AIR DISPERSION MODELING ASSESSMENT OF AIR TOXIC EMISSIONS FROM BNSF WATSON/WILMINGTON RAIL YARD

Submitted to:
California Air Resources Board

Prepared for:
BNSF Railway Company
Fort Worth, Texas

Prepared by:
ENVIRON International, Corporation
Emeryville, California

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ACRONYMS

ARB	Air Resources Board
BAAQMD	Bay Area Air Quality Management District
BNSF	BNSF Railway Company
BPIP-PRIME	Building Profile Input Program - Plume Rise Model Enhancement
CalEPA	California Environmental Protection Agency
CalOSHA	California Occupational Safety and Health Administration
CARDS	Comprehensive Aerological Reference Dataset
DPM	Diesel particulate matter
ENVIRON	ENVIRON International Corporation
GE	General Electric
GIS	Geographic Information Systems
HD	Heavy-duty
HRA	Health Risk Assessment
I	Interstate
ISC	Industrial Source Complex
IGRA	Integrated Global Radiosonde Archive
LD	Light-duty
MATES	Multiple Air Toxics Exposure Study
MOU	Memorandum of Understanding
MTBE	Methyl t-butyl ether
NAS	Naval Air Station
NCDC	National Climactic Data Center
NLCD	National Land Cover Data
NRC	National Research Council
NWS	National Weather Service
OEHHA	Office of Environmental Health Hazard Assessment
PM	Particulate matter
PMI	Point of maximum impact
POLA	Port of Los Angeles
POLB	Port of Long Beach
RAAC	Risk Assessment Advisory Committee
SCRAM	Support Center for Regulatory Atmospheric Modeling
TAC	Toxic Air Contaminant
ULSD	Ultra low sulfur diesel
UPPR	Union Pacific Railroad Company

USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VMT	Vehicle miles traveled
WBAN	Weather Bureau Army Navy

ABREVIATIONS

%	percent
AERMAP	AERMOD Terrain Processor
AERMET	AERMOD Meteorological Preprocessor
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
COOP	Cooperative Station (NWS)
kg	kilogram
km	Kilometer
L	liter
m^3	cubic meter
μg	microgram

1.0 INTRODUCTION

In June 2005, BNSF Railway Company (BNSF) and Union Pacific Railroad Company (UPRR) entered into a mutual agreement (ARB/Railroad Statewide Agreement, 2005b or the "Agreement") with the California Air Resources Board (ARB) to reduce particulate emissions from their respective rail yards that are owned and operated within the State of California. Under provisions of the Agreement, ARB staff will be performing Health Risk Assessments (HRAs) at 17 rail yards ("Designated Rail Yards") within California. The HRAs will consider emissions of toxic air contaminants (TACs) from emission sources at each Designated Rail Yard including resident and transient locomotives, on- and off-road equipment, and stationary equipment.

Generally, an HRA consists of three major parts: (1) an air emissions inventory for TAC emission sources, (2) air dispersion modeling to evaluate off-site airborne concentrations due to TAC emissions from these sources, and (3) the assessment of risks associated with these predicted airborne concentrations. The UPRR and BNSF are required to complete the first two parts of the risk assessment process under the Agreement. Under the MOU, ARB will conduct the assessment of risks part of the HRA process using the results of air dispersion exposure analyses conducted for each Designated Rail Yard. As noted in the MOU, specific objectives of these risk assessments include developing a basis for risk mitigation and risk communication, including developing information to place the estimated risks in appropriate context. To aid in developing information for risk communication, ARB will also be conducting health risk assessments for other significant sources of TACs within the vicinity of each Designated Rail Yards.

BNSF has retained ENVIRON International Corporation (ENVIRON) to assist it with the development of TAC emissions inventories and in conducting the air dispersion modeling for each of their Designated Rail Yards. Under the current draft Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities (the "draft Guidelines", (ARB 2006a)), emission inventories and air dispersion modeling results for the following BNSF Designated Rail Yards are scheduled to be submitted by September 30, 2006: Commerce/Eastern Intermodal, Commerce/Mechanical, Los Angeles Intermodal (Hobart), Richmond, Stockton, and Watson/Wilmington (the "2006 BNSF Designated Rail Yards"). However, since the release of the draft Guidelines, ARB agreed to change the timeline for submission of the emissions and air dispersion modeling results to October 31, 2006 for Commerce/Mechanical and Richmond and November 30, 2006 for Commerce/Eastern, Hobart, Watson/Wilmington, and Stockton. These submission timelines were adjusted to accommodate ARB's request for changes to previously completed emission inventories to reflect previously unreleased ARB models. This report presents the methods and results of the air dispersion modeling analysis conducted to evaluate TAC emissions from operations at the BNSF Watson/Wilmington Rail Yard located in Wilmington, California ("Wilmington").

