freight movements occur on the BNSF Hobart mainline: BNSF locomotives recorded at 29,514 per year and non-BNSF (foreign) locomotives recorded at 222 per years. Adjacent commuter rail operations include Amtrak and Metrolink. Amtrak operated 10,469 trains per year; Metrolink operated 7,280 trains per year, with activity occurring only during weekdays.

Temporal emission profiles were estimated for each activity based on hourly locomotive counts. The profiles developed accounts for hourly, daily and seasonal temporal variations and are reflected in the air dispersion modeling to capture operational variations.

According to BNSF, the BNSF interstate locomotives were fueled out of state before they entered the California borders. BNSF estimated a fuel mixture of about 50%

CARB-EPA on-road to 50% non-road diesel fuel, based on the refueling data (see the *Los Angeles-Hobart Railyard TAC Emission Inventory*, ENVIRON, 2006a). This approach overestimated non-road (i.e., non CARB-EPA diesel fuel) fuel usage, since it disregarded the consumption of out-of-state fuel before arriving California. This was, therefore, a conservative assumption. A more realistic operating scenario would be a fuel mixture of about 75% CARB-EPA on-road to 25% non-road diesel fuel, which would account for substantial volumes of non-road diesel fuel being consumed before arriving in California. By assuming a mixture of 50% CARB-EPA on-road to 50% non-road diesel fuel, BNSF estimated a sulfur content of about 1,050 ppmw.

The locomotive diesel PM emission factors used in this study is presented in Appendix D. Table III-4 presents the summary of diesel PM emissions from locomotive operation activities.

The ARB has developed an integrated approach to reduce statewide locomotive emissions through a combination of voluntary agreements, ARB and U.S. EPA regulations, incentive funding programs, and early replacement of California's line haul and yard locomotive fleets. The detailed approach has been discussed in Chapter II. Therefore, in the future, the BNSF Hobart Railyard will benefit from these mitigation measures since diesel PM emissions from locomotives are gradually reduced as the locomotive fleets turnover.

Table III-4: Locomotive Diesel PM Emissions

Activity	Diesel PM Emissions	
	Tons per year	Percent of Total
Line Haul Locomotives	**3.69**	**62%**
- BNSF Arriving/Departing Line Haul	*2.15*	*36%*
- Adjacent Freight Movements	*1.03*	*18%*
- Adjacent Commuter Rail Operations	*0.51*	*8%*
Switching	2.22	**38%**
TOTAL	**5.91**	**100%**

3. Cargo Handling Equipment

Cargo handling equipment (CHE) is the third largest diesel PM emission source at the BNSF Hobart Railyard. The diesel PM emissions from CHE was estimated at 4.2 tons in year 2005, equivalent to about 18% of the total diesel PM emissions from the BNSF Hobart railyard.

Cargo handling equipment is used to move intermodal freight and containers. Three types of CHE were utilized at the BNSF Hobart Railyard: railyard hostlers, cranes, and material handling equipment.

- Railyard hostlers are also known as yard trucks. It is the most common type of cargo handling equipment. A yard hostler is very similar to an on-road truck tractor, but is designed to move cargo containers within the railyard.
- Cranes are very large cargo container handlers that have lifting equipment mounted on a cross-beam supported on vertical legs which run on rubber tires.
- Material handing equipment includes industry trucks used to hoist and transport materials by means of one or more steel forks inserted under the load.

The CHE diesel PM emissions in the BNSF Hobart Railyard were estimated using ARB's draft version of the OFFROAD model. As indicated in Table III-5, about 60% of the CHE diesel PM emissions were due to the railyard hostlers, at about 2.5 tons per year. The material handing equipment emitted about 25% of the total CHE diesel PM emissions (1.1 tons per year). The remaining 15% of the CHE diesel PM emissions was generated by cranes at about 0.6 tons per year. Additional details of calculations and estimations are presented in the emission inventory report (ENVIRON, 2006a).

In December 2005, ARB adopted a new regulation for cargo handling equipment to reduce diesel PM and NOx emissions beginning in 2007. Implementation of this regulation will reduce diesel PM emissions by approximately 40% in 2010 and 65% in 2015, and NO_x emissions by approximately 25% in 2010 and 50% in 2015. The regulation, when fully implemented, is expected to cumulatively reduce diesel PM and NO_x emissions from all cargo handling equipment in the State by up to 80 percent by 2020. Therefore, starting in 2007, the BNSF Hobart Railyard will benefit from these mitigation measures.

Table III-5: Cargo Handling Equipment Diesel PM Emissions

Activity	Diesel PM Emissions	
	Tons per year	Percent of Total
Railyard Hostlers	2.53	60%
Material Handing Equipment	1.06	25%
Cranes	0.61	15%
TOTAL	**4.20**	**100%**

4. Other Off-Road Equipment

Diesel PM emissions from the off-road equipment were estimated using ARB's draft version of the OFFROAD model. Two types of off-road equipment, including transport refrigeration units (TRUs) and track maintenance equipment, generated 3.61 tons per year (15%) of diesel PM emissions at the BNSF Hobart Railyard. Additional details regarding the emission calculation methodologies are discussed in the ENVIRON Reports (ENVIRON, 2006a and 2006b).

TRUs are used to regulate temperatures during the transport of products with temperature requirements. For operations at the BNSF Hobart Railyard, temperatures are regulated by TRUs in boxcars and shipping containers when the material being shipped requires such temperature regulation. As shown in Table III-6, diesel PM emissions from the TRUs were estimated at about 3.57 tons per year, with more than 99% generated by the containers.

Track maintenance equipment is used to service tracks and include a variety of large and small engines and equipment. Diesel PM emissions from the track maintenance equipment at the BNSF Hobart Railyard were estimated to be 0.04 tons per year in year 2005, equivalent to about 1% of total off-road equipment diesel PM emissions.

In November 2004, ARB adopted a new regulation: *Airborne Toxic Control Measure (ATCM) for In-Use Diesel-Fueled Transport Refrigeration Units (TRUs), TRU Generator Sets and Facilities where TRUs Operate*. This regulation applies to all TRUs in California, including those coming into California from out-of-state. It requires in-use TRU and TRU generator set engines to meet specific diesel PM emissions that vary by horsepower range and engine model year, starting December 31, 2008 for engine model years 2001 or older. ARB staff estimates that diesel PM emissions for TRUs and TRU generator set engines will be reduced by approximately 65% by 2010 and 92% by 2020. Therefore, starting in 2009, the BNSF Hobart Railyard will benefit from these mitigation measures as diesel PM emissions from TRUs are gradually reduced as their fleets turnover.

Table III-6: Off-Road Equipment Diesel PM Emissions

Activity	**Diesel PM Emissions**	
	Tons per year	**Percent of Total**
Transport Refrigeration Units (TRUs)	3.57	99%
- Containers	*3.57*	*99%*
- Boxcars	*0.0002*	*< 1%*
Track Maintenance Equipment	0.04	1%
TOTAL	**3.61**	**100%**

5. Stationary Sources

The stationary sources at the BNSF Hobart Railyard include three emergency generators and one gasoline storage and dispensing unit. Diesel PM emissions were generated only from the three emergency generators, at 0.1 tons per year. Due to the lack of source parameter information and the relatively low levels of emissions from these sources, the emergency generators were not included in the air dispersion modeling.

C. CURRENT APPLICABLE DIESEL FUEL REGULATIONS AND THEIR BENEFITS TO THE RAILYARDS

1. California Air Resources Board (CARB) Diesel Fuel Specifications

The original California diesel fuel specifications were approved by the Board in 1988 and limited sulfur and aromatic contents. The requirements for “CARB diesel,” which became applicable in October 1993, consisted of two basic elements:

- A limit of 500 parts per million by weight (ppmw) on sulfur content to reduce emissions of both sulfur dioxide and directly emitted PM.
- A limit on aromatic hydrocarbon content of 10 volume percent for large refiners and 20 percent for small refiners to reduce emissions of both PM and NOx.

At a July 2003 hearing, the Board approved changes to the California diesel fuel regulations that, among other things, lowered the maximum allowable sulfur levels in California diesel fuel to 15 ppmw beginning in June 2006. Thus, ARB's specifications for sulfur and aromatic hydrocarbons are shown in Table III-7.

Table III-7: California Diesel Fuel Standards

Implementation Date	Maximum Sulfur Level (ppmw)	Aromatics Level (% by volume)	Cetane Index
1993	500	10	N/A
2006	15	10	N/A

The regulation limiting aromatic hydrocarbons also includes a provision that enables producers and importers to comply with the regulation by qualifying a set of alternative specifications of their own choosing. The alternative formulation must be shown, through emissions testing, to provide emission benefits equivalent to that obtained with a 10 percent aromatic standard (or in the case of small refiners, the 20 percent standard). Most refiners have taken advantage of the regulation’s flexibility to produce alternative diesel formulations that provide the required emission reduction benefits at a lower cost.

2. U.S. EPA On-Road Diesel Fuel Specifications

The United States Environmental Protection Agency (U.S. EPA) established separate diesel fuel specifications for on-road diesel fuel and off-road (non-road) diesel fuel. The former U.S. EPA diesel fuel standards were applicable in October 1993. The U.S. EPA regulations prohibited the sale or supply of diesel fuel for use in on-road motor vehicles, unless the diesel fuel had a sulfur content no greater than 500 ppmw. In addition, the regulation required on-road motor-vehicle diesel fuel to have a cetane index of at least 40 or have an aromatic hydrocarbon content of no greater than 35 percent by volume (vol. %). All on-road motor-vehicle diesel fuel sold or supplied in the United States, except in Alaska, must comply with these requirements. Diesel fuel, not intended for on-road motor-vehicle use, must contain dye solvent red 164.

On January 18, 2001, the U.S. EPA published a final rule which specified that, beginning June 1, 2006, refiners must begin producing highway diesel fuel that meets a maximum sulfur standard of 15 ppmw for all diesel-fueled on-road vehicles. The current U.S. EPA on-road diesel fuel standard is shown in Table III-8.

3. U.S. EPA Non-Road Diesel Fuel Specifications

Until recently, fuel supplied to outside of California was allowed a sulfur content of up to 5,000 ppmw (parts per million by weight). However, in 2004, the U.S. EPA published a strengthened rule for the control of emissions from non-road diesel engines and fuel. The U.S. EPA rulemaking requires that sulfur levels for non-road diesel fuel be reduced from current uncontrolled levels of 5,000 ppmw ultimately to 15 ppmw, though an interim cap of 500 ppmw is contained in the rule. Beginning June 1, 2007, refiners are required to produce non-road, locomotive and marine diesel fuel that meets a maximum sulfur level of 500 ppmw. This does not include diesel fuel for stationary sources. In 2010, non-road diesel fuel will be required to meet the 15 ppmw standard except for locomotives and marine vessels. In 2012, non-road diesel fuel used in locomotives and marine applications must meet the 15 ppmw standard. The non-road diesel fuel standards are shown above in Table III-8.

Table III-8: U.S. EPA Diesel Fuel Standards

Applicability	Implementation Date	Maximum Sulfur Level (ppmw)	Aromatics Maximum (% by volume)	Cetane Index (Minimum)
On-Road	2006	15	35	40
Non-road *	1993	5,000	35	40
Non-road *	2007	500	35	40
Non-road, *excluding loco/marine* *	2010	15	35	40
Non-road, *loco/marine* *	2012	15	35	40

* Non-road diesel fuels must comply with ASTM No. 2 diesel fuel specifications for aromatics and cetane.

4. What are the Current Properties of In-Use Diesel Fuel?

Table III-9 shows average values for sulfur and four other properties for motor vehicle diesel fuel sold in California before and after the California and Federal diesel fuel regulations became effective in 1993. The corresponding national averages are shown for the same properties for on-road diesel fuel only since the U.S. EPA sulfur standard does not apply to off-road or non-vehicular diesel fuel. Non-road diesel fuel sulfur levels have been recorded as about 3,000 ppmw in-use and aromatics level of about 35 percent by volume in-use.

Table III-9: Average 1999 Properties of Reformulated Diesel Fuel

Property	California	U.S.(1)
Sulfur, ppmw	10(2)	10 (2)
Aromatics, vol.%	19	35
Cetane No.	50	45
PNA, wt.%	3	NA
Nitrogen, ppmw	150	110

1 U.S. EPA, December 2000.
2 Based on margin to comply with 15 ppmw sulfur standards in June 2006.

5. Diesel Fuels Used by California-Based Locomotives

The ARB Board approved a regulation in November 2004 which extended the CARB diesel fuel requirements to intrastate locomotives (those operating 90 percent or more of the time in California) effective on January 1, 2007. UP and BNSF agreed in the 2005 railroad Agreement to dispense only CARB diesel or U.S. EPA on-road diesel fuels to interstate locomotives that fuel in California beginning on January 1, 2007.

Line haul locomotives have a range of about 800 to 1,200 miles between fuelings. BNSF locomotives typically refuel at Belen, New Mexico before traveling to Barstow, California and UP locomotives typically refuel at Salt Lake City, Utah before traveling to

Roseville in northern California or Colton in southern California. These major out-of-state railroad facilities have the option to use Federal non-road diesel fuels for the refueling of line haul locomotives.

UP and BNSF surveyed each of the California fueling centers, and major interstate fueling centers to California, to estimate the average diesel fuel properties for locomotives for the railyard health risk assessments. Diesel fuel sulfur levels were estimated to be an average of 1,050 ppmw based on the mixture of CARB, U.S. EPA on-road, and non-road diesel fuel consumed by locomotives in California in 2005. ARB staff believes this is a conservative estimate for the types of diesel fuels and sulfur levels consumed by locomotives in California.

The U.S. EPA on-road and CARB on and off-road diesel ultra low sulfur specifications (15 ppmw) went into effect on June 1, 2006. The CARB diesel fuel requirements for intrastate locomotives went into effect on January 1, 2007. The U.S. EPA non-road diesel fuel sulfur limit will drop from 5,000 ppmw to 500 ppmw on June 1, 2007. In 2012, the non-road diesel fuel limits for used in locomotives and marines will drop from 500 ppmw to 15 ppmw.

The NOx emission benefits associated with the use of CARB diesel compared to U.S. EPA on-road and non-road diesel fuels are due to the CARB aromatic hydrocarbon limit of 10 percent by volume or an emission equivalent alternative formulation limit. ARB staff estimates that use of CARB diesel provides a 6 percent reduction in NOx and a 14 percent reduction in particulate emissions compared with the use of U.S. EPA on-road and non-road diesel fuels. In addition, CARB diesel fuel will provide over a 95 percent reduction in fuel sulfur levels in 2007 compared to U.S. EPA non-road diesel fuel. This reduction in diesel fuel sulfur levels will provide SOx emission reductions, and additional PM emission reductions by reducing indirect (secondary formation) PM emissions formed from SOx.

In addition, the ARB, UP and BNSF Railroads entered into an agreement in 2005 which requires at least 80 percent of the interstate locomotives must be fueled with either CARB diesel or U.S. EPA on-road ultra low sulfur diesel fuel by January 1, 2007. Both the CARB diesel fuel regulation for intrastate locomotives and the 2005 Railroad Agreement for interstate locomotives require the use of ultra low sulfur diesel fuel in 2007, five years earlier than the U.S. EPA non-road diesel fuel regulations for locomotives in 2012.

6. What are the Potential Overall Benefits from the Use of Lower Sulfur Diesel Fuels?

Both the U.S. EPA and CARB diesel fuels had sulfur levels lowered from 500 ppmw to 15 ppmw on June 1, 2006. Under the prior sulfur specification of 500 ppmw, CARB diesel fuel in-use sulfur levels averaged around 140 ppmw versus U.S. EPA on-road sulfur levels of about 350 ppmw. With the 2006 implementation of the 15 ppmw sulfur levels, in-use levels for both CARB diesel and U.S. EPA on-road now average about 10 ppmw.

Sulfur oxides and particulate sulfate are emitted in direct proportion to the sulfur content of diesel fuel. Reducing the sulfur content of diesel fuel from the California's statewide average of 140 ppmw to less than 10 ppmw would reduce sulfur oxide emissions by about 90 percent or by about 6.4 tons per day from 2000 levels. Direct diesel particulate matter emissions would be reduced by about 4 percent, or about 0.6 tons per year in 2010 for engines not equipped with advanced particulate emissions control technologies. U.S. EPA on-road lower sulfur diesel fuel would provide similar levels of sulfur oxide and direct diesel particulate matter emission reductions.

The emissions reductions would be obtained with low sulfur diesel used in mobile on-road and off-road engines, portable engines, and those stationary engines required by district regulations to use CARB diesel. In addition, NOx emissions would be reduced by 7 percent or about 80 tons per year for those engines not currently using CARB diesel, assumed to be about 10 percent of the stationary engine inventory and including off-road mobile sources such as interstate locomotives.

The lower sulfur diesel makes much more significant emissions reductions possible by enabling the effective use of advanced emission control technologies on new and retrofitted diesel engines. With these new technologies, emissions of diesel particulate matter and NOx can be reduced by up to 90 percent. Significant reductions of non-methane hydrocarbons and carbon monoxide can also be achieved with these control devices.

D. Off-Site Diesel PM Emissions Summary

ARB staff analyzes the significant off-site emission sources based on two categories: mobile and stationary. The off-site emissions were estimated for the sources within a two-mile distance from the joint boundaries of the four Commerce railyards. For the BNSF Hobart Railyard, off-site sources do not include emissions from the other three railyards in Commerce area.

1. Mobile Sources

For the off-site mobile sources, the analysis focused on on-road heavy duty diesel trucks, as they are the primary source of diesel PM from the on-road vehicle fleet. ARB staff estimated mobile emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a two-mile distance from the joint boundaries of the four Commerce railyards are included in the analysis. The estimates do not include the diesel PM emissions generated from other modes such as extended idling, starts, and off-road equipment outside the rail yards. Individual sources such as local truck distribution centers and warehouses were not evaluated due to insufficient activity data, but their truck traffic related to these facilities is reflected in the roadway link traffic activities. Because the off-site mobile sources have only

Roadway link: is defined as a discrete section of roadway with unique estimates for the fleet specific population and average speed and is classified as a freeway, ramp, major arterial, minor arterial, collector, or centroid connector.

focused on the on-road diesel emissions, the exclusion of extended idling and off-road equipment may result in an underestimation of off-site mobile sources emissions.

Within a two-mile distance from the joint boundaries of the four Commerce railyards, off-site diesel PM emissions are predominantly generated by mobile sources which emit around 113 tons per year. The majority of the off-site diesel PM emissions are from diesel-fueled heavy duty trucks traveling on freeways I-5, I-710, CA-60, I-10 and major local streets.

The diesel PM off-site mobile source emissions were estimated based on the local traffic flow, and calculated by different classifications of truck gross vehicle weights, as shown in Table III-10. For the year 2005, the total diesel PM emissions are estimated at about 113.2 tons per year with 99% from heavy-heavy duty and medium heavy duty trucks. The two truck classifications account for about 92.7 and 19 tons per year, respectively.