1.1 Objectives

The purpose of this report is to summarize ENVIRON's methods used to conduct the air dispersion exposure assessment of TAC emissions from the BNSF Wilmington Yard and to provide the results of this analysis to ARB for their completion of the HRA for this rail yard. As discussed in the draft Guidelines (ARB 2006a), the air dispersion modeling exposure assessment requires the selection of the dispersion model, the data that will be used in the dispersion model (pollutants to be modeled with appropriate averaging times, source characterization, building downwash, terrain, meteorology) and the identification of receptors whose potential exposure will be considered in ARB's HRA. ENVIRON previously provided to ARB a report that described ENVIRON's model selection, meteorological data selection, and meteorological data processing methodologies for all the 2006 BNSF Designated Rail Yards (ENVIRON 2006). ARB approved these aspects of the air dispersion modeling analysis on August 3, 2006.[1] The remainder of this introduction section summarizes ENVIRON's selection of the air dispersion model to provide the modeling context for the methods discussed in the remainder of this report.

1.2 Methodologies

As discussed in the draft Guidelines, "air dispersion modeling uses mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source" (ARB 2006a). The Agreement currently requires that air dispersion modeling be performed to estimate airborne concentrations from the dispersion of TAC and particulate matter emissions from relevant sources at each Designated Rail Yard. The emissions of diesel particulate matter (DPM) are separated from other particulate related TAC emission data in the model input and output (ARB 2006a). Air dispersion modeling requires the selection of an appropriate dispersion model and input data based on regulatory guidance, common industry standards/practice, and/or professional judgment. In general, ENVIRON performed air dispersion modeling for the BNSF Designated Rail Yards consistent with previous studies and/or guidance documents prepared by ARB (ARB 2004, 2005a, 2005c, 2006a) and the United States Environmental Protection Agency (USEPA 2000, 2004a, 2004b, 2005a, 2005b).

[1] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

ENVIRON used the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD version 04300) to estimate airborne concentrations resulting from TAC emissions from the BNSF Wilmington Yard. The AERMOD model was developed as a replacement for USEPA's Industrial Source Complex (ISC) air dispersion model to improve the accuracy of air dispersion model results for routine regulatory applications and to incorporate the progress in scientific knowledge of atmospheric turbulence and dispersion. Both models are near-field, steady-state Gaussian plume models, and use site-representative hourly surface and twice-daily upper air meteorological data to simulate the effects of dispersion of emissions from industrial-type releases (e.g., point, area, and volume) for distances of up to 50 kilometers (USEPA 2005b).

For the past 20 years, refined near-field air dispersion modeling has typically been conducted using USEPA's Industrial Source Complex (ISC) model. However, on November 9, 2005, the USEPA promulgated final revisions to the federal Guideline on Air Quality Models (USEPA 2005a). These revisions recommend that AERMOD, including the PRIME building downwash algorithms, be used for dispersion modeling evaluations of criteria air pollutant and toxic air pollutant emissions from typical industrial facilities. A one-year transition period commenced from the promulgation date of November 9, 2005. AERMOD provides better characterization of plume dispersion than does ISC, according to USEPA (USEPA 2003). AERMOD also is the model recommended by ARB in the draft Guidelines (ARB 2006a).

1.3 Report Organization

This report is divided into six sections as follows:

Section 1.0 - Introduction: describes the purpose and scope of this report and outlines the report organization.

Section 2.0 - Site Description: provides a brief description of the Wilmington Facility and its operations.

Section 3.0 - Emission Inventory Summary: summarizes the TAC emission inventory results that were previously submitted to ARB under a separate report (included as Appendix A).

Section 4.0 - Air Dispersion Modeling: describes the air dispersion modeling methods used to estimate air chemical concentrations.

Section 5.0 -Uncertainties: summarizes some of the uncertainties resulting from various assumptions used in the air dispersion evaluation as well as from those used in the emission inventory development.

Section 6.0 – References: includes all references cited in this report.

The appendices include supporting information as follows:

Appendix A: provides ENVIRON's previous report to ARB on the emission estimation methodologies and results.

Appendix B: provides the tables of hourly, daily, and seasonal temporal information for source activities

Appendix C: provides the electronic SCREEN3 input and output files for plume rise adjustments for locomotive movement activities

Appendix D: provides the electronic AERMOD-ready meteorological data files and raw surface and upper air meteorological data files

Appendix E: provides the electronic building downwash input and output files

Appendix F: provides the electronic digital elevation model (DEM) files

Appendix G: provides the electronic shapefiles containing census data for the Wilmington/Greater Los Angeles area

Appendix I: discusses the sensitivity analysis used to determine the spacing and extents of the receptor grids

Appendix I: provides the electronic input and output files for AERMOD

Appendix J: provides the electronic air concentration tables in Microsoft Access database files

2.0 SITE HISTORY

The Wilmington site description incorporated in this evaluation is based primarily on information provided by BNSF and its contractors' staff. The following information is included to facilitate understanding of this site's operations as evaluated by this work.