Table III-10: Summary of Off-Site Mobile Source Diesel PM Emissions by Vehicle Type

Vehicle Types of Off-Site Mobile Diesel PM Sources	Gross Vehicle Weight (pounds)	Diesel PM Emissions	
		Tons per year	Percent of Total
Light-Heavy Duty Diesel Trucks	8,501-14,000	**1.5**	**1%**
Medium-Heavy Duty Diesel Trucks	14,001-33,000	**19.0**	**17%**
Heavy-Heavy Duty Trucks	> 33,000	**92.7**	**82%**
Total	**-**	**113.2**	**100%**

As shown in Table III-11, the four freeways, I-5, I-710, CA-60, I-10 contribute approximately 75.3 tons per year of diesel PM emissions, which account for over 66% of total mobile sources diesel PM emissions. The methodology for mobile diesel PM emission estimation is presented in Appendix A.

Table III-11: Summary of Off-Site Mobile Source Diesel PM Emissions by Freeways

Sources	Diesel PM Emissions	
	Tons per year	Percent of Total Off-site Mobile Sources
I-5 Freeway	40.0	35%
I-710 Freeway	15.1	13%
CA-60 Freeway	15.5	14%
I-10 Freeway	4.7	4%
TOTAL	75.3	66%

ARB staff also estimates the diesel PM emissions by HHD trucks traveling between the BNSF Hobart Railyard gate and the major freeway (I-710). These emissions are estimated at about 4.7 tons per year, which are not part of railyard diesel PM emissions, but contribute about 4% of the off-site diesel PM emissions. The detailed methodology and calculations are presented in Appendix E.

2. Stationary Sources

Emissions from off-site stationary source facilities are identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts for stationary sources within their jurisdiction. The CEIDARS facilities whose locations fell within the two-mile distance from the joint boundaries of the four Commerce railyards are selected. Diesel PM emissions are estimated from stationary internal combustion (IC) engines burning diesel fuel, operating at stationary sources reported in CEIDARS. The detailed methodology of off-site stationary source emissions is presented in Appendix B

Within a two-mile distance from the joint boundaries of the four Commerce railyards, the diesel PM emissions from stationary sources are estimated at about 0.19 tons per year, or less than 1% of the total off-site diesel PM emissions. Three major stationary sources, Los Angeles City Department of General Services, City of Vernon Light & Power Department, and Los Angeles County Sheriff's Department contribute about 300 pounds per year of the diesel PM emissions.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the BNSF Hobart Railyard. There are 2,620 stationary toxic air contaminant sources identified within the two-mile distance from the joint boundaries of the four Commerce railyards. The total emissions of toxic air contaminant s, other than diesel PM emitted from these stationary sources, were estimated at about 210 tons per year. Over 100 toxic air contaminant species are identified among these emissions, in which ammonia, toluene and methyl chloroform are the three major contributors with emissions estimated at 57, 25, and 24 tons per year, respectively. Not all of these toxic air contaminants are identified as carcinogens. According to ARB' *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000), diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, and formaldehyde are defined as the top 5 potential cancer risk contributors, based on ambient concentrations. These TACs account for 95% of the State's estimated potential cancer risk levels. This study also concluded that diesel PM contributes over 70% percent of the state's estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000). Among the off-site TACs emissions, the top 5 cancer risk contributors (without diesel PM) were estimated at about 1.6 tons per year.

Cancer potency factors (CPF) are expressed as the 95% upper confidence limit of excess cancer cases occurring in an exposed population assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of $(mg/kg\text{-}day)^{-1}$.

The Office of Environmental Health Hazard Assessment (OEHHA) has estimated an inhalation cancer potency factor (CPF) for individual chemicals and some chemical mixtures such as whole diesel exhaust. Diesel PM contains many individual cancer causing chemicals. The individual cancer causing chemicals from diesel exhaust are not separately evaluated so as to avoid double counting. The four compounds listed here are given a weighting factor by comparing each compound's CPF to the diesel PM CPF. This factor is multiplied by the estimated emissions for that compound, which gives the cancer potency weighted toxic emissions as shown in Table III-12. As can be seen in Table III-12, the potency weighted toxic emissions for these TACs are about 0.07 tons per year, which is substantially less than off-site diesel PM emissions.

Table III-12: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding the BNSF Hobart Railyard

Compound	Cancer Potency Factor	Weighting Factor	Estimated Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	113.2	**113.2**
1,3-Butadiene	0.6	0.55	0.007	**0.0037**
Benzene	0.1	0.09	0.435	**0.0392**
Carbon Tetrachloride[4]	0.15	0.14	0.001	**0.0001**
Formaldehyde	0.021	0.02	1.159	**0.0221**
Total (non-diesel PM)	**-**	**-**	**1.60***	**0.065***

*: Numbers may not add precisely due to rounding.

[4] Very small amount of carbon tetrachloride are emitted today. Ambient concentrations are highly influenced by past emissions due to the long atmospheric life time of this compound.

In addition, ARB staff evaluated the potential cancer risk levels caused by the use of gasoline in the South Coast Air Basin. Table III-13 shows the emissions of four major carcinogen compounds of gasoline exhausts in the South Coast Air Basin in the year of 2005 (ARB, 2006c). As indicated in Table III-13, the potency weighted emissions of these four toxic air contaminants from all types of gasoline sources are estimated at about 816 tons per year, or about 11% of diesel PM emissions in the South Coast Air Basin. If only gasoline-powered vehicles are considered, the potency weighted emissions of these four TACs are estimated at about 438 tons per year, or about 6% of diesel PM emissions in the Basin. Hence, gasoline-powered vehicular sources are not included in the analysis.

Table III-13: Comparison of Major Gasoline-Use Related Toxic Air Contaminants with Diesel PM Emissions in the South Coast Air Basin

Compound	TACs Emissions (tons/year)			
	From All Sources	Potency Weighted**	From Gasoline Vehicles	Potency Weighted**
Diesel PM	7,446	**7,446**	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**17**	314	**3**
Total (non-diesel PM)	10,668	**817**	3,829	**438**

**: Based on cancer potency weighting factors.

IV. AIR DISPERSION MODELING FOR THE BNSF HOBART RAILYARD

In this chapter, ARB staff presents the air dispersion modeling performed to estimate the transport and dispersion of diesel PM emissions resulting from the sources in and around the BNSF Hobart Railyard. A description of the air quality modeling parameters is listed, including air dispersion model selection, emission source characterizations, meteorological data, model receptor network, and building wake effects. ARB staff also describes model input preparation and output presentation.

A. Air Dispersion Model Selection

Air dispersion models are often used to simulate atmospheric processes for applications where the spatial scale is in the tens of meters to tens of kilometers. Selection of air dispersion models depends on many factors, such as characteristics of emission sources (point, area, volume, or line), the type of terrain (flat or complex) at the emission source locations, and source-receptor relationships. For the BNSF Hobart Railyard, ARB staff selected the U.S. EPA's newly approved air dispersion model AERMOD to estimate the impacts associated with diesel PM emissions in and around the railyard. AERMOD represents for American Meteorological Society / Environmental Protection Agency Regulatory Model Improvement Committee (**AER**MIC) **MOD**EL. It is a state-of-art air dispersion model and is a replacement for its predecessor, the U.S. EPA Industrial Sources Complex (ISC) air dispersion model.

AERMOD has become a U.S. EPA regulatory dispersion model specified by the *U.S. EPA Guideline for Air Quality Methods (*40 CFR Part 51, Appendix W*)* (U.S. EPA, 2005). AERMOD is also the recommended model in the *ARB Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b).

AERMOD is a steady-state plume model that incorporates current concepts about air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. These approaches have been designed to be physically realistic and simple to implement.

B. Source Characterization and Parameters

The emission sources from the locomotives and other mobile sources at the BNSF Hobart Railyard are characterized as either a point source or a volume source depending on whether they are stationary or moving. When a mobile source is stationary, such as when it is idling or undergoing load testing, the emissions are simulated as a series of point sources. Model parameters for point sources include emission source height, diameter, exhaust temperature, exhaust exit velocity, and emission rate. The locomotive exhaust temperatures and stack heights vary by locomotive makes, models, notch settings and operation time. While the BNSF assumed more specific temperatures and stack heights from their switchers andline haul locomotives fleets, the UP used data from the Roseville Railyard Study (ARB, 2004) based on the most prevalent locomotive model of switchers and line hauls to parameterize locomotive emission settings. In total, the assumptions on the locomotive emission parameters are slightly different between UP and BNSF; however, both are within reasonable ranges according to their activities, and the slight differences in stack height have an insignificant impact on predicted air concentrations, within 2 percent, based on a sensitivity analysis conducted by ARB staff.

According to the BNSF, some locomotives at the Hobart Railyard had been equipped with AESS (automatic engine start-stop) or SmartStart device (by ZTR Control System) in 2005[5]. However, the BNSF used a more conservative approach that did not incorporate the benefits of using the devices in the locomotive emissions estimation. ARB staff believes that the BNSF's approach is more protective in terms of health impacts.

When a mobile source is traveling, the emissions are simulated as a series of volume sources to mimic the initial lateral dispersion of emissions by the exhaust stack's movement through the atmosphere. Key model parameters for volume sources include emission rate (strength), source release height, and initial lateral and vertical dimensions of volumes.

The emissions from all stationary sources (storage tanks, sand tower, waste water treatment plant, etc.) and portable sources (welders, steam cleaners, air compressors, etc.) are simulated as a series of point sources.

The emission rates for individual locomotives are a function of locomotive type, notch setting, activity time, duration, and operating location. Emission source parameters for all locomotive model classifications at the railyard include emission source height, diameter, exhaust temperature, and exhaust velocity. Detailed information on the emission source parameters is presented in the ENVIRON reports (ENVIRON, 2006a and 2006b). Because the stationary locomotives were not uniformly distributed throughout the railyard, the locations of individual locomotive emission sources used for the model inputs were determined based on the detailed locomotive distribution and activity information provided by BNSF.

C. Meteorological Data

In order to run AERMOD, the following hourly surface meteorological data are required: wind speed, wind direction, ambient temperature, and opaque cloud cover. In addition, the daily upper air sounding data need to be provided (U.S. EPA, 2004b).

These meteorological variables are important to describe the air dispersion in the atmosphere. The wind speed determines how rapidly the pollutant emissions are diluted and influences the rise of emission plume in the air, thus affecting downwind concentrations of pollutants. Wind direction determines where pollutants will be

[5] Staff communication between the ARB, BNSF, and ENVIRON, September, 2007.

transported. The difference of ambient temperature and the emission releasing temperature from sources determines the initial buoyancy of emissions. In general, the greater the temperature difference, the higher the plume rise. The opaque cloud cover and upper air sounding data are used in calculations to determine other important dispersion parameters. These include atmospheric stability (a measure of turbulence and the rate at which pollutants disperse laterally and vertically) and mixing height (the vertical depth of the atmosphere within which dispersion occurs). The greater the mixing height is, the larger the volume of atmosphere is available to dilute the pollutant concentration.

The meteorological data used in the model are selected on the basis of representativeness. Representativeness is determined primarily on whether the wind speed/direction distributions and atmospheric stability estimates generated through the use of a particular meteorological station (or set of stations) are expected to mimic those actually occurring at a location where such data are not available. Typically, the key factors for determining representativeness are proximity of the meteorological station and the presence or absence of nearby terrain features that might alter airflow patterns.

The area surrounding the BNSF Hobart railyard is generally flat and would not be expected to exhibit significant variations in wind patterns within relatively short distances. The dominant terrain features/water bodies that may influence wind patterns in this part of the Los Angeles Basin include the hills to the north and east and the Pacific Ocean further to the west. Meteorological stations that collect wind speed, wind direction, temperature, and pressure data that may be appropriate for AERMOD located within a 10-km radius of the BNSF Hobart railyard include: Lynwood, Los Angeles-North Main Street, and Pico Rivera, operated by South Coast Air Quality Management District (SCAQMD); and Los Angeles Downtown University of Southern California (USC) Campus station, operated by National Weather Service (NWS).

ENVIRON evaluated these four meteorological stations and identified that the Pico Rivera station and Los Angeles-North Main Street station appear to be influenced by local terrain variations due to the hills nearby. Based on ARB criteria for representativeness (ARB, 2006b), the Lynwood station was determined as the most representative meteorological station for the BNSF Hobart Railyard. However, the Lynwood station did not record temperature and cloud cover data from 2000 to 2005. Therefore, hourly wind speed and direction data from the Lynwood station, and temperature and cloud cover data from the Los Angeles downtown USC station were selected to be used in the AERMOD. The upper air sounding data were chosen from the San Diego-Miramar NAS stations (ENVIRON, 2006). Detailed meteorological data selection is discussed in *Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards* (ENVIRON, 2006c).

Wind rose: a rose-like shape plot that depicts wind speed and direction patterns to illustrate prevailing wind

According to ARB railyard health risk assessment guidelines (ARB, 2006b), five years of meteorological data are recommended to be used in the air toxic health risk assessment. For this study, four years (2002 through 2005) of meteorological data from Lynwood and USC stations were selected (ENVIRON, 2006c) for the BNSF Hobart Railyard air dispersion modeling because it had adequate completeness and quality, and were the most recent year available. Surface parameters supplied to the model were specified for the area surrounding the surface meteorological monitoring site as recommended by AERMOD and ARB Guidelines (ARB, 2006b). According to the sensitivity analyses conducted by BNSF, the impacts on the diesel PM air concentration predictions by using the long-term (i.e., five-year) vs. short-term (i.e., one-year) are found to be insignificant. This is consistent with the findings from a sensitivity analysis from one of UP railyards conducted by ARB staff (see Appendix G). Therefore, whether five-year or one-year meteorological data are used, the modeling results show similar estimated exposures and potential cancer risks surrounding the railyard facility.

Figure IV-1 presents the wind rose and Figure IV-2 provides the wind class frequency distributions for the meteorological data used in BNSF Hobart Railyard air dispersion modeling. The yearly average wind speed is 1.3 meters per second. The prevailing wind over the modeling domain blows from southwest to northeast.

The detailed procedures of meteorological data preparation and quality control are described in the ENVIRON report (ENVIRON, 2006c). To ensure consistency between the BNSF and UP air dispersion modeling analyses for railyards in the Commerce area, the meteorological data prepared by ENVIRON for the BNSF Hobart Railyard and other two nearby BNSF railyards (BNSF Commerce Eastern and BNSF Sheila) were also used by UP’s consultant Sierra Research for the UP Commerce Railyard.

Figure IV-1: Wind Rose Plot for the BNSF Hobart Railyard Area (Lynwood Station, 2002- 2005)

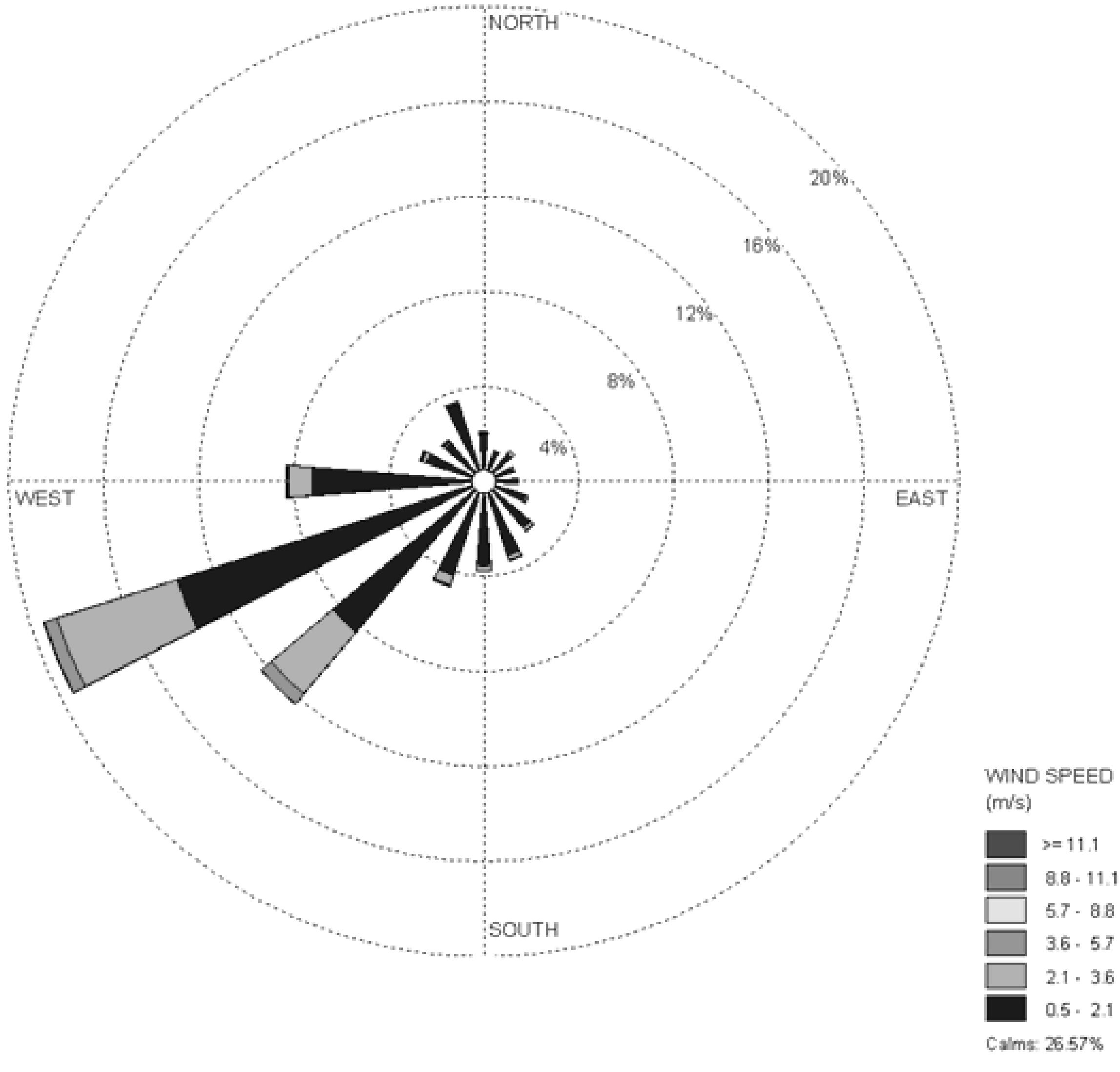
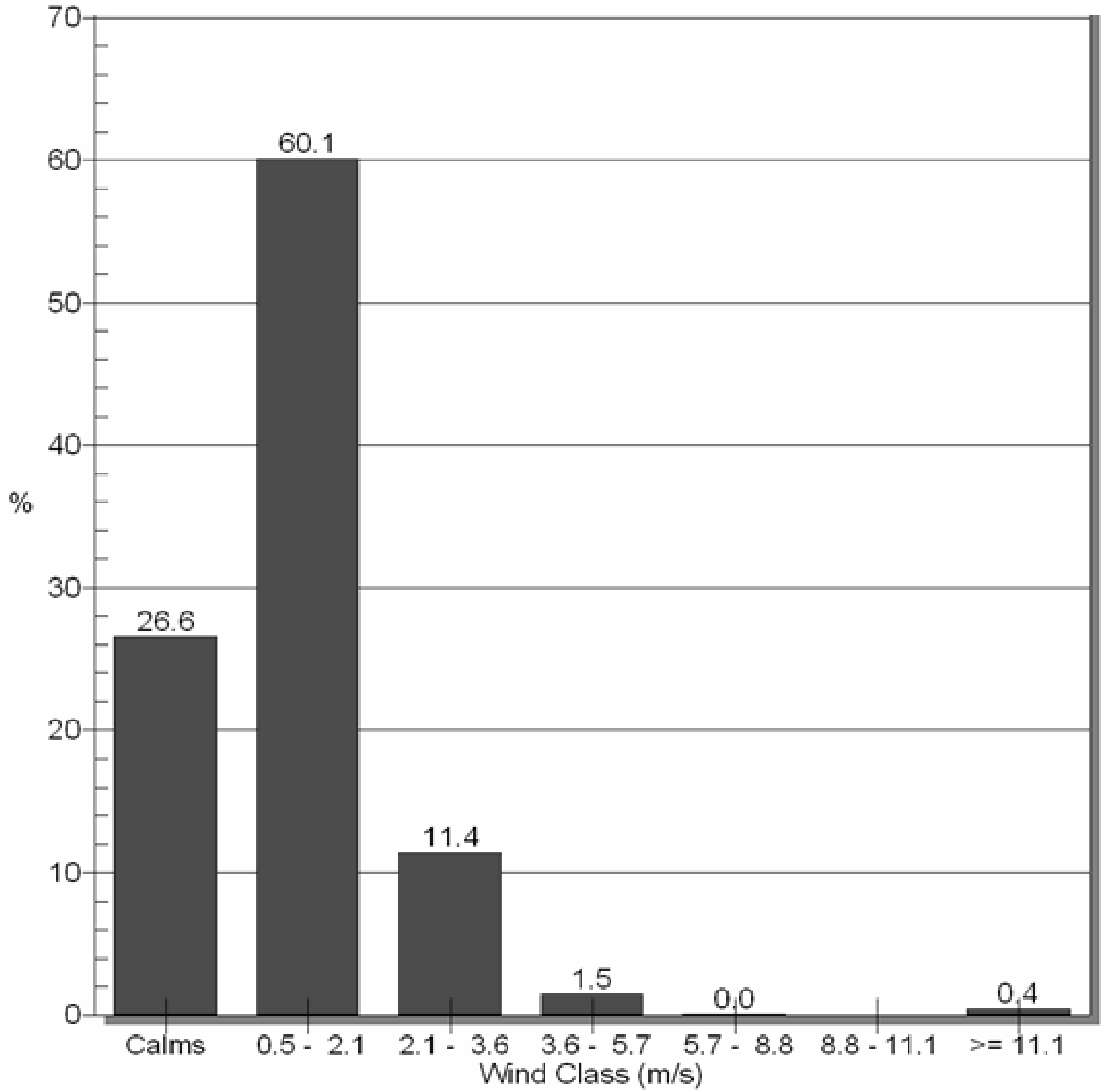


Figure IV-2: Wind Class Frequency Distribution Plot for the BNSF Hobart Railyard Area (Lynwood Station, 2002-2005)



D. Model Receptors

Model receptors are the locations where the model provides concentrations. A Cartesian grid receptor network is used in this study where an array of points are identified by their x (east-west) and y (north-south) coordinates. This receptor network is capable of identifying the emission sources within the railyard with respect to the receptors in the nearby residential areas.

According to the *ARB Railyard Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b), the modeling domain is defined as a 20×20 km region, which covers the railyard in the center of domain and extends to the surrounding areas. To better capture the different concentration gradients surrounding the railyard area, three sets of receptor grids were used. The ARB's Guidance require coarse and fine modeling receptor grids, in which the Cartesian receptor networks used in model simulations include a fine receptor grid with spacing of 50 meters out to a distance of approximately 500 meters from the facility boundary, and a coarse receptor grid with spacing of 500 meters out to ten kilometers from the railyard boundary. A medium receptor grid was applied to model simulations in addition to coarse and fine receptor grids, with spacing of 250 meters out to a distance of approximately 1,500 meters from the railyard boundary. The locations of the fine, medium and coarse receptor grid networks are presented in Figures IV-3a, IV-3b, and IV-3c, respectively.

E. Building Wake Effects

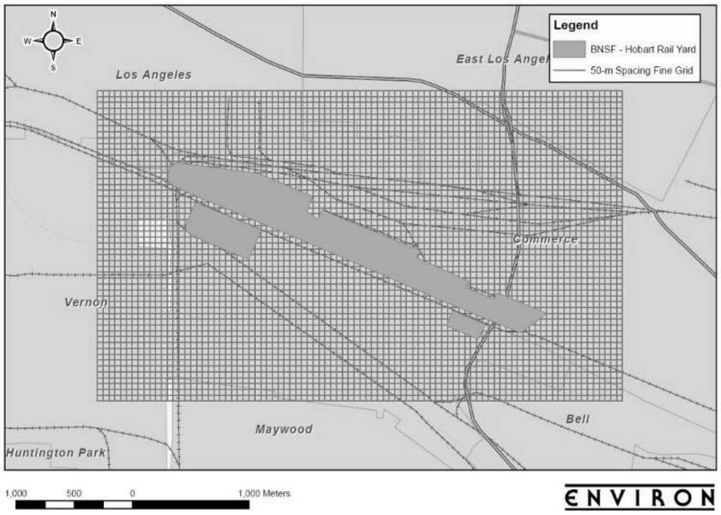
If pollutant emissions are released at or below the "Good Engineering Practice" height as defined by U.S. EPA Guidance (U.S. EPA, 2004a), the plume dispersion may be affected by surrounding facility buildings and structures. The aerodynamic wakes and eddies produced by the buildings or structures may cause pollutant emissions to be mixed more rapidly to the ground, causing elevated ground level concentrations. The AERMOD model has the option--Plume Rise Model Enhancements-- to account for potential building-induced aerodynamic downwash effects. Although all BNSF railyards included building wake effects in their modeling analyses, BNSF conducted a sensitivity analysis and found that the building wake effect has an insignificant impact on the diesel PM air concentrations of the railyard (ENVIRON, 2006b). Detailed treatments of building downwash effects can be found from the ENVIRON Report (ENVIRON, 2006b).

F. Model Implementation Inputs

AERMOD requires four types of basic implementation inputs: control, source, meteorological, and receptor. Control inputs are required to specify the overall job control options for the model run, such as dispersion option, pollutant species, averaging time, etc. Source inputs require source identification and source type (point or volume). Each source type requires specific parameters to define the source. The required inputs for a point source are emission rate, release height, emission source diameter, exhaust exit temperature, and exhaust exit velocity.

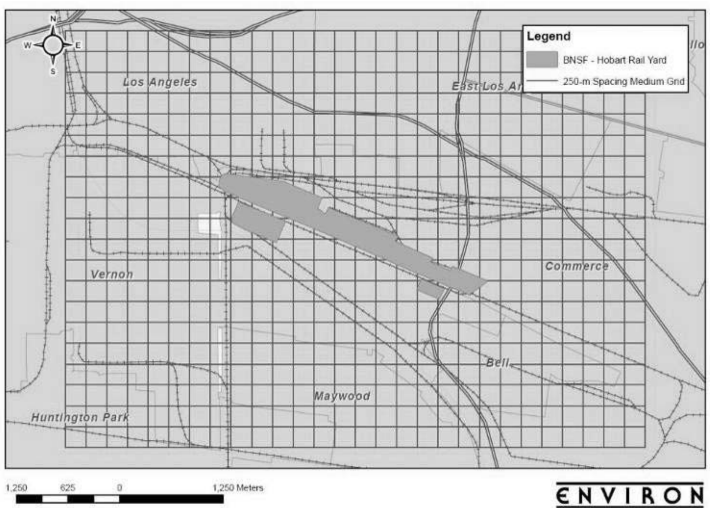
Meteorological and receptor inputs have been discussed in Sections IV-C and IV-D. The requirements and the format of input files to the AERMOD are documented in the user's guide of AERMOD (U.S. EPA, 2004b). The model input files for this study is provided in the air dispersion modeling report (ENVIRON, 2006b).

Figure IV-3: Receptor Grid Networks of Air Dispersion Modeling at the BNSF Hobart Railyard



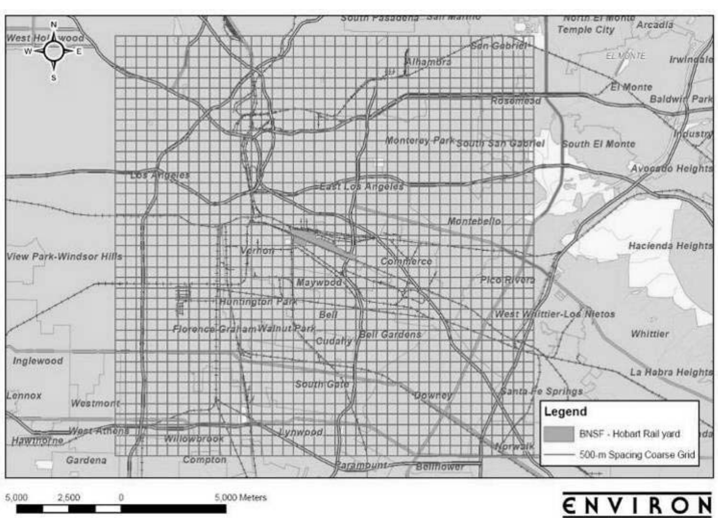
(a)

Fine Grid



(b)

Medium Grid



(c)

Coarse Grid

V. HEALTH RISK ASSESSMENT OF THE BNSF HOBART RAILYARD

This chapter discusses how to characterize potential cancer and non-cancer risks associated with exposure to toxic air contaminants (TACs), especially diesel PM, emitted in and around the BNSF Hobart Railyard. In addition, the detailed health risk assessment (HRA) results are presented and the associated uncertainties are discussed qualitatively.

A. ARB Railyard Health Risk Assessment Guidelines

The railyard HRA follows *The Air Toxics Hot Spots Program Risk Assessment Guidelines* published by OEHHA, and is consistent with the methodologies used for the UP Roseville Railyard Study (ARB, 2004a). The OEHHA Guidelines outline a tiered approach to risk assessment, providing risk assessors with flexibility and allowing for consideration of site-specific differences:

- Tier 1: a standard point-estimate approach that uses a combination of the average and high-end point-estimates.
- Tier 2: utilizes site-specific information for a risk assessment when site-specific information is available and is more representative than the Tier-1 point-estimates.
- Tier 3: a stochastic approach for exposure assessment when the data distribution is available.
- Tier 4: also a stochastic approach, but allows for utilization of site-specific data distribution.

> **Percentile:** Any one of the points dividing a distribution of values into parts each of which contain 1/100 of the values. For example, the 65th percetile breathing rate is a value such that the breathing rates from 65 percent of population are less or equal to it.

The Health Risk Assessment is based on the yard specific emission inventory and air dispersion modeling predictions. The OEHHA guidelines recommend that all health hazard risk assessments adopt a Tier-1 evaluation for the Hot Spots Program, even if other approaches are also presented. Two point-estimates of breathing rates in Tier-1 methodology are used in this HRA, one representing an average and the other representing a high-end value based on the probability distribution of breathing rate. The average and high-end of point-estimates are defined as 65th percentile and 95th percentile from the distributions identified in the OEHHA guidelines (OEHHA, 2000). In 2004, ARB recommended the interim use of the 80th percentile value (the midpoint value of the 65th and 95th percentile breathing rates referred as an estimate of central tendency) as the minimum value for risk management decisions at residential receptors for the breathing intake (ARB, 2004b). The 80th percentile corresponds to a breathing rate of 302 Liters/Kilogram-day (302 L/Kg-day) from the probability distribution function. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources.

The ARB has also developed *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* to help ensure that the air dispersion modeling and HRA performed for each railyard meet the OEHHA guidelines.

B. Exposure Assessment

Exposure assessment is a comprehensive process that integrates and evaluates many variables. Three process components have been identified to have significant impacts on the results of a health risk assessment – emissions, meteorological conditions, and exposure duration of nearby residents. The emissions have a linear effect on the risk levels, given meteorological conditions and defined exposure duration. Meteorological conditions can also have a critical impact on the resultant ambient concentration of a toxic pollutant, with higher concentrations found along the predominant wind direction and under calm wind conditions. An individual's proximity to the emission plume, how long he or she breathes the emissions (exposure duration), and the individual's breathing rate play key roles in determining potential risk. The longer the exposure time for an individual, the greater the estimated potential risk for the individual. The risk assessment adopted in this study generally assumes that the receptors will be exposed to the same toxic levels for 24 hours per day for 70 years. If a receptor is exposed for a shorter period of time to a given pollutant concentration of diesel PM, the cancer risk will proportionately decrease. Children have a greater risk than adults because they have greater exposure on a per unit body weight basis and also because of other factors.

Diesel PM was not the only toxic air contaminant emitted in the BNSF Hobart Railyard. A relatively small amount of gasoline PM and toxic gases were generated from on-road fleet vehicles, portable engines, and track maintenance equipment. Toxic gases were also generated from the gasoline storage and dispensing facility. The gasoline PM emissions were estimated at about 0.007 tons or 14 pounds per year. Other top non-PM TACs (1,3-butadiene, benzene, formaldehyde, and acetaldehyde) emissions were about 0.02 tons or 40 pounds per year, which are much lower compared to the 23 tons per year of the diesel PM emissions in the railyard. In addition, adjusting these emissions on a cancer potency weighted basis for their toxic potential (see a similar analysis for off-site air toxic contaminants on Table II-3), these non-diesel PM toxic air contaminants have less than a thousandth of the potency weighted emissions as compared to diesel PM (less than 0.01 vs. 23.4 tons per year). Hence, only diesel PM emissions are presented in the on-site exposure assessment.

The ARB staff also evaluated the other TACs generated around the railyard. There are 2,620 stationary TAC sources identified within the two-mile distance from the joint boundaries of the four Commerce railyards. The total emissions of TACs other than diesel PM emitted from these stationary sources were estimated at about 210 tons per year. Over 100 TAC species are identified among these emissions, in which ammonia, toluene and methyl chloroform are three major contributors with emissions estimated at 57, 25, and 24 tons per year, respectively. Not all of these TACs are identified as carcinogens. According to ARB' *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000), diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, formaldehyde are defined as the top 5 cancer risk contributors, which account for 95% of the state's estimated potential cancer risk levels (ARB, 2000). This study also concluded that diesel PM contributes over 70% of the statewide estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000). Among the off-site TACs emissions, the top four non-diesel-PM cancer risk contributors were estimated at about 1.6 tons per year. As discussed in Chapter III, the potency weighted toxic emissions of these TACs are about 0.07 tons per year, or about 140 pounds per year, which are substantially less than diesel PM emissions and are not included in the report. As such, the health impacts in this study primarily focus on the risks from the diesel PM emissions.

In addition, ARB staff evaluated the emissions of four major carcinogen compounds of gasoline exhausts in the South Coast Air Basin in the year of 2005, as discussed in Chapter III. The potency weighted emissions of these four toxic air contaminants from all types of gasoline sources are estimated at about 816 tons per year, or about 11% of diesel PM emissions in the South Coast Air Basin. If only gasoline-powered vehicles are considered, the potency weighted emissions of these four TACs are estimated at about 438 tons per year, or about 6% of diesel PM emissions in the Basin. Therefore, the potential cancer risk levels contributed by non-diesel PM TACs emitted from off-site gasoline-powered vehicular sources are substantially less than the potential cancer risk levels associated with diesel PM, and are not included in the analysis.

The relationship between a given level of exposure to diesel PM and the cancer risk is estimated by using the diesel PM cancer potency factor (CPF). A description of how the diesel cancer potency factor was derived can be found in the document entitled *Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant* (ARB, 1998); and a shorter description can be found in the *Air Toxics Hot Spot Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors* (OEHHA, 2002). The use of the diesel PM CPF for assessing cancer risk is described in the OEHHA Guidelines (OEHHA, 2003). The potential cancer risk is estimated by multiplying the inhalation dose by the CPF of diesel PM, i.e., $1.1(mg/kg\text{-}day)^{-1}$.

C. Risk Characterization

Risk characterization is defined as the process of obtaining a quantitative estimate of risk. The risk characterization process integrates the results of air dispersion modeling and relevant toxicity data (e.g., diesel PM cancer potency factor) to estimate potential cancer or non-cancer health effects associated with air contaminant exposure.

Exposures to pollutants usually occur through different intake pathways, such as air breathing, dermal contact, ingestion of contaminated produce, and ingestion of fish that have taken up contaminants from water bodies. These exposures can all contribute to an individual's health risk. However, diesel PM risk is evaluated by the inhalation pathway only because the risk contributions by other pathways of exposure are known to be insignificant compared to the inhalation pathway and difficult to quantify. It should be noted that the background or ambient diesel PM concentrations are not incorporated into the risk quantification in this study. Therefore, the estimated potential health risk in the study should be viewed as an addition to the background impacts.

Because the risk characterization is an integrated process from a series of procedures, the overall associated uncertainties are also linked to the uncertainty from each procedural component. Additional details and associated uncertainty on the risk characterization are provided in the Toxic Hot Spot Program Risk Assessment Guidelines (OEHHA, 2003), and discussed in Section V-D.

In the following sections, the predicted cancer and non-cancer risk levels resulting from on-site and off-site emissions are presented. Note that the railyard related health risks in this report only present the impact of the BNSF Hobart Railyard, i.e., the impact from the other three railyards in the Commerce area are not addressed in this report.

1. *Risk Characterization Associated with On-Site Emissions*

a) Cancer Risk

> An **isopleth** is a line drawn on a map through all points of equal value of some measurable quantity; in this case, cancer risk.

The potential cancer risks levels associated with the estimated diesel PM emissions at the BNSF Hobart Railyard are displayed by using isopleths, based on the 80th percentile breathing rate and 70 year exposure duration for residents**.** In this study, ARB staff elected to present the cancer risk isopleths focusing on risk levels of 10, 25, 50, 100, 250, 500, and 1,000 in a million. Figure V-1 and Figure V-2 present these isopleths. Figure V-1 indicates the potential can risk levels of adjacent areas around the railyard, and Figure V-2 shows the potential risk impacts over regional areas. In each figure, the risk isopleths are overlaid onto a satellite image of the Commerce area surrounding the BNSF Hobart Railyard, to better illustrate the land use (residential, commercial, industrial, or mixed use) of these impacted areas.