2.1 Site Setting and Description

Wilmington is located at 1302 Lomita Boulevard in Wilmington, California and is approximately six kilometers northwest of downtown Long Beach and 25 kilometers south of downtown Los Angeles. As shown in Figure 2-1, Wilmington is located in a predominantly commercial and manufacturing area with several residential areas bordering or within one kilometer of the Facility. Wilmington is bordered by East Lomita Boulevard to the north, commercial and/or manufacturing properties to the east, East L Street to the south, and residential, commercial, and/or manufacturing properties to the west. The southern end of the Wilmington Yard is bisected by the Pacific Coast Highway. Wilmington is also located within five kilometers of three other major roadways, including: I-405 to the north, I-710 to the east, and I-110 to the west. The Ports of Los Angeles and Long Beach are located approximately five kilometers to the south/southeast of the Wilmington Yard. Figure 2-2 depicts available land use data from the United States Geological Survey's (USGS's) National Land Cover Dataset (USGS 2006) within 20 kilometers (km) of Wilmington, as required by the draft Guidelines (ARB 2006a). Table 2-1 summarizes the percentage of each land use category within this 20-km radius.

The Facility generally runs from the north to the south and consists of a classification yard and Trainmaster Office building with adjacent parking areas. The Wilmington Yard is primarily used as a staging area for trains moving through the Alameda Corridor, thus most locomotives enter and depart the Facility from the northeast (i.e., to/from the Alameda Corridor). A small number of trains enter and exit the Facility through single rail lines at the northwest and south entrances to the Facility.

2.2 Facility Operations

Activities at Wilmington include locomotive refueling, locomotive switching, locomotive line-haul, track maintenance equipment, transportation refrigeration units, and on-road fleet vehicle activities. The approximate locations of these activities at the Facility are shown in Figures 2-3 through 2-5.

The Wilmington Yard primarily consists of a classification yard to support train arrival and departure activities. The classification yard is approximately one kilometer in length and contains approximately 20 parallel rail lines that converge to two single rail lines at the north end of the Facility and a single rail line at the south end of the Facility. The emission activities (and emission categories, as designated in Appendix A) related to locomotive operations and locomotive support operations occurring in the classification yard and the adjacent area around the Trainmaster Office Building are outlined below.

Facility Emissions Activities:

A2. Locomotive Refueling
D. Switching
E. Arriving-Departing Line Haul
K1a. Container TRUs
K1b. Boxcar TRUs
K2. Track Maintenance
J. On-Road Fleet Vehicles

Locomotive service at the Wilmington Yard is limited to direct refueling by truck. Locomotive idling emissions occur during refueling along an approximately 100-meter segment of rail near the west boundary of the Facility north of the Pacific Coast Highway overpass as indicated in Figure 2-3a. Locomotive switching activities are limited to the rail segments north of the Pacific Coast Highway overpass due to noise concerns in residential areas adjacent to the southwest boundary of the Facility. The locations of stationary and movement locomotive switching operations are shown in Figure 2-3a. Arriving and departing locomotive line-haul activities may occur on any of the rail lines within the Facility as shown in Figure 2-3b. As discussed above, the majority of locomotives (i.e., 90%) enter and depart the Facility from the direction of the Alameda Corridor (i.e., from the northeast), and the remainder of locomotive traffic into and out of the Facility is approximately evenly split between the northwest and south entrances (i.e., 5% at each of these two entrances). Container and boxcar TRU activities occur anywhere locomotives operate south of the "Y" intersection of the rail lines at the north end of the Facility, and track maintenanace equipment operations may occur over all rail lines at the Facility. The locations of container and boxcar TRUs and track maintenance equipment operating areas are shown in Figure 2-4.

BNSF on-road fleet vehicle activities (i.e., employee vehicles) are confined to the triangular-shaped area surrounding the Trainmaster Office at the northern end of the Facility as indicated in Figure 2-5. Non-BNSF on-road fleet vehicles include the fuel trucks that deliver fuel directly to locomotives. These fuel trucks enter the Facility at an ingress near the west boundary, travel along the west boundary, and pull up alongside the locomotive(s) along the section of track designated for locomotive fueling activities as discussed above. The on-site travel path for the non-BNSF on-road fleet vehicles is shown in Figure 2-5.

3.0 EMISSION INVENTORY SUMMARY

ENVTRON estimated emissions for BNSF Wilmington Yard activities and provided this to ARB previously (Appendix A). The methodology used to calculate the DPM and gasoline TAC emission factors were described in this previous submission to ARB. Detailed calculation methodologies and the resulting emission factors are included as Appendix A. The remainder of this section provides a brief summary of the Wilmington activities for which TAC emissions were estimated.

3.1 Locomotive DPM Emissions

ENVTRON described Wilmington locomotive operations by dividing the emissions activities into three emissions categories:

A. Locomotive Maintenance
D. Switching
E. Arriving and Departing Trains

Category designations (i.e., A, D, and E) for each locomotive activity were assigned in Appendix A.