The OEHHA Guidelines require that for health risk assessments, the cancer risk for the maximum exposure at the point of maximum impact should be reported. The point of maximum impact (PMI), which is defined as a location or the receptor point with the highest cancer risk level outside of the railyard boundary, with or without residential exposure, is predicted to be located at the north side of the railyard fence line, near the on-road container truck operation area. This is directly downwind of high emission density area for the prevailing southwesterly wind, where about 60 percent of facility-wide diesel PM emissions were generated (see the emission allocation in Appendix F). The cancer risk at the PMI is estimated to be about 3,000 chances in a million. The land use in the vicinity of the PMI is primarily zoned for transportation and industrial use. However, there can be residents potentially to live within this zoned area. In the residential zoned area, the potential cancer risk of maximally exposed individual resident (MEIR) or maximum individual cancer risk (MICR) is estimated at about 500 chances in a million. As indicated by Roseville Railyard Study (ARB, 2004a), the location of the PMI may vary depending upon the settings of the model inputs and parameters, such as meteorological data set or emission allocations in the railyard. Therefore, given the estimated emissions, modeling settings, and the assumptions applied to the risk assessment, there are great uncertainties associated with the estimation of PMI and MICR. These indications should not be interpreted as a literal prediction of disease incidence but more as a tool for comparison. In addition, the estimated point of maximum impact and maximum individual cancer risk may not be replicated by air monitoring.

ARB staff also conducted a comparison of cancer risks estimated at the PMI versus MICR, and the differences of facility-wide diesel PM emissions between the UP and BNSF railyards. The ratios of cancer risks at the PMI or MICR to the diesel PM emissions do not suggest that one railroad's facilities have statistically higher cancer risks than the other railroad's or vice versa. Rather, the differences are primarily due to emission spatial distributions from individual operations among railyards.

Figure V-1: Estimated Adjacent Area Potential Cancer Risks (Chances per Million) Associated with the Diesel PM Emissions from the BNSF Hobart Railyard

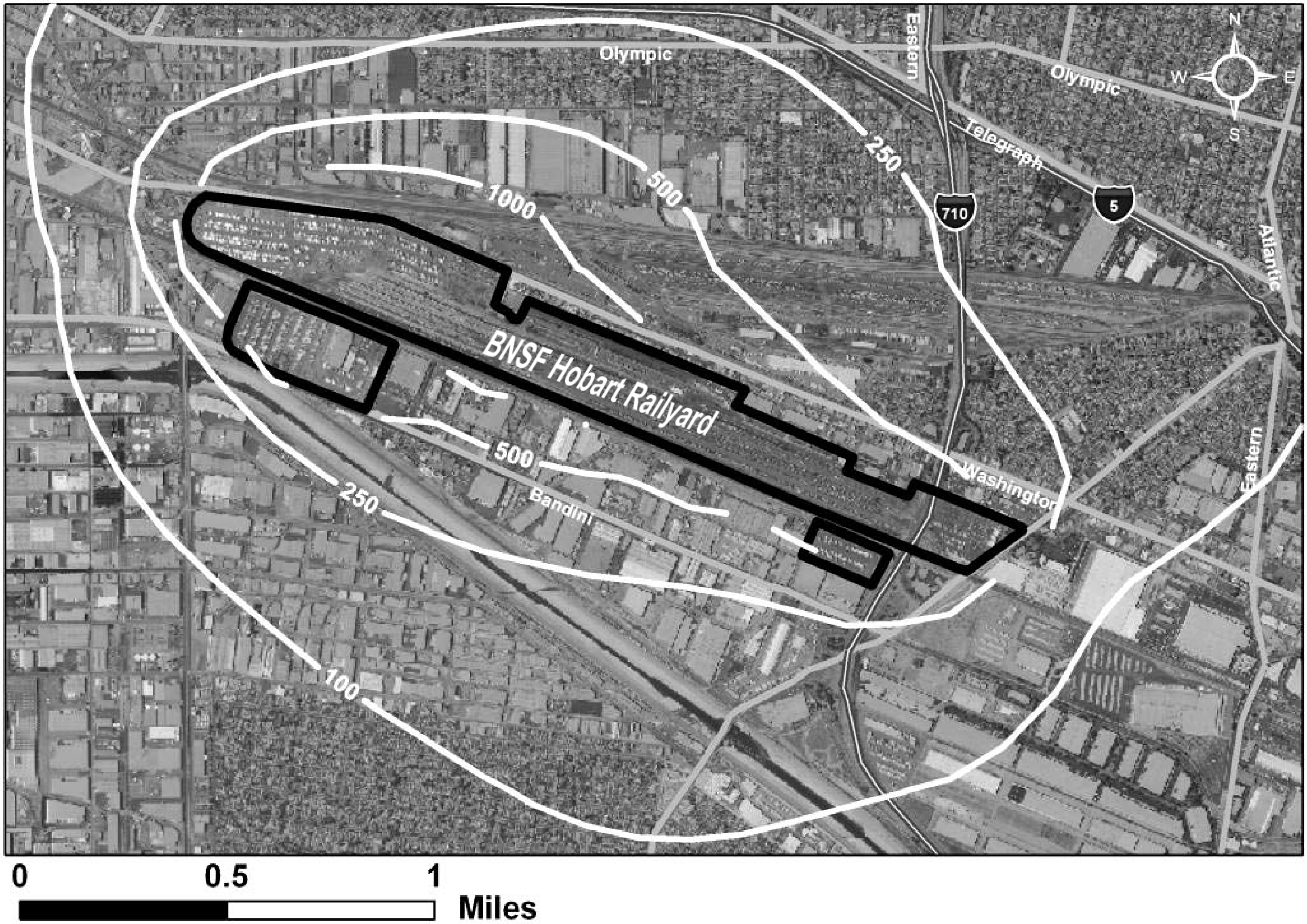


Figure V-2: Estimated Regional Area Potential Cancer Risks (Chances per Million) Associated with the Diesel PM Emissions from the BNSF Hobart Railyard

As indicated by Figure V-1 and Figure V-2, the area with the greatest impact has an estimated potential cancer risk of over 1000 chances in a million, occurring in the area right next to the boundaries of the railyard fence line. The land use of this area is identified as industrial use. Because of the characteristics of meteorology, the ambient diesel PM concentrations become more dispersive northeast of the railyard. The estimated potential cancer risks are about 500 chances in a million at approximately 300 yards (up to 600 yards in the northeast) from the railyard boundaries. The land within this zone is mainly for industrial use; only about 100 residents live within this zone. The estimated cancer risks decrease to about 250 in a million at approximately a half mile (up to one mile in the northeast) from the railyard boundaries. Some residential areas are located in the north part of this zone. At about one mile from the railyard boundaries (up to two miles in the northeast) from the railyard boundaries, the estimated cancer risks decrease to about 100 chances per million. The estimated potential cancer risks further decrease to 50 in a million at about 1.5 miles (up to 3.5 miles in the northeast) from the railyard boundaries, then to 25 in a million at approximately 2.5 miles (up to 5 miles in the northeast) from the railyard boundaries. At about 4 miles (up to 8 miles in the northeast) from the railyard boundaries, the estimated cancer risks are at 10 in a million or lower.

It is important to understand that these risk levels represent the predicted risks (due to the BNSF Hobart Railyard diesel PM emissions) above the existing background risk levels. For the broader South Coast Air Basin, the estimated regional background risk level is estimated to be 720 in a million caused by diesel PM and about 1,000 in a million caused by all toxic air pollutants in the year of 2000 (ARB, 2006c).

The OEHHA Guidelines recommend a 70-year lifetime exposure duration to evaluate the potential cancer risks for residents. Shorter exposure durations of 30 years and 9 years may be evaluated for residents and school-age children, respectively, as a supplement. These three exposure durations – 70 years, 30 years, and 9 years – all assume exposure for 24 hours a day, and 7 days a week. It is important to note that children, for physiological as well as behavioral reasons, have higher rates of exposure than adults on a per unit body weight basis (OEHHA, 2003).

To evaluate the potential cancer risks for off-site workers, the OEHHA Guidelines recommend that a 40-year exposure duration be used, assuming workers have a different breathing rate (149 L kg^{-1} day^{-1}) and exposure for an 8-hour workday, five days a week, 245 days a year.

Table V-1 shows the equivalent risk levels of 70- and 30-year exposure durations for exposed residents; and 40- and 9-year exposure durations for off-site workers and school-age children, respectively. As shown in Table V-1, the 10 in a million isopleth line in Figure V-2 would become 4 in a million for exposed population with a shorter residency of 30 years, 2.5 in a million for exposed school-age children, and 2 in a million for off-site workers.

To conservatively communicate the risks, ARB staff presents the estimated cancer risk isopleths all based on 70-year resident exposure duration, even for those impacted industrial areas where no resident lives.

Table V-1: Equivalent Potential Cancer Risk Levels for 70-, 40-, 30- and 9-Year Exposure Durations

Exposure Duration (years)	Equivalent Risk Level (chance in a million)					
70	10	25	50	100	250	500
30	4	11	21	43	107	214
9*	2.5	6.3	12.5	25	63	125
40‡	2	5	10	20	50	100

* Exposure duration for school-aged children.
‡ Exposure duration for off-site workers.

The more populated areas near the BNSF Hobart Railyard are located north and south of the railyard. There is a triangle residential area between the BNSF Hobart Railyard and UP Commerce Railyard. Most part of this triangle area has an estimated potential risk of over 100 chances in a million. Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated risks above 10 chances in a million levels encompasses approximately 51,000 acres where about 848,000 residents live. Table V-2 presents the exposed population and area coverage size for various impacted zones of cancer risks.

Table V-2: Impacted Areas and Exposed Population Estimated for the Diesel PM Emissions from the BNSF Hobart Railyard

Estimated Cancer Risk (chances per million)	Impacted Area (acres)	Estimated Population Exposed
10 - 25	33,000	552,000
26 - 50	10,000	156,000
51 - 100	4,700	92,000
101 - 250	2,500	41,000
251 - 500	700	7,100
501 - 1000	270	100
> 1000	70	0

Individuals may be more sensitive to toxic exposures than the general population. These sensitive populations are identified as school-age children and seniors. The sensitive receptors include schools, hospitals, day-care centers and elder care facilities. There are 28 sensitive receptors around the BNSF Hobart Railyard from the distance of 2 miles, including 8 schools, 12 child care centers and 8 hospitals. Table V-3 summarizes the number of sensitive receptors in various levels of estimated cancer risks for 70-year exposure duration.

Table V-3: Estimated Number of Sensitive Receptors at Various Levels of Potential Cancer Risks Associated with Diesel PM Emissions from the BNSF Hobart Railyard

Estimated Cancer Risk (chances in a million)	Number of Sensitive Receptors
51 – 100	10
101 – 250	13
251 – 500	5

b) Non-Cancer Chronic Risk

The quantitative relationship between the amount of exposure to a substance and the incidence or occurrence of an adverse health impact is called the dose-response assessment. According to the OEHHA Guidelines (OEHHA, 2003), dose-response information for non-carcinogens is presented in the form of Reference Exposure Levels (RELs). OEHHA has developed chronic RELs for assessing non-cancer health impacts from long-term exposure.

A chronic REL is a concentration level, expressed in units of micrograms per cubic meter ($\mu g/m^3$) for inhalation exposure, at or below which no adverse health effects are anticipated following long-term exposure. Long-term exposure for these purposes has been defined as 12% of a lifetime, or about eight years for humans (OEHHA, 2003).

The methodology for developing chronic RELs is fundamentally the same as that used by U.S. EPA in developing the inhalation Reference Concentrations (RfCs) and oral Reference Doses (RfDs). Chronic RELs are frequently calculated by dividing the no observed adverse effect level (NOAEL) or lowest observed adverse effect levels (LOAEL) in human or animal studies by uncertainty factors (OEHHA, 2003).

A substantial number of epidemiologic studies have found a strong association between exposure to ambient particulate matter and adverse health effects. For diesel PM, OEHHA has determined a chronic REL at 5 $\mu g/m^3$, with the respiratory system as the hazard index target (OEHHA, 2003).

It should be emphasized that exceeding the chronic REL does not necessarily indicate that an adverse health impact will occur. However, levels of exposure above the REL have an increasing but undefined probability of resulting in an adverse health impact, particularly in sensitive individuals (e.g., the very young, the elderly, pregnant women, and those with acute or chronic illnesses).

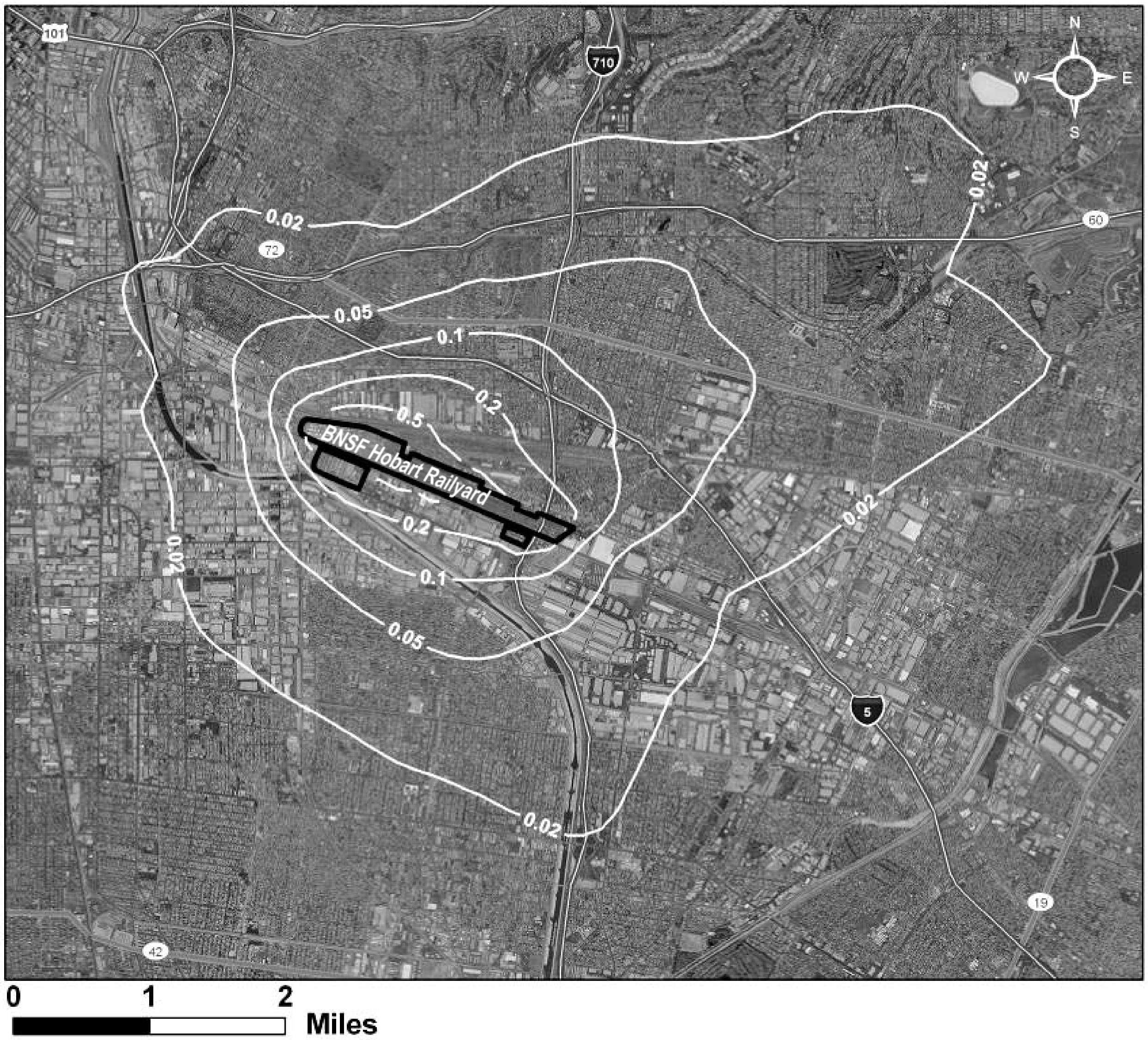
The significance of exceeding the REL is dependent on the seriousness of the health endpoint, the strength and interpretation of the health studies, the magnitude of combined safety factors, and other considerations (OEHHA, 2003).

It is important to note that Reference Exposure Level (REL) for diesel PM is essentially the U.S. EPA Reference Concentration first developed in the early 1990s based on histological changes in the lungs of rats. Since the identification of diesel PM as a Toxic Air Contaminant (TAC), California has evaluated the latest literature on particulate matter health effects to set the Ambient Air Quality Standard. Diesel PM is a component of particulate matter. Health effects from particulate matter in humans include illness and death from cardiovascular and respiratory disease, and exacerbation of asthma and other respiratory illnesses. Additionally, a body of literature has been published, largely after the identification of diesel PM as a TAC and adoption of the REL, which shows that diesel PM can enhance allergic responses in humans and animals. Thus, it should be noted that the REL does not reflect adverse impacts of particulate matter on cardiovascular and respiratory disease and deaths, exacerbation of asthma, and enhancement of allergic response.

The hazard index (HI) is then calculated by taking the annual average diesel PM concentration, and dividing by the chronic REL of 5 $\mu g/m^3$. An HI value of 1 or greater indicates an exceedance of the chronic REL, and some adverse health impact would be expected.

As part of this study, ARB staff conducted an analysis of the potential non-cancer chronic health impacts associated with exposures to the model-predicted levels of directly emitted diesel PM from on-site sources. The HI values were calculated, and then plotted as a series of isopleths in Figure V-3. As can be seen, the potential non-cancer chronic health hazard index from diesel PM emissions for the residential area around the BNSF Hobart railyard are estimated to be less than 0.5. According to OEHHA Guidelines (OEHHA, 2003), these levels indicate that the potential non-cancer chronic public health risks are less likely to happen. A small region right next to the northwest side the BNSF Hobart Railyard fence line has a HI value over 1.0. The land use of this region is identified as industrial use. No residential or sensitive receptors were identified within this zone.

Figure V-3: Estimated Potential Non-Cancer Chronic Health Risks (Indicated as Hazard Indices) Associated with the Diesel PM Emissions from the BNSF Hobart Railyard



c) Non-Cancer Acute Risk

According to the OEHHA guidelines, an acute reference exposure level (REL) is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to that concentration for the specified exposure duration (generally one hour) on an intermittent basis. Non-cancer acute risk characterization involves calculating the maximum potential health impacts, based on short-term acute exposure and reference exposure levels. Non-cancer acute impacts for a single pollutant are estimated by calculating a hazard index.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute REL. It is only specific compounds of diesel exhaust (e.g., acrolein) that independently have potential acute effects (such as irritation of the eyes and respiratory tract), and an assigned acute REL. However, acrolein is primarily used as a chemical intermediate in the manufacture of adhesives and paper. It has also been found as a byproduct of any burning process, such as fire, and tobacco smoke. Acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other compounds in the diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. More importantly, given the multitude of activities ongoing at facilities as complex as railyards, there are much higher levels of uncertainties associated with hourly-specific emission data and estimated maximum concentrations, which are essential to assess acute risk. Therefore, non-cancer acute risk is not addressed quantitatively in this study. From a risk management perspective, ARB staff believes it is reasonable to focus on diesel PM cancer risk because it is the predominant risk driver and the most effective parameter to evaluate risk reduction actions. Further, actions to reduce diesel PM will also reduce non-cancer risks.