From data provided by BNSF and through discussions with BNSF operations staff, ENVTRON determined the overall activity of locomotive operations. The locomotive operations data, detailed in Appendix A, included the number of engines and the typical time in notch setting for those engines active at the Facility. ENVTRON inferred locomotive movements and time in engine notch settings based on information provided by BNSF. See Appendix A for a detailed description of the information and estimates used to define operations and resulting emissions within activity categories A, D and E. Temporal emission profiles were developed for each locomotive activity based on hourly locomotive counts. Variable hourly, daily, and seasonal emission factors were applied in the air dispersion modeling to approximate the temporal variations in emissions from locomotive activities, as discussed in Section 4.3. These temporal emission factors are presented in electronic tables in Appendix B.

3.2 DPM and Gasoline TAC Emissions from On-Road Fleet Vehicles

On-road fleet vehicles (designated as activity category J in Appendix A) included BNSF fleet vehicles (i.e., employee vehicles owned by BNSF and road-legal vehicles owned by BNSF such as passenger vehicles and small trucks) used for both on-site and off-site travel and non-BNSF fleet vehicles (i.e., fuel trucks used to refuel locomotives). DPM and gasoline TAC emissions due to BNSF and non-BNSF on-road fleet vehicle activities were estimated using the emission factors from the draft EMFAC2005 model provided by ARB (2006c) and an average on-site travel distance. Appendix A presents additional details regarding the methods used to estimate emissions from these vehicle activities.

3.3 DPM and Gasoline TAC Emissions from Off-Road Equipment

ENVIRON categorized off-road equipment at the Facility into two main types of equipment: TRUs and track maintenance equipment (designated as activity category K in Appendix A). TRUs are used to regulate temperatures during the transport of products with temperature requirements. For BNSF operations at Wilmington, temperatures are regulated by TRUs in boxcars and shipping containers when the material being shipped requires such temperature regulation. TRU emissions were estimated using the draft version of the OFFROAD model provided by ARB (2006c). TRU yearly activity was estimated using the time onsite by TRU configuration (either railcar or shipping container) and mode of transport. This activity data was used along with ARB default age, horsepower, and load factor input estimates in the OFFROAD model to estimate TRU emissions. Additional details regarding the emission calculation methodologies are discussed in Appendix A.

Track maintenance equipment included equipment used to service tracks and included a variety of large and small engines and equipment. BNSF California track maintenance equipment can be used on any or all tracks within California to maintain the network. Therefore, DPM and gasoline TAC emissions for a given facility were estimated by apportioning the sum of emissions from all track maintenance equipment in California by site using the relative track mileage (including all tracks, main line and other tracks) at the site to the California total track mileage. Total exhaust emissions from track maintenance equipment were estimated using the draft version of the OFFROAD model (ARB 2006c). Additional details regarding the emission calculation methodologies are discussed in Appendix A.

3.4 Emission Estimates Summary

Tables 3-1a and 3-1b summarize the total annual emissions, operating hours, and the emission rate (in grams per second or grams per square meter per second) for each emission source by activity subcategory for DPM and gasoline emission sources, respectively. ENVIRON performed the air dispersion modeling to estimate period-average DPM and gasoline concentrations using χ/Q emission rates (i.e., one gram per second per source for point and volume sources and one gram per second divided by the total surface area of the source group for each area source), resulting in period-average dispersion factors. Tables 3-1a and 3-1b include the emission rates (in grams per second) applied to the period-average dispersion factors from the air dispersion model to calculate period-average air concentrations. Table 3-1b also includes the maximum hourly TOG emission rates for gasoline sources used to estimate maximum one-hour TAC concentrations.

Table 3-2 outlines the annual DPM and TAC emissions estimated for each of the main source categories described in this section and their contribution to the total DPM and gasoline TOG and PM emissions. The emissions for each of the activities were distributed spatially and temporally over the range of operations as described in more detail in Section 4.

4.0 AIR DISPERSION MODELING

ENVIRON performed air dispersion modeling to estimate exposure concentrations from the dispersion of DPM and TAC emissions from routine operational sources at Wilmington. ENVIRON evaluated DPM emissions from locomotive and on- and off-road diesel engines as well as TAC emissions from gasoline engines. Air dispersion modeling requires the selection of an appropriate dispersion model and input data based on regulatory guidance, common industry standards/practice, and/or professional judgment. As stated previously, ENVIRON performed air dispersion modeling generally consistent with previous studies and guidance documents (ARB 2004, 2005a, 2005c, 2006a and USEPA 2000, 2004a, 2004b, 2005a, 2005b) based on the information available at the time of the assessment. The type of air dispersion model and modeling inputs (i.e., pollutants to be modeled with appropriate averaging times, source characterization and parameters, meteorological data, building downwash, terrain, land use, and receptor locations) that we used in the air dispersion modeling for Wilmington are discussed below.

4.1 Model Selection and Model Control Options

As discussed in the Introduction, ENVIRON used the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD version 04300) to estimate airborne concentrations resulting from DPM and TAC emissions from the BNSF Wilmington Yard as recommended in the draft Guidelines (ARB 2006a) and USEPA air dispersion modeling guidelines (2005b). AERMOD was developed as a replacement for USEPA's Industrial Source Complex (ISC) air dispersion model to improve the accuracy of air dispersion model results for routine regulatory applications and to incorporate the progress in scientific knowledge of atmospheric turbulence and dispersion. This change was made in November 2005 (USEPA 2005a). After a one-year transition period for the change in model (i.e., as of November 9, 2006), ISC will no longer be considered a USEPA-approved model for certain regulatory applications. Both models are near-field, steady-state Gaussian plume models, and use site-representative hourly surface and twice-daily upper air meteorological data to simulate the effects of dispersion of emissions from industrial-type releases (e.g., point, area, and volume) for distances of up to 50 kilometers (USEPA 2005b).

AERMOD is appropriate for use in estimating ground-level short-term ambient air concentrations resulting from non-reactive buoyant emissions from sources located in simple and complex terrain. ENVIRON conducted the air dispersion analysis using AERMOD in the regulatory default mode, which includes the following modeling control options:

- adjusting stack heights for stack-tip downwash (except for building downwash cases),
- incorporating the effects of elevated terrain,
- employing the calms processing routine, and
- employing the missing data processing routine.

4.2 Modeled Pollutants and Averaging Periods

Calculation of chemical concentrations for use in exposure analysis requires the selection of appropriate concentration averaging times. ENVIRON based the selection of appropriate averaging times on the toxicity criteria data developed by the California Environmental Protection Agency (CalEPA).

For DPM, CalEPA has developed toxicity criteria for both carcinogenic and chronic non-carcinogenic effects (CalEPA 2005a, 2005b) Therefore, ENVIRON estimated the annual average DPM concentration over the span of the meteorological data for ARB's use in estimating cancer and chronic non-cancer risk. ENVIRON did not calculate maximum short-term concentrations (one-hour averages) for DPM as an acute toxicity criteria for DPM has not been developed by the CalEPA (i.e., no acute reference exposure level (REL) is listed) (CalEPA 2000).

ENVIRON evaluated a large number of non-DPM TACs in this assessment from non-DPM sources (mainly from gasoline engine emissions) as identified in the speciation profiles discussed in Appendix A. ENVIRON estimated both annual-average and maximum one-hour concentrations for each non-DPM TAC. In order to substantially reduce modeling complexity and run time, maximum one-hour TOG exhaust, TOG evaporative, and PM exhaust emission rates (as opposed to maximum one-hour individual TAC emission rates) were input into the air dispersion model. Speciation profiles containing the fractions of individual TACs for TOG exhaust, TOG evaporative, and PM exhaust emissions (discussed in Appendix A) were then applied to the TOG exhaust, TOG evaporative, and PM exhaust concentrations estimated by the dispersion model to calculate concentrations of individual TACs. This methodology resulted in conservative estimates (i.e., over-predictions) of the maximum one-hour concentrations for individual TACs.

4.3 Source Characterization and Parameters

Source characterization, location, and parameter information is necessary to model the dispersion of air emissions. ENVIRON modeled DPM and other TAC emissions from operational sources at Wilmington, as described above. In general, we determined source locations from the activity information discussed in Section 2, facility plot plans, information provided by BNSF personnel and contractors, and/or recent aerial photographs of the facility and surrounding areas. ENVIRON accounted for temporal (i.e., hourly, daily, and/or seasonal) variations in activities and emissions from each source by using variable hourly, daily, and seasonal emission factors where available. ENVIRON represented emissions from locomotive sources, vehicular sources, and mobile equipment sources as one of the following source types, and generally consistent with the draft Guidelines (ARB 2006a), where possible:

- Point source (a source with emissions emanating from a known point, with buoyancy due to either thermal or mechanical momentum). A point source is characterized by a height, diameter, temperature, and exit velocity.
- Volume source (a source with emissions that have no buoyancy and are emanated from a diffuse area). A volume source is characterized by an initial lateral and vertical dimension (initial dispersion) and a release height.
- Area source (a source with emissions that have no buoyancy and are emanated from a diffuse plane or box). An initial vertical dimension and release height may also be specified for an area source.

ENVIRON used point sources to model emissions from stationary idling locomotive source activities. ENVIRON used volume sources to represent emissions from moving sources along specific pathways (e.g., moving locomotives, trucks, and cars). ENVIRON used area sources to represent emissions from mobile equipment and vehicles operating over large areas. Additional details regarding the characterization of sources, source locations, and modeling parameters for each source category discussed in Section 3.0 are described below.

4.3.1 Locomotives at the Facility

4.3.1.1 Stationary Idling Locomotives

ENVIRON represented DPM emissions from stationary idling locomotive refueling, switching, and line-haul activities by point sources spaced approximately every 50 meters similar to ARB's Roseville Study (ARB 2004). ENVIRON placed point sources along railway lines at Wilmington in areas where stationary idling activities occur, staggering point sources on adjacent parallel railway lines.

According to BNSF personnel, locomotive idling emissions occur during refueling along an approximately 100-meter segment of rail near the west boundary of the Facility north of the Pacific Coast Highway overpass. Point sources representing locomotive idling emissions during refueling are shown in Figure 4-1a.