The cumulative impacts (cancer and non-cancer risks) from all four Commerce railyards are presented in a separate report.

2. *Risk Characterization Associated with Off-Site Emissions*

ARB staff evaluated the impacts from off-site pollution sources near the BNSF Hobart Railyard facility using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM emission sources located within a two-mile distance from the joint boundaries of the four Commerce railyards were included. Diesel PM off-site emissions used in the off-site modeling runs consisted of about 113.2 tons per year from roadways and 0.2 tons per year from stationary facilities, representing emissions for 2005. The diesel PM emissions from all four Commerce railyards are not analyzed in the off-site air dispersion modeling. The same meteorological data and coarse receptor grid system used for on-site air dispersion modeling was used for the off-site modeling runs.

The estimated potential cancer risks and non-cancer chronic health hazard index associated with off-site diesel PM emissions are illustrated in Figure V-4 and Figure V-5, respectively. As indicated in Figure V-4, the zone of impacts of estimated cancer risks associated with off-site diesel PM emissions is significantly larger than that of the BNSF Hobart Railyard. This result is expected because the diesel PM emissions from the significant off-site sources are equivalent to five times of the BNSF Hobart Railyard diesel PM emissions. Figure V-5 illustrates that the non-cancer chronic health risks associated with off-site diesel PM emissions are insignificant.

Based on the 2000 U.S. Census Bureau’s data, the zone of impact of the estimated potential cancer risks above 100 cases in a million levels associated with off-site diesel PM emissions encompasses approximately 28,000 acres where about 430,000 residents live. For comparison with the BNSF Hobart Railyard health risks, the same level of potential cancer risks (100 cases in a million) associated with railyard diesel PM emissions covers about 3,700 acres with a population of approximately 48,000. Detailed calculations and methodologies used in off-site air dispersion modeling are presented in Appendix C. Table V-4 presents the exposed population and area coverage size for various impacted zones of cancer risks associated with off-site diesel PM emissions.

Table V-4: Impacted Areas and Exposed Population Estimated for the Off-Site Diesel PM Emissions

Estimated Cancer Risk (chances per million)	Impacted Area (acres)	Estimated Population Exposed
10 - 25	126,000*	650,000*
26 - 50	25,420*	529,000*
51 - 100	18,070*	303,000*
101 - 250	17,350	285,000
251 - 500	8,610	100,000
>500	2,330	45,000

*: Approximate estimates due to partial of these isopleths extend beyond the air dispersion model domain.

Figure V-4: Estimated Potential Cancer Risk Levels (Chances per Million) Associated with the Off-Site Diesel PM

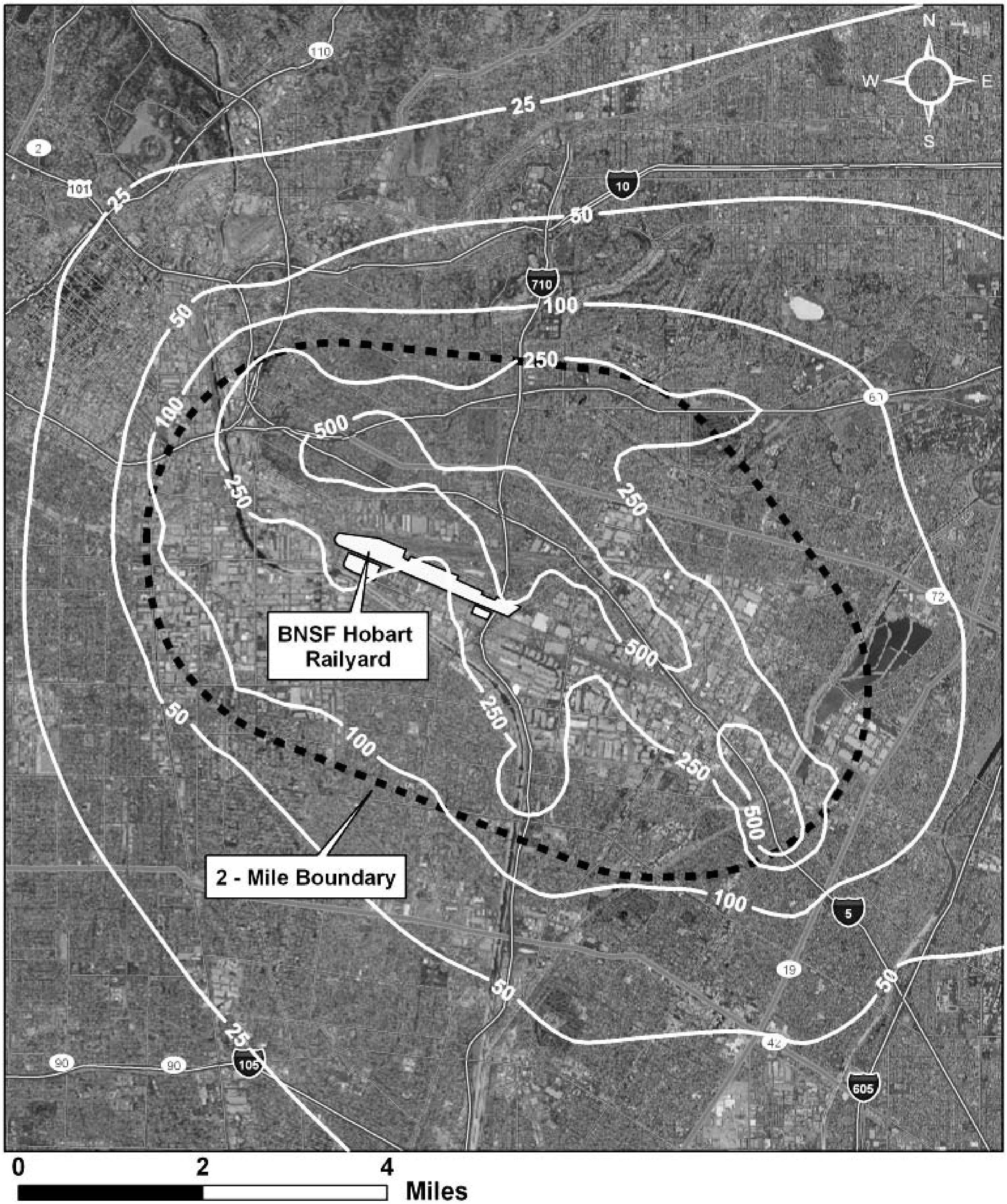
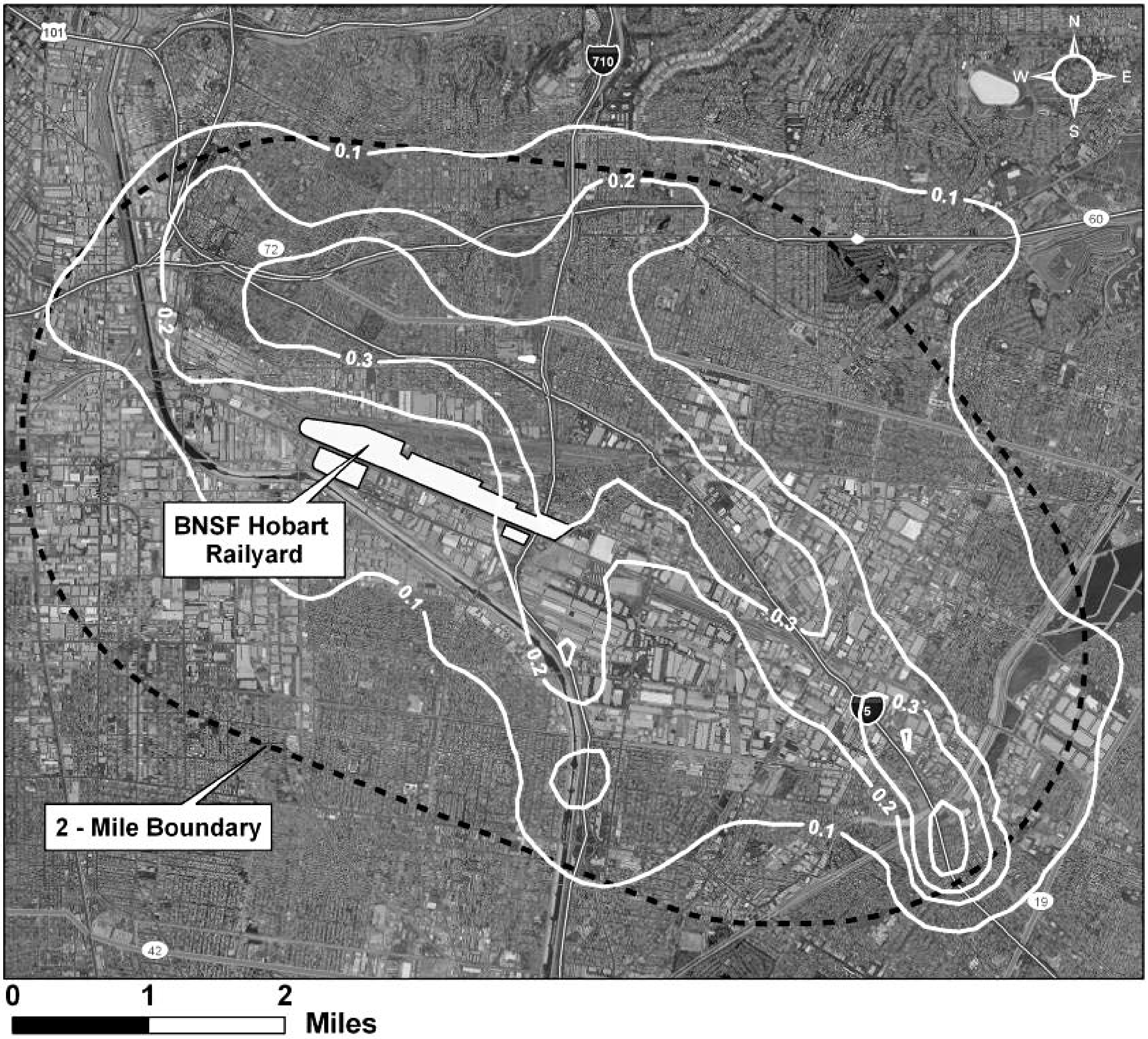


Figure V-5: Estimated Potential Non-Cancer Chronic Health Risks (Indicated as Hazard Indices) Associated with the Off-Site Diesel PM Emissions



D. Uncertainty and Limitations

Risk assessment is a complex procedure which requires the integration of many variables and assumptions. The estimated diesel PM concentrations and risk levels produced by a risk assessment are based on several assumptions, many of which are designed to be health protective so that potential risks to individual are not underestimated.

As described previously, the health risk assessment consists of three components: (1) emission inventory, (2) air dispersion modeling, and (3) risk assessment. Each component has a certain degree of uncertainty associated with its estimation and prediction due to the assumptions made. Therefore, there are uncertainties and limitations with the results.

The following subsections describe the specific sources of uncertainties in each component. In combination, these various factors may result in potential uncertainties in the location and magnitude of predicted concentrations, as well as the potential health effects actually associated with a particular level of exposure.

1. Emission Inventory

The emission rate often is considered to be proportional to the type and magnitude of the activity at a source, e.g., the operation. Ideally, emissions from a source can be calculated on the basis of measured concentrations of the pollutant in the sources and emission strengths, e.g., a continuous emission monitor. This approach can be very costly and time consuming and is not often used for emission estimation. Instead, emissions are usually estimated by the operation activities or fuel consumption and associated emission factors based on source tests.

The uncertainties of emission estimates may be attributed to many factors such as a lack of information for variability of locomotive engine type, throttle setting, level of maintenance, operation time, and emission factor estimates. Quantifying individual uncertainties is a complex process and may in itself introduce unpredictable uncertainties[6].

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[6] The railyard HRAs have been performed using a methodology according to the ARB's and OEHHA Guidelines, and consistent with previous health risk analyses conducted by ARB. Similar to any model with estimations, the primary barriers of an HRA to determine objective probabilities are lack of adequate scientific understanding and more precise levels of data. Subjective probabilities are also not always available.

Tier-1 methodology is a conservative point approach but suitable for the current HRA's scope, given the condition and lack of probability data. Tier-1 approach used in the HRAs is consistent with previous health risk analyses performed by ARB, "The Roseville Railyard Study (ARB, 2004)" and "Diesel PM Exposure Assessment Study for the Ports of Los Angeles and Long Beach (ARB, 2006b)". By recognizing associated uncertainties or variability, the HRAs have qualitatively discussed the limitation and caveats of possible underestimation and overestimation in emission inventory and modeling predictions because of assumptions and simplifications. The discussion provides an additional reference for HRA results even though quantitative uncertainty bounds are unavailable. Most importantly, it is not practical to characterize and quantify the uncertainty of estimated health risks without the support of robust scientific data and actual probability distribution functions of model variables. An attempt to incorporate subjective judgments on uncertainty analyses can lead to misinterpretation of HRA findings.

For locomotive sources at the BNSF Hobart Railyard, the activity rates include primarily the number of engines in operation and the time spent in different power settings. The methodology used for the locomotive emissions is based on these facility-specific activity data. The number of engines operating in the facility is generally well-tallied by BNSF's electronic monitoring of locomotives entering and leaving the railyard. However, the monitoring under certain circumstances may produce duplicate readings that can result in overestimates of locomotive activity. In addition to recorded activity data, surveys and communications with facility personnel, and correlations from other existing data, (e.g., from the Roseville Railyard Study (ARB, 2004a)), all were used to verify the emission estimations in the emission inventory.

Uncertainties also exist in estimates of the engine time in mode. Idling is typically the most significant operational mode, but locomotive event recorder data could not distinguish when an engine is on or off during periods when the locomotive is in the idle notch. As a result, a professional judgment is applied to distinguish between these two modes. While the current operations may not be precisely known, control measures already being implemented are expected to result in reduced activity levels and lower emissions than are estimated here for future years.

As discussed previously, emission factors are often used for emission estimates according to different operating cycles. The Roseville Railyard Study (ARB, 2004a) developed representative diesel PM emission factors for locomotives in different duty cycles. To reduce the possible variability of locomotive population and the uncertainty from assumptions, the emission factors were updated in the study to cover a wide range of locomotive fleet in the State (see Appendix D). The fuel usage in the locomotives in 2005 was calculated from the BNSF's annual fuel consumption database. These critical updates for locomotive emission inventory have established the most representative locomotive emission factors for the study.

For non-locomotive emissions, uncertainty associated with vehicles and equipment at the railyard facility also exists because the duty cycles (i.e., engine load demanded) are less well characterized. Default estimates of the duty cycle parameters may not accurately reflect the typical duty demanded from these vehicles and equipment at any particular site. In addition, national and state regulations have targeted these sources for emission reductions. Implementation of these rules and fleet turnover to newer engines meeting more strict standards should significantly reduce emissions at these rail sites in future years. However, the effects of these regulations have not been incorporated in the emission estimates, so estimated emissions are greater than those expected for future years at the same activity level.

2. Air Dispersion Modeling

An air dispersion model is derived from atmospheric diffusion theory with assumptions or, alternatively, by solution of the atmospheric-diffusion equation assuming simplified forms of effective diffusivity. Within the limits of the simplifications involved in its derivation, the model-associated uncertainties are vulnerably propagated into its downstream applications.

Model uncertainty may stem from data gaps that are filled by the use of assumptions. Uncertainty is often considered as a measure of the incompleteness of one's knowledge or information about a variate whose true value could be established if a perfect measurement is available. The structure of mathematical models employed to represent scenarios and phenomena of interest is often a key source of model uncertainty, due to the fact that models are often only a simplified representation of a real-world system, such as the limitation of model formulation, the parameterization of complex processes, and the approximation of numerical calculations. These uncertainties are inherent and exclusively caused by the model's inability to represent a complex aerodynamic process. An air dispersion model usually uses simplified atmospheric conditions to simulate pollutant transport in the air, and these conditions become inputs to the models (e.g., the use of non site-specific meteorological data, uniform wind speed over the simulating domain, use of surface parameters for the meteorological station as opposed to the railyard, substitution of missing meteorological data, and simplified emission source representation). There are also other physical dynamics in the transport process, such as the small-scale turbulent flow in the air, which are not characterized by the air dispersion models. As a result of the simplified representation of real-world physics, deviations in pollutant concentrations predicted by the models may occur due to the introduced uncertainty sources.

The other type of uncertainty is referred as reducible uncertainty, a result of uncertainties associated with input parameters of the known conditions, which include source characteristics and meteorological inputs. However, the uncertainties in air dispersion models have been improved over the years because of better representations in the model structure. In 2006, the U.S. EPA modeling guidance was updated to replace the Industrial Source Complex model with AERMOD as a recommended regulatory air dispersion model for determining single source and source complex. Many updated formulations have been incorporated into the model structure from its predecessor, ISCST3, for better predictions from the air dispersion process. Nevertheless, quantifying overall uncertainty of model predictions is infeasible due to the associated uncertainties described above, and is beyond the scope of this study.

3. *Risk Assessment*

The toxicity of toxic air contaminants is often established by available epidemiological studies, or, where data from humans are not available, the use of data from animal studies. The diesel PM cancer potency factor is based on long-term study of railyard workers exposed to diesel exhaust at concentrations approximately ten times typical ambient exposures (OEHHA, 2003). The differences within human populations usually cannot be easily quantified and incorporated into risk assessments. Factors including metabolism, target site sensitivity, diet, immunological responses, and genetics may influence the response to toxicants. In addition, the human population is much more diverse both genetically and culturally (e.g., lifestyle, diet) than inbred experimental animals. The variability among humans is expected to be much greater than in laboratory animals. Adjustment for tumors at multiple sites induced by some carcinogens could result in a higher potency. Other uncertainties arise (1) in the assumptions underlying the dose-response model used, and (2) in extrapolating from large experimental doses, where, for example, other toxic effects may compromise the assessment of carcinogenic potential due to much smaller environmental doses. Also, only single tumor sites induced by a substance are usually considered. When epidemiological data are used to generate a carcinogenic potency, less uncertainty is involved in the extrapolation from workplace exposures to environmental exposures. However, children, a subpopulation whose hematological, nervous, endocrine, and immune systems are still developing and who may be more sensitive to the effects of carcinogens on their developing systems, are not included in the worker population and risk estimates based on occupational epidemiological data are more uncertain for children than adults.

Estimates of human exposures to diesel PM are often based on limited availability of data and are mostly derived based on estimates of emissions and duration of exposure. Different epidemiological studies also suggest somewhat different levels of risk. When the Scientific Review Panel (SRP) identified diesel PM as a toxic air contaminant (ARB, 1998), the panel members endorsed a range of inhalation cancer potency factors (1.3 x 10^{-4} to 2.4 x 10^{-3} $(\mu g/m^3)^{-1}$) and a risk factor of 3×10^{-4} $(\mu g/m^3)^{-1}$, as a reasonable estimate of the unit risk. From the unit risk factor an inhalation cancer potency factor of 1.1 $(mg/kg\text{-}day)^{-1}$ can be calculated, which is used in the study. There are many epidemiological studies that support the finding that diesel exhaust exposure elevates relative risk for lung cancer. However, the quantification of each uncertainty applied in the estimate of cancer potency is very difficult and can be itself uncertain

This study adopts the standard Tier 1 approach recommended by the OEHHA for exposure and risk assessment. The Tier 1 approach is an end-point estimate methodology without the consideration of site-specific data distributions. The OEHHA recommends the lifetime 70-year exposure duration with a 24-hour per day exposure be used for determining residential cancer risks. This will ensure a person residing in the vicinity of a facility for a lifetime will be included in the evaluation of risk posed by the facility. Lifetime 70-year exposure is a conservative estimate, but it is a historical benchmark for comparing facility impacts on receptors and for evaluating the effectiveness of air pollution control measures. Although it is not likely that most people will reside at a single residence for 70 years, it is common that people will spend their entire lives in a major urban area. While residing in urban areas, it is very possible to be exposed to the emissions of another facility at the next residence. In order to help ensure that people do not accumulate an excess unacceptable cancer risk from cumulative exposure to stationary facilities at multiple residences, the 70-year exposure duration is used for risk management decisions. However, if a facility is notifying the public regarding health risk, it is a useful indication for a person who has resided in his or her current residence less than 70 years to know that the calculated estimate of his or her cancer risk is less than that calculated for a 70-year risk (OEHHA, 2003). It is important that the risk estimates generated in this study not be interpreted as the expected rates of disease in the exposed population, but rather as estimates of potential risk. Risk assessment is best viewed as a comparative tool rather than a literal prediction of diesel incidence in a community.

Moreover, since the Tier-1 methodology is used in the study for the health risk assessment, the results have been limited to deterministic estimates based on conservative inputs. For example, an 80^{th} percentile breathing rate approach is used to represent a 70-year lifetime inhalation that tends toward the high end for the general population. Moreover, the results based on the Tier-1 estimates do not provide an indication of the magnitude of uncertainty surrounding the quantities estimated, nor an insight into the key sources of underlying uncertainty.

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APPENDIX A

METHODOLOGY FOR ESTIMATING OFF-SITE MOBILE SOURCE DIESEL PM EMISSIONS

Introduction:

This assessment includes on-road mobile emissions from all heavy duty diesel truck running exhaust as it is the primary source of diesel particulate emissions within the on-road vehicle fleet. Traditionally, on-road mobile emission inventories are generated at the county scale using California's emission factor model EMFAC and then allocated to large grid cells using the Direct Travel Impact Model (DTIM). To enhance the spatial resolution we have estimated emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a 2-mile buffer of the combined Commerce yards and all links within a 1-mile buffer of all other yards were included in this assessment.

As more and more work has been done to understand transportation modeling and forecasting, access to local scale vehicle activity data has increased. For example, the various Metropolitan Planning Organizations (MPOs) are mandated by the Federal government to maintain a regional transportation plan and regional transportation improvement plan. These reports assess the impact the travel growth and assess various transportation improvement plans[1]. Planning is based on travel activity results from Transportation Demand Models (TDMs) that forecast traffic volumes and other characteristics of the transportation system. Currently, more than a dozen MPOs as well as the California Department of Transportation (Caltrans) maintain transportation demand models. Through a system of mathematical equations TDMs estimate vehicle population and activity estimates such as speed and vehicle miles traveled (VMT) based on data about population, employment, surveys, income, roadway and transit networks and transportation costs. The activity is then assigned a spatial and temporal distribution by allocating them to roadway links and time periods. A roadway link is defined as a discrete section of roadway with unique estimates for the fleet specific population and average speed and is classified as a freeway, ramp, major arterial, minor arterial, collector, or centroid connector. Link based emission inventory development utilizes these enhanced spatial data and fleet and pollutant specific emission factors to estimate emissions at the neighborhood scale.

Methodology:

Estimating emissions from on-road mobile sources outside the rail yards was broken into four main processes and described below. The first step involves gathering vehicle activity data specific to each link on the roadway network. Each link contains 24 hours worth of activity data including vehicle miles traveled, vehicle type, and speed. The activity is then apportioned to the various heavy duty diesel truck types (Table A-1) where speed-specific VMT is then matched to an emission factor from EMFAC to estimate total emissions from each vehicle type for each hour of the day. The working draft of EMFAC (version V2.23.7), rather than EMFAC2007, was used for this assessment because at the time this project was underway EMFAC2007 was not completed. The working draft of EMFAC (version V2.23.7), however, contains nearly all the revisions in EMFAC2007 that would affect these calculations.

Table A-1: Heavy Duty Truck Categories

Class	Description	Weight (GVW)	Abbreviation	Technology Group
T4	**Light-Heavy Duty Diesel Trucks**	8,501-10,000	LHDDT1	DIESEL
T5	**Light-Heavy Duty Diesel Trucks**	10,001-14,000	LHDDT2	DIESEL
T6	**Medium-Heavy Duty Diesel Trucks**	14,001-33,000	MHDDT	DIESEL
T7	**Heavy-Heavy Duty Diesel Trucks**	33,001+	HHDDT	DIESEL

Step 1: Obtain Link-Specific Activity Data

The link specific activity data for heavy duty trucks necessary to estimate emissions are speed and vehicle miles traveled (VMT), where VMT is a product of vehicle volume (population) and link length. Link activity for Ventura, Los Angeles, Orange, and more than 90% of Riverside and San Bernardino counties are provided by the Southern California Association of Governments (SCAG) Heavy Duty Truck Transportation Demand Model. Heavy duty truck activity is modeled using truck specific data, commodity flows and goods movement data. SCAG, however, is the only MPO with a heavy duty truck model. The remaining counties under the rail yard study are covered by the Integrated Transportation Network (ITN) developed by Alpine Geophysics[2]. The Integrated Transportation Network was developed by stitching together MPO transportation networks and the Caltrans statewide transportation network. Link specific truck activity from the ITN is estimated as a fraction of the total traffic on the links[2] and is based on the fraction of trucks within each county as it is estimated in EMFAC.

The product of truck volume and link length is referred to as vehicle miles traveled (VMT) and has units of miles. Transportation demand models provide total VMT for each link without further classification into the various heavy duty truck weight and fuel type classifications. Therefore, in order to assess the emissions only from heavy duty diesel trucks the total heavy duty truck VMT is multiplied by the fraction of trucks that are diesel. Once the total diesel VMT is calculated the heavy duty truck diesel VMT is multiplied by the fraction of trucks that make up the four weight classifications. The fuel and weight fractions are specific to each county and are derived from total VMT for each weight and fuel class in EMFAC for each county. The data is then compiled into an activity matrix (Table A-2) composed of a link identification code, hour of the day, speed, light heavy duty diesel 1 truck (LHDDT1) VMT, light heavy duty diesel 2 truck (LHDDT2) VMT, medium heavy duty diesel truck (MHDDT) VMT, and heavy heavy duty diesel truck (HHDDT) VMT.

Table A-2: Activity Matrix Example

49761	12	45	0.37	0.48	3.17	5.51
49761	**3**	**45**	0.14	0.18	1.16	**2.00**
49761	3	35	0.16	0.21	1.37	2.38
50234	4	55	0.19	0.26	1.68	2.92

Step 2: Derive Gram per Mile Emission Factors

The second step of the emission inventory process involves developing emission factors for all source categories for a specified time period, emission type, and pollutant. Running exhaust emission factors based on vehicle type, fuel type and speed were developed from the Emfac mode of EMFAC. These are composite emission factors based on the model year distribution for each county and provided in units of grams of emissions per mile traveled. Emission factors are based on test cycles that reflect typical driving patterns, and non-extended idling is included.

Finally, a matrix of emission factors by speed and vehicle type was assembled for each county for light heavy-duty diesel trucks 1 and 2 (LHDDT1 and LHDDT2), medium heavy-duty diesel trucks (MHDDT) and heavy heavy-duty diesel trucks (HHDDT). The following is an example of such a matrix (Table A-3):

Table A-3: Emission Factor Matrix Example

	Diesel PM Emission Factors (g/mile)			
Speed (mph)	**LHD1** DSL	**LHD2** DSL	**MHD** DSL	**HHD** DSL
12	0.101	0.145	0.631	2.371
20	0.072	0.105	0.455	1.277
45	0.037	0.054	0.235	**0.728**
60	0.033	0.047	0.206	1.095

Step 3: Calculate Emissions

Diesel particulate matter (DPM) emission factors are provided as grams per mile specific to each speed and heavy duty truck type (see table above). To estimate emissions the activity for each diesel heavy duty truck type was matched to the corresponding emission factor (EF). For example, a 0.25 mile long link at 3 am in the morning has 8 heavy heavy-duty diesel trucks (HHDDTs) traveling at 45 miles per hour. This equates to a VMT of 2.00 miles (8 trucks*0.25 miles). EMFAC has provided a gram per mile emission factor for HHDDT traveling at 45 mph in Los Angeles County as

0.728 grams DPM/mile. In order to estimate total emissions from HHDDTs on that link during that hour of the day the following calculation is made:

$$TotalEmissions(\,grams\,) = EF \cdot (Volume \cdot LinkLength\,) = EF \cdot VMT$$
$$TotalEmissions(\,grams\,) = EF \cdot VMT = 0.728\,\frac{grams}{mile} \cdot 2.00 miles = 1.45 grams$$

The steps outlined above and in Steps 1 and 2 can be represented with this single equation that provides an emissions total for each link for each hour of the day.

$$Emissions = VMT_{link} \cdot \sum_{i,j} Fraction_{i,j} \cdot EF_{i,j}$$

where

- Emissions – the total emissions in grams for each link
- i = represents the individual diesel heavy duty truck types (LHDDT1, LHDDT2 – light heavy duty diesel trucks 1 and 2; MHDDT – medium heavy duty diesel truck; and HHDDT – heavy heavy duty diesel truck)
- j – represent the hours of the day (hours 1-24)
- VMT_{Link} - total VMT for that link for all heavy duty trucks (gasoline and diesel)
- Fraction = the fraction of the VMT that is attributable to each diesel heavy duty truck type The fraction is estimated based on VMT estimates in EMFAC: Example: $VMT_{MHDDT}/VMT_{\text{all heavy duty trucks (gasoline \& diesel)}}$
- EF = the heavy duty diesel truck emission factors. The emission factor is vehicle type and speed specific and is thus matched according to the link specific activity parameters.

From this expression diesel particulate matter emissions are provided for each link and for each hour of the day. Finally, emissions are summed for all links for all hours of the day to provide a total daily emission inventory.

Step 4: QA/QC – Quality Assurance/Quality Control

To assure that the total emissions were calculated correctly the total emissions (grams) were divided by the total diesel VMT to estimate a composite diesel gram per mile emission factor. This back-calculated emission factor was checked against emission factors in EMFAC. In addition, where possible, heavy duty truck gate counts provided for the rail yards were checked against traffic volumes on the links residing by the gates.

Limitations and Caveats

We have made several important assumptions in developing this inventory. While these assumptions are appropriate at the county level they may be less appropriate for the particular areas modeled in this assessment. For example, the county specific default model year distribution within EMFAC, and vehicle type VMT fractions were assumed to be applicable for all links within the domain modeled. In the vicinity of significant heavy heavy-duty truck trip generators it is reasonable to expect that surrounding links will also have higher heavy heavy-duty truck fractions. In these cases using EMFAC county vehicle mix fractions may underestimate the total diesel particulate emissions from on-road heavy duty trucks. In this inventory EMFAC county defaults were employed as there is insufficient data available to assess the vehicle mix fractions surrounding the railyards.

Travel demand model results are checked by comparing actual traffic counts on links where the majority of vehicle travel takes place. Therefore, there will be greater uncertainty associated with activity from minor arterials, collectors, and centroid connectors than from higher volume freeways. Data based strictly on actual traffic counts for each street would provide better activity estimates, but unfortunately very little data is available for such an analysis. While links representing freeways are accurately allocated spatially, the allocation of neighborhood streets and other minor roads are not as well represented.

The emissions inventory developed for this study only included diesel particulate matter emissions from running exhaust as it is the primary diesel source from on-road mobile sources. Emissions from other modes such as off-road equipment, extended idling, starts, and off-road equipment outside the rail yards were excluded. Vehicle activity on roadways outside of distribution centers, railyards, and ports, however, are included as they are captured on the roadway network by the travel demand models.

REFERENCES

[1] "SCAG Transportation Modeling", http://www.scag.ca.gov/modeling/ [Accessed January 2007].

[2] Wilkinson, James (Alpine Geophysics); et al. "Development of the California Integrated Transportation Network (ITN)," Alpine Geophysics – Atmospheric and Hydrologic Sciences, La Honda, CA (2004). http://www.arb.ca.gov/airways/CCOS/docs/III3_0402_Jun06_fr.pdf

APPENDIX B

METHODOLOGY FOR ESTIMATING OFF-SITE STATIONARY SOURCE DIESEL PM EMISSIONS

Emissions from off-site stationary source facilities were identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts for stationary sources within their jurisdiction.

Geographic information system (GIS) mapping tools were used to create a one-mile buffer zone outside the property boundary footprint reported for each railyard. The CEIDARS facilities whose latitude/longitude coordinates fell within the one-mile buffer zone were selected. Because of the close proximity of railyards in the Commerce area, the four railyards (Commerce-BNSF, Commerce-UP-Main, Commerce-UP-Eastern, and Commerce-UP-Mechanical/Sheila) were enclosed in a combined polygon outline, and a two-mile buffer zone was then used around the combined polygon footprint.

The reported criteria pollutants in CEIDARS include carbon monoxide, nitrogen oxides, sulfur oxides, total organic gases, and particulate matter (PM). The reported toxic pollutants include the substances and facilities covered by the Air Toxics “Hot Spots” (AB 2588) program. Diesel exhaust particulate matter (diesel PM) was estimated from stationary internal combustion (IC) engines burning diesel fuel, operating at stationary sources reported in CEIDARS. Diesel PM emissions were derived from the reported criteria pollutant PM that is ten microns or less in diameter (criteria pollutant PM10) emitted from these engines. In a few cases, diesel exhaust PM was reported explicitly under the “Hot Spots” reporting provisions as a toxic pollutant, but generally the criteria pollutant PM10 reported at diesel IC engines was more comprehensive than the toxics inventory, and was, therefore, the primary source of data regarding diesel PM emissions.

The CEIDARS emissions represent annual average emission totals from routine operations at stationary sources. For the current analysis, the annual emissions were converted to grams per second, as required for modeling inputs for cancer and chronic non-cancer risk evaluation, by assuming uniform temporal operation during the year. (The available, reported emission data for acute, maximum hourly operations were insufficient to support estimation of acute, maximum hour exposures).

The CEIDARS 2004 database year was used to provide the most recent data available for stationary sources. Data for emissions, location coordinates, and stack/release characteristics were taken from data reported by the local air districts in the 2004 CEIDARS database wherever available. However, because microscale modeling requires extensive information at the detailed device and stack level that has not been routinely reported, historically, by many air districts, much of the stack/release information is not in CEIDARS. Gaps in the reported data were addressed in the following ways. Where latitude/longitude coordinates were not reported for the stack/release locations, prior year databases were first searched for valid coordinates, which provided some additional data. If no other data were available, then the coordinates reported for the overall facility were applied to the stack locations. Where parameters were not complete for the stack/release characteristics (i.e., height, diameter, gas temperature and velocity), prior year databases were first searched for valid data. If no reported parameters were available, then U.S. EPA stack defaults from the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) program were assigned. The U.S. EPA stack defaults are assigned based on the Source Classification Code (SCC) or Standard Industrial Classification (SIC) code of the operation. If an applicable U.S. EPA default was not available, then a final generic default was applied. To ensure that the microscale modeling results would be health-protective, the generic release parameters assumed relatively low height and buoyancy. Two generic defaults were used. First, if the emitting process was identifiable as a vent or other fugitive-type release, the default parameters assigned were a height of five feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. For all remaining unspecified and unassigned releases, the final generic default parameters assigned were a height of twenty feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. All English units used in the CEIDARS database were converted to metric units for use in the microscale modeling input files.

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APPENDIX C

METHODOLOGY FOR THE AIR DISPERSION MODELING OF OFF-SITE DIESEL PM EMISSIONS

Impacts from off-site pollution sources near the BNSF Hobart rail yard facility were modeled using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM (DPM) emission sources located out to a distance of two miles from the perimeter of the BNSF Hobart rail yard were included. Other emission sources that were located immediately beyond the two mile zone from the facility, such as a high-volume freeway, have the potential to impact receptors in the modeling grid, but were not considered.

To facilitate modeling of these off-site emission sources, the information summarized in Table C-1 was provided by external sources.

Table C-1. Data Provided by Others for Off-Site Emission Source Modeling.