As indicated above, the Wilmington Yard contains approximately 20 parallel rail lines that converge to two rail lines (at one point converging to one rail line before splitting back into two rail lines) at the north end of the Facility and a single rail line at the south end of the Facility. Due to the close proximity of the rail lines at the Wilmington Yard (approximately one meter apart in the central section of the Yard), placement of point sources on every rail line at vertically spaced 50-meter intervals would result in lines of closely-spaced points in the horizontal direction. Also, this distribution of point sources would not be representative of stationary switching and line-haul sources at the Yard, and these lines of closely-spaced point sources could result in modeling anomalies. In order to more evenly distribute point sources in both the horizontal and vertical directions, reduce modeling complexity, and decrease model run-times, five sets of point sources (i.e., five lines of staggered point sources) were used to represent the 20 rail lines for stationary locomotive switching and line-haul activities at the Yard, as indicated in Figures 4-1a and 4-1b.

Emissions were distributed among the point sources representing stationary locomotive switching and line-haul activities based on information from BNSF personnel. According to BNSF personnel, switching activities occur only on sections of rail north of the Pacific Coast Highway overpass due to noise concerns in the residential areas near the southwest boundary of the Facility. Because stationary switching activities can occur on any rail line in this area, ENVIRON distributed emissions uniformly among the point sources comprising stationary switching activities. The locations of point sources representing stationary locomotive switching activities are shown in Figure 4-1a.

According to BNSF personnel, the majority (i.e., 90%) of arriving and departing line-haul locomotives enter and depart the Facility from the direction of the Alameda Corridor (i.e., from the northeast), and the remainder of locomotive traffic into and out of the Facility is approximately evenly split between the northwest and south entrances (i.e., 5% from the northwest and 5% from the south). BNSF personnel also indicated that the 95% of arriving-departing line haul locomotives entering the Facility from the north remain on the sections of the rail lines north of the Pacific Coast Highway overpass. Based on this information, ENVIRON weighted idling emissions for the point sources at the three entrances to the Facility (i.e., 90% to the northeast entrance, 5% to the northwest entrance, and 5% to the south entrance). ENVIRON also distributed idling line-haul emissions such that 95% of the total idling line-haul emissions occur on sections of rail north of the Pacific Coast Highway overpass and 5% of total idling line-haul emissions occur on sections of rail south of the Pacific Coast Highway overpass. In addition, ENVIRON assumed that point sources representing idling on rail lines that had converged (i.e., rail lines near the entrances at the north and south ends of the Facility) would have higher emissions (directly proportional to the number of individual tracks comprising the converged section of rail) than point sources representing the individual parallel rail lines in the central part of the Facility. This is a result of the higher amount of locomotive traffic and idling experienced on the converged lines near the Facility entrances as locomotives move into and out of the Facility. The locations of point sources representing stationary locomotive line-haul activities are shown in Figure 4-1b.

According to BNSF personnel, locomotive refueling, switching, and line-haul activities occur seven days per week and can occur anytime during the day. Thus, ENVIRON assumed that emissions from stationary locomotive refueling, switching, and arriving-departing line-haul activities occur 24 hours per day, seven days per week. Table 3-1a summarizes the emissions and operating hours for each stationary locomotive activity. Variable hourly, daily, and seasonal emission factors were also applied to approximate the temporal variations in emissions from these sources. These variable emission profiles are summarized in electronic tables in Appendix B.

Facility personnel provided source parameter information (i.e., release height, velocity, temperature, and diameter), which was based on the specific locomotive types for each stationary idling activity. ENVIRON performed fleet-averaging of locomotive source parameters as recommended by the draft Guidelines (ARB 2006a) to reduce the large number of potential sources (from approximately 1143 to 225) related to the stationary locomotive activities at Wilmington. Fleet-averaging of source parameters was performed by weighting the source parameters for each locomotive model type by the percentage of emissions from each locomotive model type for a given locomotive activity. Table 4-1 summarizes the fleet-average source parameters for stationary locomotive activities at Wilmington.

4.3.1.2 Locomotive Movement

ENVIRON represented moving locomotive DPM sources by individual volume sources spaced approximately every 85 meters similar to ARB's Roseville Study (ARB 2004). ENVIRON selected larger volume source spacing than was previously used in

ENVIRON's *Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Commerce/Mechanical Rail Yard* ("BNSF Commerce/Mechanical") Report (ENVIRON 2006b), ENVIRON's *Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Richmond Rail Yard* ("BNSF Richmond") Report (ENVIRON 2006c), and ENVIRON's *Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Commerce/Eastern Rail Yard* ("BNSF Commerce/Eastern") Report (ENVIRON 2006d) to prevent overlap of larger volume sources covering multiple rail lines. ENVIRON placed sources along railway lines at Wilmington where movement activities occur. According to BNSF personnel, locomotive movement emissions had the same spatial and temporal distribution as idling emissions for switching and line-haul activities. These distributions are described in detail in Section 4.3.1.1 above. Figures 4-2a and 4-2b show the locations of modeled volume sources for locomotive switching and line-haul movement activities, respectively, at the Facility. Table 3-1a summarizes the emissions and operating hours for each locomotive movement activity. Variable hourly, daily, and seasonal emission factors were also applied to approximate the temporal variations in emissions from these sources. These variable emission profiles are summarized in electronic tables in Appendix B.