Type of Data	Description	Data Source
Emission Estimates	Off-site DPM emissions for 2005 Mobile Sources: 113.2 TPY DPM Stationary Sources: 0.2 TPY DPM	PTSD/MSAB
Receptor Grid	41x41 Cartesian grid covering 400 km^2 with uniform spacing of 500 meters. Grid origin: (380400, 3753500) in UTM Zone 11.	Environ
Meteorological Data	AERMET-Processed data for 2005 *Surface*: Lynwood and LA/USC *Upper Air*: San Diego Miramar	Environ
Surface Data	Albedo: 0.15 to 0.19 Bowen Ratio: 0.52 to 4.71 Surface Roughness: 0.87 to 0.97	Environ

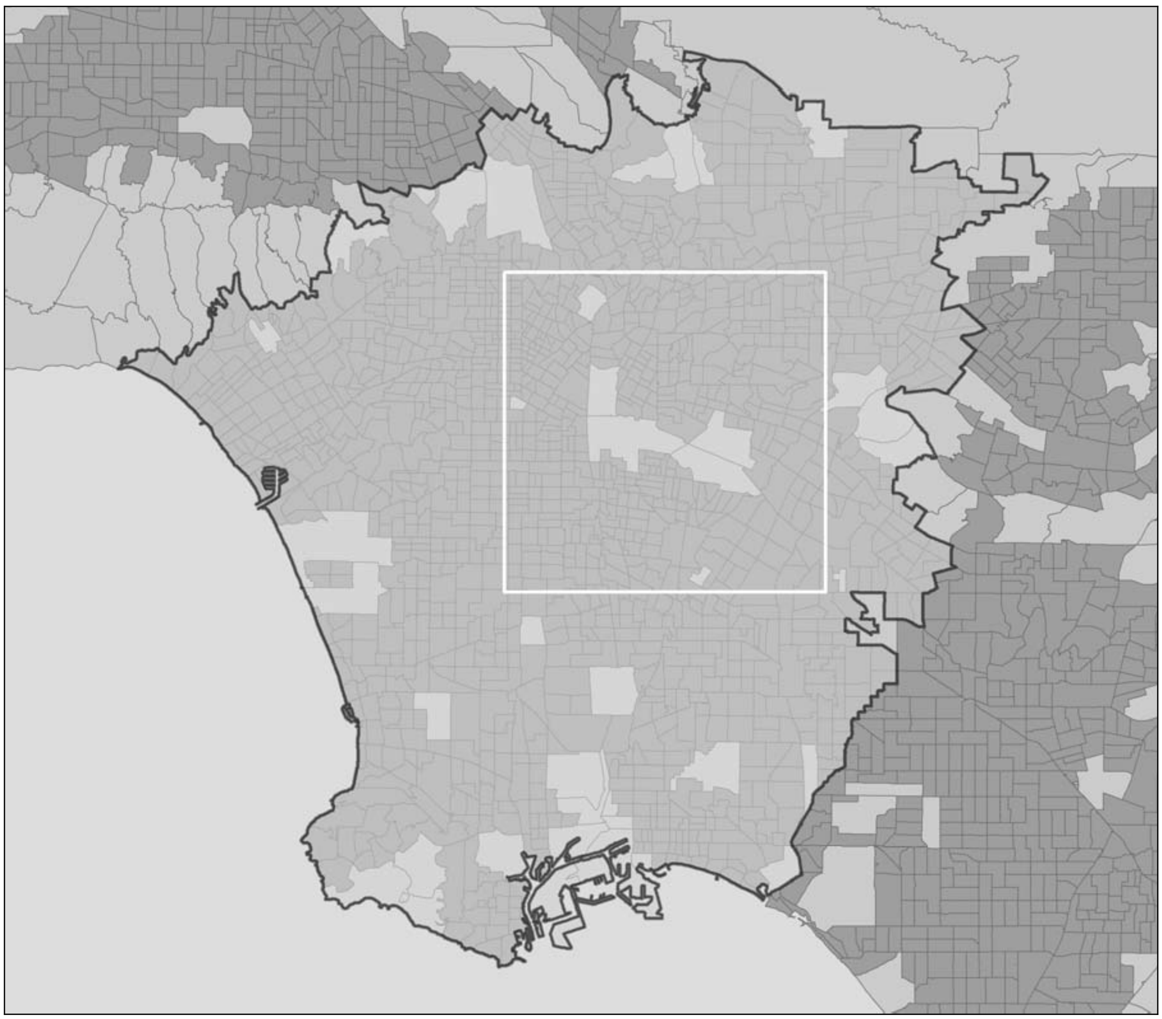
The spatial and temporal emissions provided for these sources were converted into the appropriate AERMOD ready files. The off-site emissions were modeled using the same coarse receptor grid and meteorological data used by the consultants for their rail yard model runs, as indicated in the table above.

Figure C-1 illustrates the region surrounding the BNSF Hobart modeling domain. The domain has dimensions 20 km x 20 km and contains a grid of 1681 receptors with a 500 meter uniform grid spacing.

Figure C-1: Region surrounding the BNSF Hobart rail facility with the modeling domain indicated by the black outline.

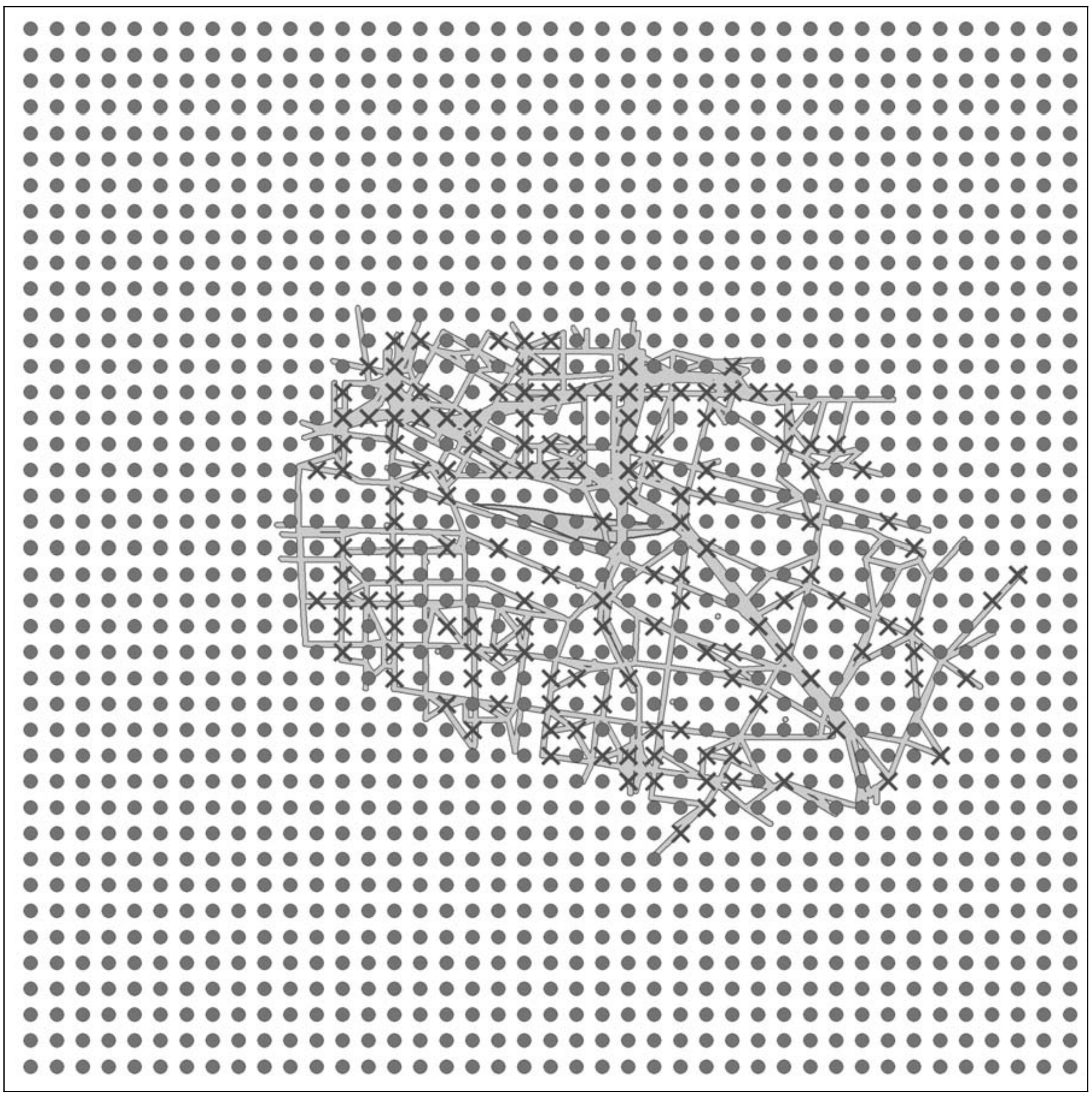
AERMOD requires an estimate of the urban population for urban source modeling. The urban population parameter was determined by estimating the area of continuous urban features as defined by the model guidelines (AERMOD Implementation Guide September 27, 2005). According to the guidelines, areas with a population of at least 750 people per square kilometer are considered urban. The BNSF Hobart model domain is in a region with considerable urbanization. The continuous urban area selected can be seen in Figure C-2. The population in this selected area is 6,476,185.

Figure C-2: BNSF Hobart Urban Population
Orange denotes areas with at least 750 people/km^2. The highlighted region is the contiguous urban area used for modeling purposes.



The off-site stationary and on-road emission sources used in the BNSF Hobart model runs are plotted along with the receptor network in Figure C-3. These sources do not represent all stationary and roadway sources within the domain, but rather a subset made up of those roadways and facilities within two miles of the perimeter of the rail yard facility. Diesel PM off-site emissions used in the off-site modeling runs consisted of 113.2 tons per year from roadways and 0.2 tons per year from stationary facilities, representing emissions for 2005. Roadway emissions were simulated as AERMOD area sources with an aspect ratio of no greater than 100 to 1, with a width of 7.3 meters and a release height of 4.15 meters.

Figure C-3: BNSF Hobart receptor network including off-site sources and rail facility



As indicated above, Figure C-3 illustrates a 20 km x 20 km gridded receptor field with uniform 500 meter spacing of receptors that are plotted as "●". Because a uniform grid sometimes places receptors on a roadway, those within 35 meters of a roadway were omitted. The basis for this is that these receptors are likely to fall on the roadway surface, versus a dwelling or workplace, and have high model-estimated concentrations, which could skew average concentration isopleths. Locations where receptors were removed are displayed as an "**x**" in Figure C-3. After removal, 1533 of the original 1681 receptors remained.

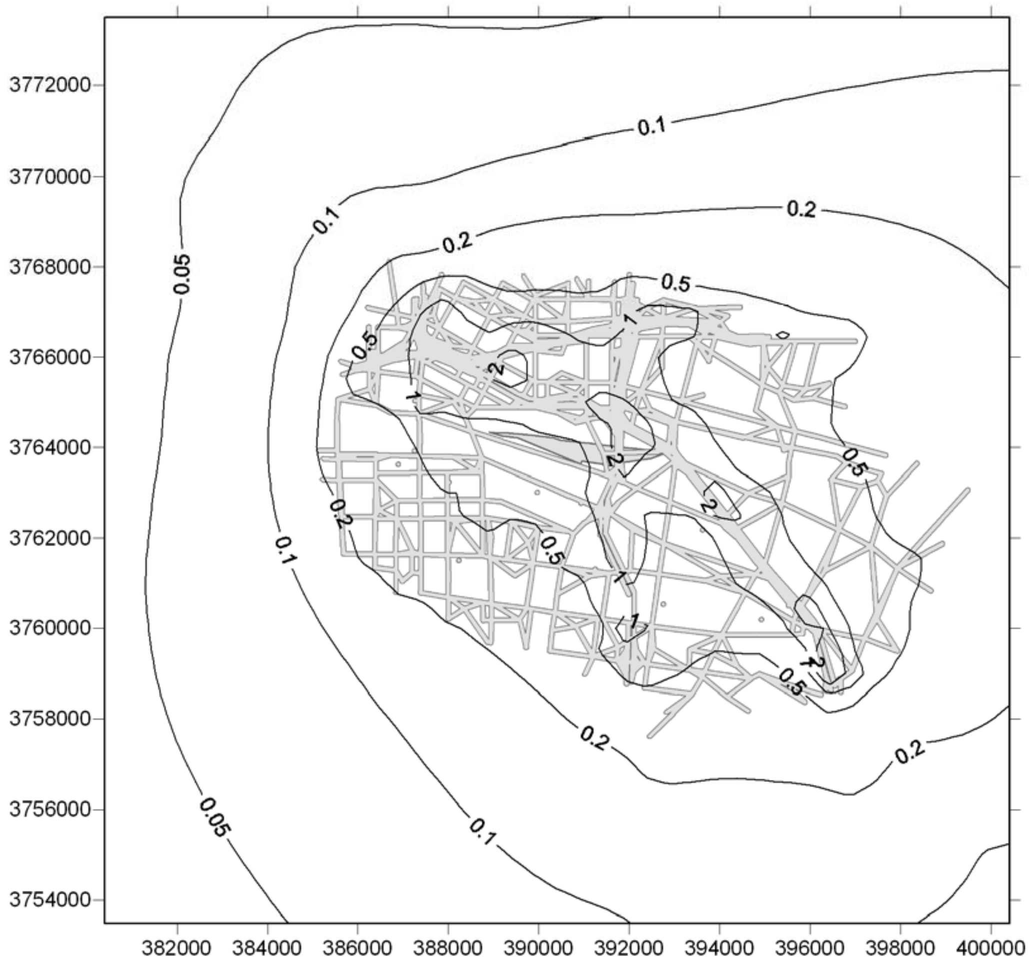
The same meteorological data used by ENVIRON was used for the off-site modeling runs. The data were compiled by Environ from the nearby Lynwood (33.922°N, 118.211°W) and Los Angeles/USC (34.02°N, 118.28°W) stations. Upper air data for the same time period was obtained from the San Diego Miramar upper air station (32.833°N, 117.117°W). The model runs used one year of meteorological data from 2005.

Figure C-4 shows annual average diesel PM concentrations from the off-site emissions. Highest values occur near major freeways; the five highest concentrations at a receptor and their locations are provided in Table C-2.

Table C-2: BNSF Hobart maximum annual concentrations in ug/m3

X	Y	Mobile	Stationary	Total (Off-site)
396400	3759000	3.380	0.0004	3.380
396400	3759500	3.339	0.0005	3.339
395900	3760500	2.944	0.0017	2.946
391400	3765000	2.747	0.0010	2.748
393900	3763000	2.617	0.0007	2.618

Figure C-4: BNSF Hobart off-site sources and rail yard with modeled annual average concentrations from off-site sources in ug/m^3



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APPENDIX D

TABLE OF LOCOMOTIVE DIESEL PM EMISSION FACTORS

Table D-1: Locomotive Diesel PM Emission Factors (g/hr)

Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switcher	N	31.0	56.0	23.0	76.0	131.8	146.1	181.5	283.2	324.4	420.7	ARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	177.7	194.8	241.2	383.4	435.3	570.9	ARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	216.2	237.5	303.5	507.4	600.4	771.2	ARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	288.0	285.9	355.8	610.4	681.9	871.2	ARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	271.7	275.1	338.9	593.7	699.1	884.2	ARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	228.7	323.6	467.7	666.4	1058.5	1239.3	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	149.8	223.4	290.0	344.6	446.8	553.3	ARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	220.1	349.0	407.1	796.5	958.1	1038.3	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	322.6	302.9	307.7	268.4	275.2	341.2	ARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	261.5	271.0	304.1	334.9	383.6	499.7	ARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	197.3	267.3	343.9	392.4	397.3	573.3	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	205.7	243.9	571.5	514.6	496.9	460.3	average of ARB & CN2508[1]
Dash 9	1	16.9	88.4	62.1	140.2	272.8	354.5	393.4	466.4	445.1	632.1	CSXT595[2]
Dash 9	2	7.7	42.0	69.3	145.8	273.0	337.4	376.0	375.1	419.6	493.5	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, these emission rates were originally developed for the ARB Roseville Rail Yard Study (October 2004), and were subsequently adjusted based on an average fuel sulfur content of 0.11% by ENVIRON as part of the BNSF efforts for their analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006).
2. Emission rates added by ENVIRON based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006)
3. SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006)

APPENDIX E

ESTIMATION OF DIESEL PM EMISSIONS FROM THE HHD TRUCKS TRAVELING BETWEEN THE INTERMODAL RAILYADS AND MAJOR FREEWAYS

Introduction:

Diesel-fueled heavy-heavy-duty (HHD) trucks (weight >33,001 pounds) traveling between the intermodal railyards and major freeways generate certain amount of diesel PM emissions, which contribute the off-site diesel PM emissions. Using the same methodology in estimating the off-site HHD trucks diesel PM emissions, ARB staff estimated the diesel PM emissions of HHD trucks traveling between the railyard gates and the freeways. Estimate of the diesel PM emissions from HHD diesel trucks can be performed based on average speed on the local streets, distances traveled locally between the gates and the freeways, truck count at the railyard gates, and EMFAC model.

This analysis is conducted for the intermodal railyards whose diesel-fueled HHD trucks are a major contributor to the diesel PM emissions. At some railyards, HHD trucks also are idling or queuing outside of the railyards. These activities have been covered by the railyard on-site emission inventories and are not included in this analysis.

Methodology:

Estimating diesel PM emission from HHD diesel trucks can be performed by the following steps:

- Assume the average speed of trucks traveling on local streets between the railyard gates and the entrance/exit ramps of freeways.
- Select the most frequently traveled freeways for each railyard.
- Measure the distances from the gates to the ramps of selected freeways for each railyard using Google Earth Pro mapping tool.
- Use working draft of EMFAC model to obtain emission factor (gram per mile) associated with truck type, fuel use, and model year (as described in Appendix A: Methodology for Estimating Off-site Diesel PM Mobile Source Emissions).
- Calculate the associated diesel PM emissions.

Step 1: Assume average speed of trucks traveling between the railyard gates and the freeways

The speeds of HHD trucks traveling on local streets range from 5 mph (start from the gate) to 35 mph (enter the freeway) depending on the time of travel, traffic conditions, etc. ARB staff assumes these speeds are averaged at about 20 mph.

Step 2: Select the most frequently traveled freeways for each railyard

This step is based on the assumption that the truck traffic heavily concentrated on one freeway than the others. According to the judges from the railyard operators, ARB staff chose the most frequently traveled freeways for each intermodal railyard, as described in Table E-1.

Table E-1 The Most Frequently Traveled Freeways by Railyards and the Distances from the Railyard Gates to the Freeways

Railyards	Frequent Traveled Freeways	Roundtrip Distances from Gates to Freeways (miles)
UP Commerce	710	2.6
BNSF Hobart	710	2.6
BNSF Commerce/Eastern	I-5	2.1
UP LATC	I-5	0.7
UP Mira Loma	60	2.2
BNSF Richmond	580	1.74

Step 3: Measure the distances from the railyard gates to the ramps of selected freeways using Google Earth Pro mapping tool.

The distances of the local streets from the railyard gates to the entrance/exit ramps of the selected freeways are estimated by Google Earth Pro mapping tools. The results are presented in Table 1.

Step4: Utilize working EMFAC to obtain emission factor

The working draft of EMFAC, rather than EMFAC 2007 was used in the analysis as described in Appendix A. Emission factors based on vehicle type (in this case HHD diesel trucks), fuel type, and speed were developed by EMFAC. These are composite emission factors based on the model year distribution for each county and provided in units of grams of emissions per mile traveled. Finally, a matrix of emission factors by speed and vehicle type was assembled for each county for heavy heavy-duty diesel trucks. The following is an example of such a matrix (Table E-2).

Table E-2: Emission Factor of HHD for Matrix Example

Speed (mph)	HHD DSL EF (g/mi)
12	2.371
20	**1.277**
45	0.728
60	1.095

Step5: Calculate the HHD diesel PM emissions

The calculation of diesel PM emissions can be expressed by the following equation:

Total Emission (grams) = EF X (Volume X DistanceTraveled)

EF represents diesel PM emission factor. The volume of trucks count at the railyard's gates was provided by the railyard operators.

The emissions inventory developed by this methodology only included diesel PM emissions from running exhaust as it is the primary diesel source from on-road mobile sources. Emissions from other modes such as idling, starts, and tire and break wear were excluded.

The results of the HHD Trucks diesel PM emissions while traveling between each intermodal railyards and major freeways are presented in Table E-3.

Table E-3: Estimated HHD Diesel PM Emissions from Gate to Freeway**

Railyard	Route	Distance (Miles)		Truck Trips per Day	Diesel PM	
		One way	Round Trip		g/day***	tpy
BNSF Hobart	*Gate to I-710**	1.3	2.6	3533	11,730	**4.72**
UP Commerce	*Gate to I-710**	1.3	2.6	1026	3,406	**1.37**
BNSF Commerce/Eastern	*Gate to I-5**	1.05	2.1	557	1,495	**0.60**
UP Mira Loma	*Gate to SR-60**	1.1	2.2	321	901	**0.36**
UP LATC	*Gate to I-5**	0.35	0.7	512	457	**0.18**
BNSF Richmond	*Gate to I-580**	0.87	1.74	153	314	**0.13**
	Total					**7.36**

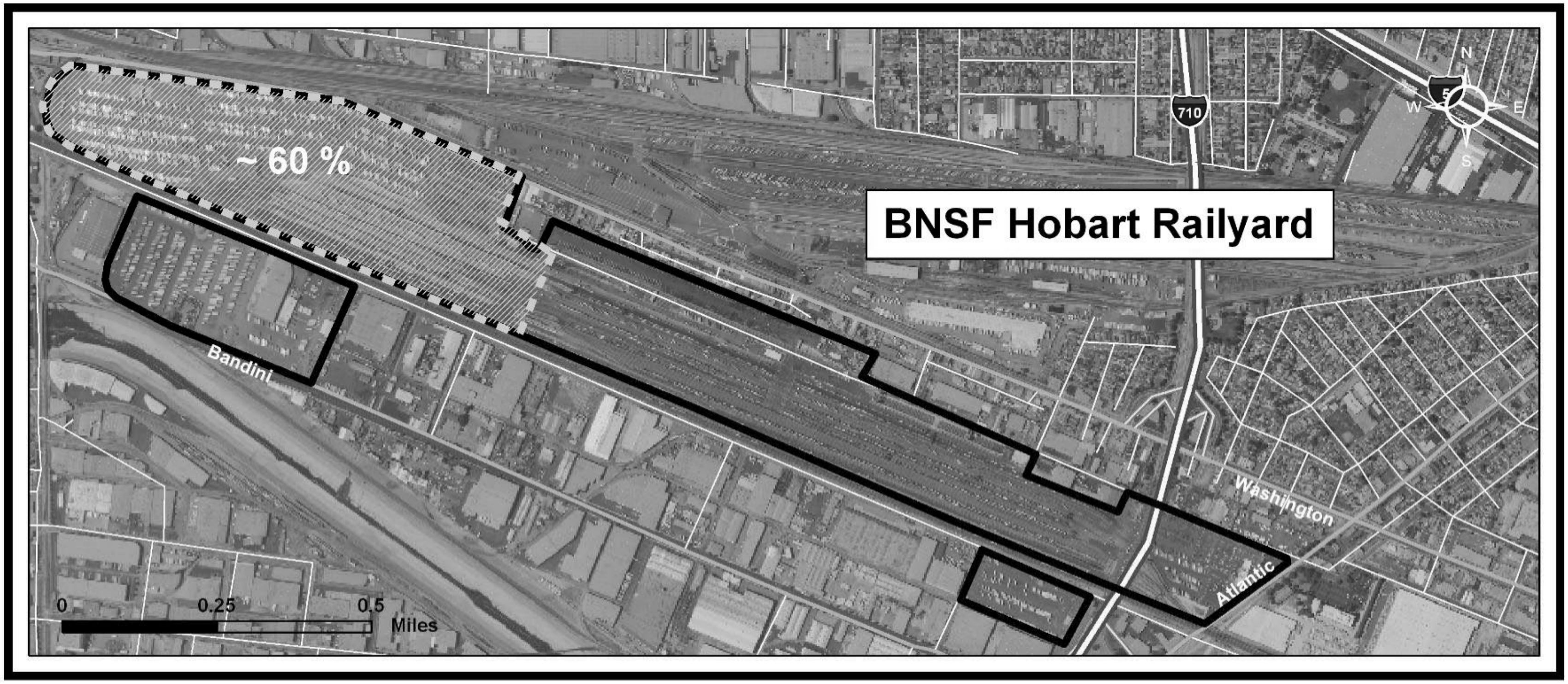
Notes: * Assumed all trucks take this route

** Assumed all trucks' speeds are 20 mph from gate to freeway

*** HHD Emission Factors at 20 mph: 1.277 g/mi for LA County and 1.176 g/mi for Contra Costa County

APPENDIX F
SPATIAL ALLOCATIONS OF MAJOR DIESEL PM EMISSION SOURCES AT BNSF HOBART RAILYARD

Figure F-1 The BNSF Hobart Railyard shown with the shaded area accounting for about 60 percent of facility-wide diesel PM emissions.



Note: According to the emission inventory, about 60% of the facility-wide emissions at the BNSF Hobart Railyard occurs in the west end of the yard as shown in the Figure. The activities in the area largely includes truck operation, locomotives, and cargo handling equipment, accounting for about 15 tons of diesel PM emissions in 2005.

Figure F-2 Spatial allocation of locomotive emissions at BNSF Hobart Railyard.

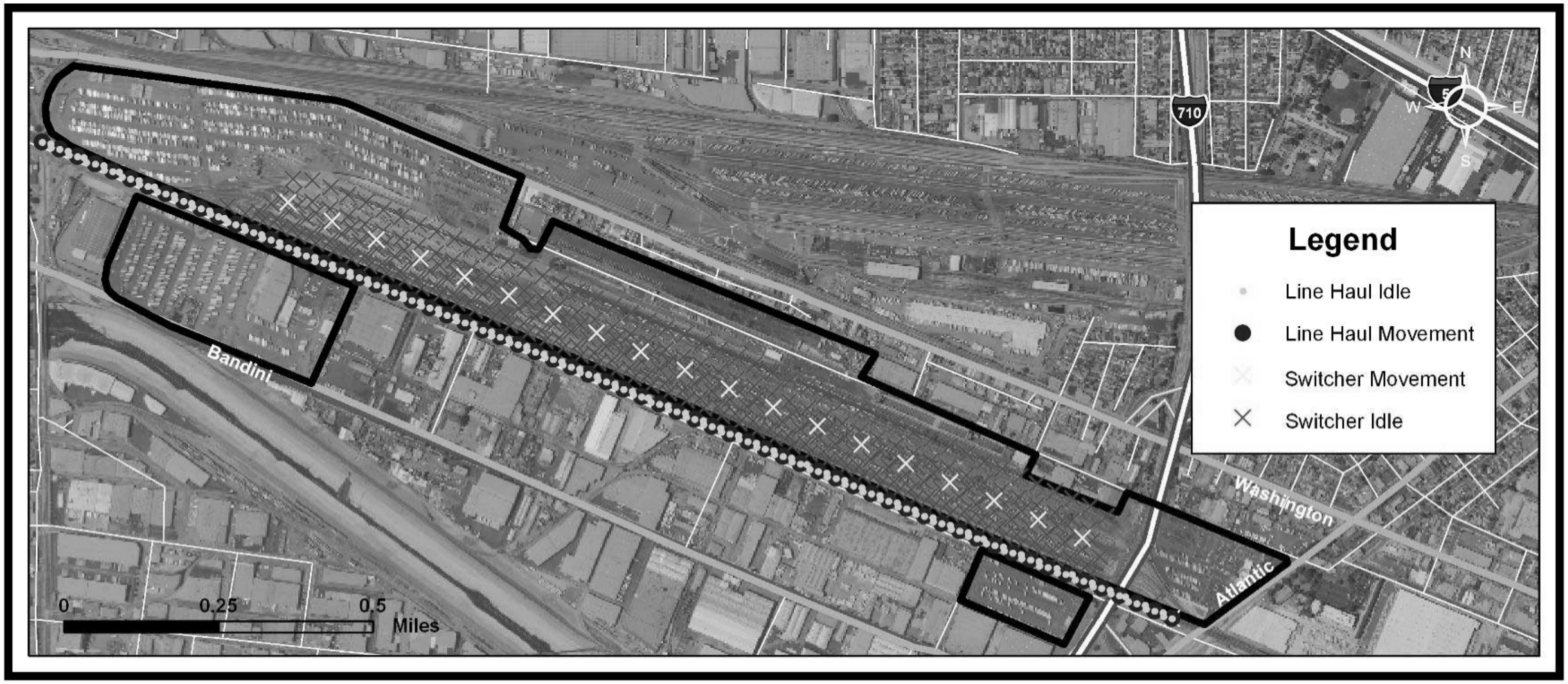


Figure F-3 Spatial allocation of on-road container trucks and fleet diesel PM emissions at BNSF Hobart Railyard.

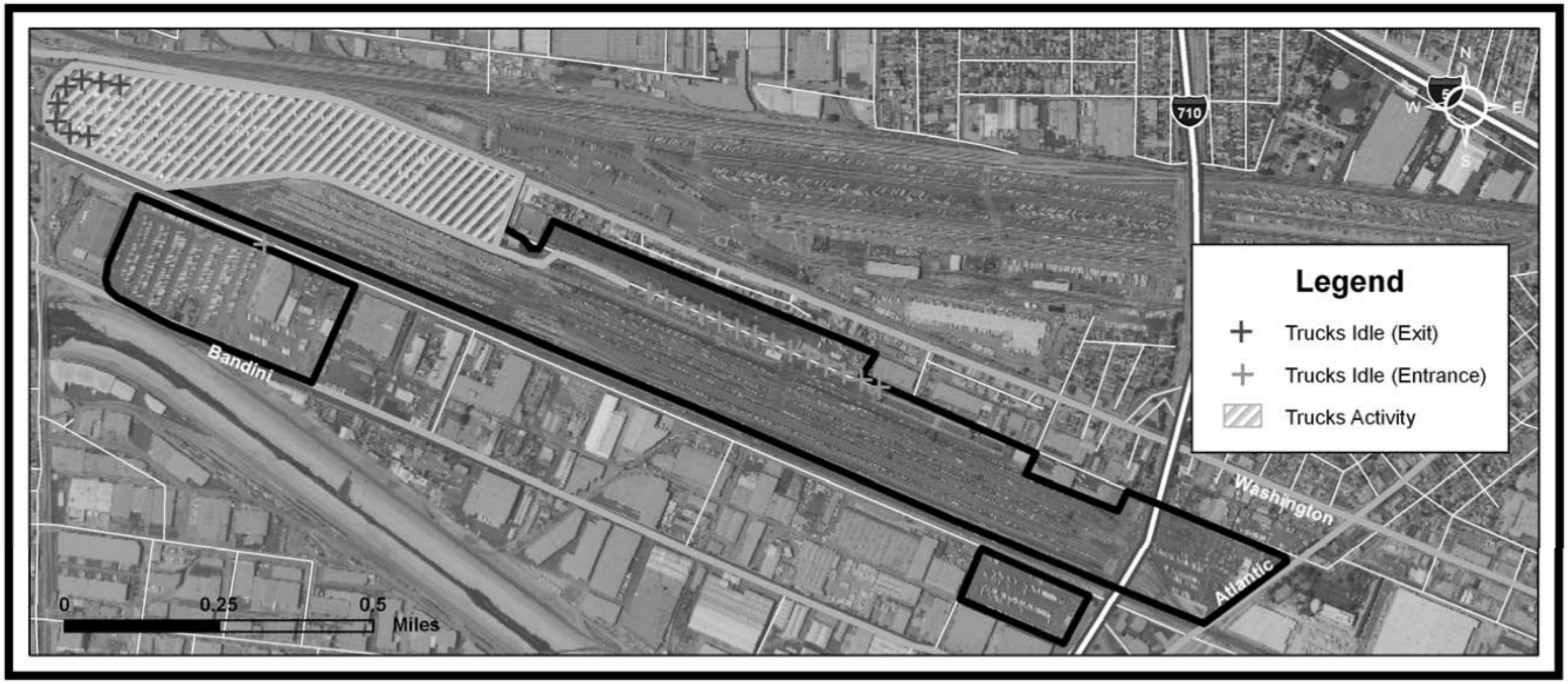
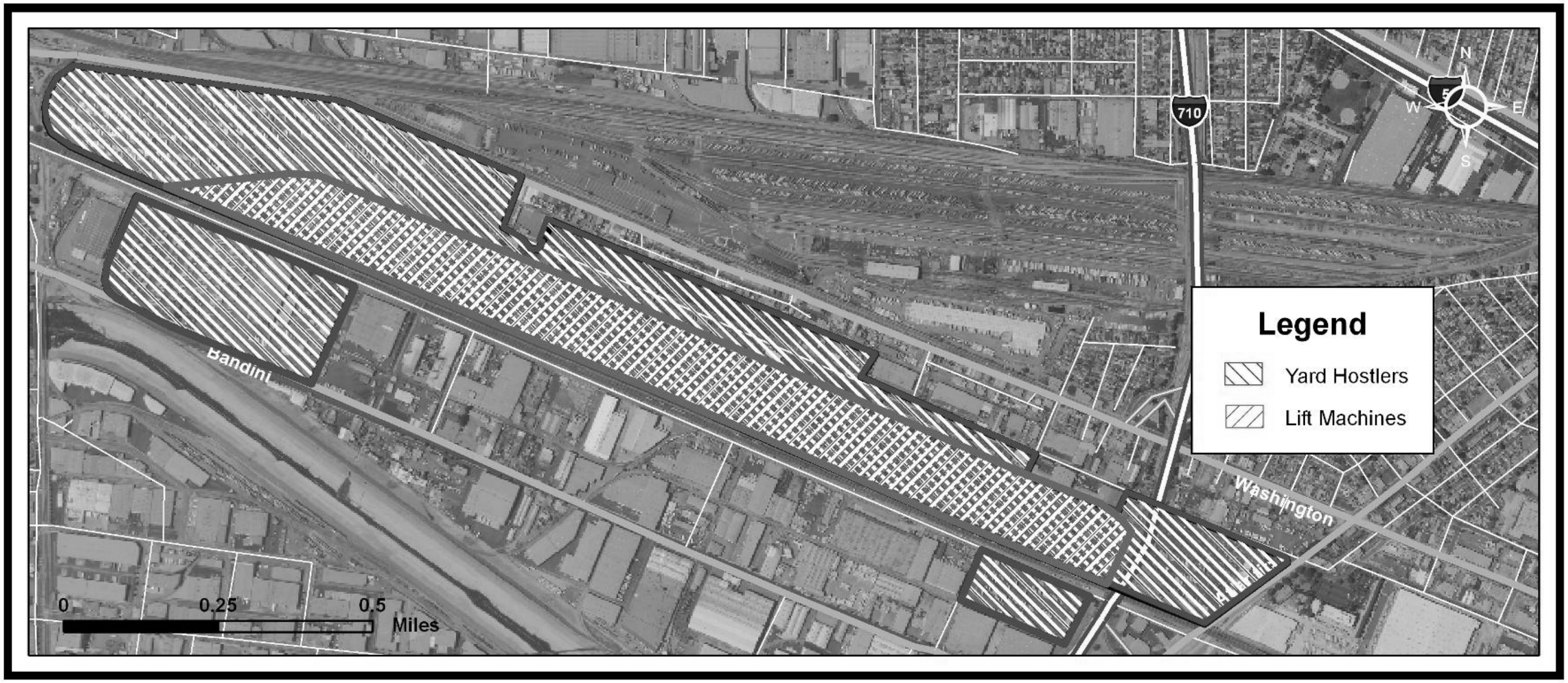


Figure F-4 Spatial allocation of cargo handling equipment diesel PM emissions at BNSF Hobart Railyard.



APPENDIX G

AERMOD MODEL SENSITIVITY ANALYSIS OF METEOROLOGICAL DATA (ONE- VS. FIVE-YEAR DATA)

Figure G-1 AERMOD's Simulated Diesel PM Concentrations (due to On-site and Off-site Diesel PM Emissions) around UP Stockton Railyard Using One-year Meteorological Data..

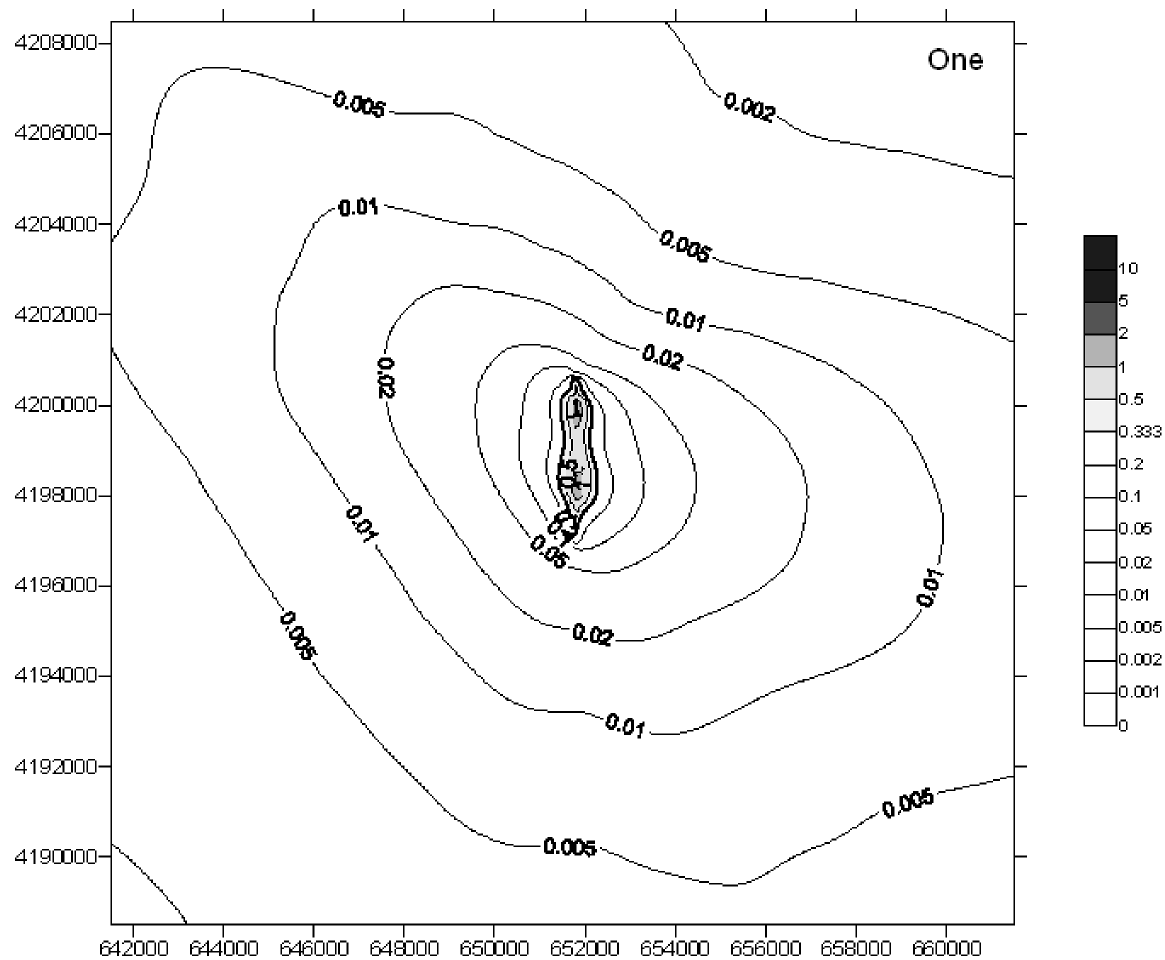


Figure G-2 AERMOD's Simulated Diesel PM Concentrations (due to On-site and Off-site Diesel PM Emissions) around UP Stockton Railyard Using Five-year Meteorological Data.