For locomotive movement sources occurring along single rail lines, ENVIRON set the length of side for each volume source equal to the width of the fleet-average locomotive. In order to reduce modeling complexity and decrease model run-times, and in order to reduce the number of volume sources required to represent multiple parallel rail lines, ENVIRON used larger volumes with the length of side equal to the combined width of the rail lines plus the width of a locomotive. ENVIRON used a similar methodology (i.e., volumes with the length of side equal to the combined width of the rail lines plus the width of a locomotive) to represent converging or diverging rail lines, resulting in progressively smaller volumes as the rail lines converged and progressively larger volumes as rail lines diverged. ENVIRON performed sensitivity analyses to evaluate the use of a single set of larger volume sources versus multiple sets of smaller volume sources along multiple parallel rail lines and converging rail lines. These sensitivity analyses demonstrated that the use of larger volume sources with 50-meter source spacing generally resulted in receptor concentrations within five percent of the receptor concentrations predicted by the multiple sets of smaller volume sources and smaller source spacing. The results of these sensitivity analyses are discussed in more detail in Appendix C of ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b). ENVIRON calculated the corresponding initial lateral dimension of each volume source from USEPA guidance (USEPA 2004b).

ARB accounted for buoyancy effects of exhaust from locomotive movement activities by calculating plume rise adjustments to the release height using USEPA's SCREEN3 model for all 11 different locomotive models considered in the study (ARB 2004). Due to variability in locomotive travel speeds, hourly wind speeds, and hourly stability class, a potentially large uncertainty is associated with these plume rise adjustments. ENVIRON also calculated plume rise adjustments to the release height using the SCREEN3 model and a methodology similar to that of ARB (ARB 2004). Due to the uncertainty associated with variable locomotive speeds, hourly wind speeds, and hourly stability class, plume rise adjustments were calculated based on fleet-average locomotive parameters for individual locomotive activities. For source activities with multiple notch settings (e.g., locomotive switching), ENVIRON selected plume rise predictions based on fleet-average source parameters for the single notch setting with the highest percentage of activity emissions. For movement activities with a range of locomotive speeds, the wind speed in SCREEN3 was set equal to the maximum locomotive speed, resulting in lower, more conservative plume rise adjustments. ENVIRON calculated the corresponding initial lateral dimension of each volume source from USEPA (USEPA 2004b) guidance. Tables 4-1 and 4-2 summarize the modeling source parameters, approximate travel speeds, and plume rise adjustments used for locomotive movement sources at Wilmington. Electronic SCREEN3 input and output files used to determine plume rise adjustments are attached in Appendix C.

4.3.2 Off-Road Equipment

4.3.2.1 Container and Boxcar TRUs

As container and boxcar TRUs may be located over large areas the Facility, and as specific modeling source parameters were not available, ENVIRON conservatively represented DPM emissions from container and boxcar TRUs by area sources as recommended by the draft Guidelines (ARB 2006a). ENVIRON placed area sources over areas where container and boxcar TRU activities occur. According to BNSF facility personnel, container and boxcar TRUs may be located anywhere on rail lines south of the "Y" intersection of the rail lines entering the Facility at the northeast and northwest corners. The locations of area sources representing container and boxcar TRUs are shown in Figure 4-3. Emissions were distributed uniformly throughout the TRU operating areas based on information from BNSF personnel. ENVIRON assumed that emissions from container and boxcar TRUs occur 24 hours per day, seven days per week, based on information from BNSF personnel. Table 3-1a summarizes the DPM emissions and operating hours for container and boxcar TRUs at the Facility.

Model-specific source parameter information (i.e., release height, velocity, temperature, and diameter) for container and boxcar TRUs was not available from BNSF personnel. ENVIRON conservatively assumed the release height of both container and boxcar TRUs (1.0 meters) based on photographs of container TRUs. ENVIRON did not account for the elevated release height for multiple, vertically stacked containers or the height of the base of the container TRUs above the ground for containers on trailers or boxcar containers (i.e., the release height was based on the release point above the base of the container or boxcar, not above the ground). This conservative assumption likely results in over-predictions of receptor concentrations. ENVIRON calculated the corresponding initial vertical dimension of each area source from USEPA (USEPA 2004b) guidance. Table 4-3 summarizes the modeling source parameters for container and boxcar TRUs at Wilmington.

4.3.2.2 Track Maintenance Equipment

As track maintenance equipment operations may occur anywhere locomotives travel within the Facility, and as specific modeling source parameters were not available for track maintenance equipment, ENVIRON conservatively represented DPM and gasoline TAC emissions from track maintenance equipment by area sources as recommended by the draft Guidelines (ARB 2006a). ENVIRON placed area sources over railway lines at Wilmington in areas where track maintenance activities occur. The locations of area sources representing track maintenance equipment are shown in Figure 4-3. Emissions within this operating area were distributed uniformly based on information from BNSF personnel. ENVIRON assumed that emissions from track maintenance activities occur weekdays (i.e., Monday through Friday) from 7 a.m. to 7 p.m. based on information from BNSF personnel. Tables 3-1a and 3-1b summarize the DPM and gasoline emissions, respectively, and operating hours for track maintenance equipment.

Model-specific source parameter information (i.e., release height, velocity, temperature, and diameter) for track maintenance equipment was not available from BNSF personnel. Because track maintenance equipment generally appeared to be similar in height to locomotives and have vertical emissions releases, ENVIRON assumed an average release height corresponding to the lowest moving locomotive release height adjusted for plume rise (i.e., the lowest adjusted release height in Table 4-2). ENVIRON calculated the corresponding initial vertical dimension of each area source from USEPA (USEPA

2004b) guidance. Table 4-3 summarizes the modeling source parameters for track maintenance equipment activities at Wilmington.

4.3.3 On-Road Fleet Vehicles

On-road fleet vehicle activities at the Wilmington Yard include BNSF on-road fleet vehicles (i.e., employee vehicles) and non-BNSF on-road fleet vehicles (i.e., fuel trucks that refuel locomotives). Because BNSF on-road fleet vehicles may travel anywhere in the area adjacent to the Trainmaster Office building and travel paths are not well-defined, ENVIRON represented DPM and gasoline TAC emissions from BNSF on-road fleet vehicles by area sources as recommended by the draft Guidelines (ARB 2006a) and in discussions with ARB staff.[2] In constrast, the non-BNSF on-road fleet vehicles follow a very specific pathway to the locomotive refueling area. These vehicles enter the Facility at the ingress along the west boundary of the Facility along the west boundary to the locomotive refueling area. ENVIRON represented non-BNSF on-road fleet vehicle movements along this travel pathway by individual volume sources spaced approximately every 50 meters, similar to locomotive movement activities. The locations of the area source representing the BNSF on-road fleet vehicle travel area and volume sources representing the non-BNSF on-road fleet vehicle travel path are shown in Figure 4-4. ENVIRON assumed that emissions from BNSF and non-BNSF on-road fleet vehicles occur 24 hours per day, seven days per week based on information from BNSF personnel. Tables 3-1a and 3-1b summarize the DPM and gasoline emissions, respectively, and operating hours for BNSF and non-BNSF on-road fleet vehicles.

Model-specific source parameter information (i.e., release height, velocity, temperature, and diameter) for BNSF and non-BNSF on-road fleet vehicles was not available from BNSF personnel. Based on information from a previous ARB study (ARB 2000) and recommendations by ARB staff,[3] ENVIRON used a release height of 0.6 meters for on-road fleet vehicles. ENVIRON assumed that exhaust emissions from on-road fleet vehicles were released horizontally, and that plume rise due to differences in temperature between the vehicle exhaust and ambient air was negligible. ENVIRON calculated the corresponding initial vertical dimension of each volume and area source from USEPA (USEPA 2004b) guidance. Table 4-4 summarizes the modeling source parameters for BNSF and non-BNSF on-road fleet vehicle activities at Wilmington.

[2] Personal communication. Gavin Hoch of ENVIRON by telephone with Jing Yuan of ARB on August 24, 2006.
[3] Ibid.

4.4 Meteorological Data

AERMOD requires a meteorological input file to characterize the transport and dispersion of pollutants in the atmosphere. Surface and upper air meteorological data inputs as well as surface parameter data describing the land use and surface characteristics near the site are first processed using AERMET, the meteorological preprocessor to AERMOD. The output file generated by AERMET is the meteorological input file required by AERMOD. Details of AERMET and AERMOD meteorological data needs are described in USEPA guidance documents (USEPA 2004a, 2004b). As ENVIRON previous received ARB approval of meteorological data selection and processing methods (ENVIRON 2006a), the remainder of this section only briefly describes the following two key aspects of the AERMET analysis: the surface and upper air meteorological data selected and the surface parameter evaluation for Wilmington. ENVIRON has provided the raw meteorological data and the AERMOD model-ready meteorological data files as an electronic attachment in Appendix D.

4.4.1 Surface and Upper Air Meteorological Data

The focus of the HRA to be conducted by ARB is the characterization of risk in the areas immediately surrounding Wilmington. As such, ENVIRON selected meteorological data for air dispersion modeling based upon their spatial and temporal representativeness of conditions in the immediate vicinity of the rail yard. As described in ENVIRON's report on meteorological data selection and processing methods previous approved by ARB (ENVIRON 2006), ENVIRON selected the wind speed and wind direction data from the St. Peter and Paul School station for the twelve-month period from July 2005 through June 2006 as the most representative available wind speed, wind direction, temperature, and pressure data for use in the air dispersion analysis of the BNSF Wilmington Rail Yard. ENVIRON used cloud cover data (as the St. Peter and Paul School station did not record cloud cover data) from the National Weather Service's (NWS's) Los Beach Daugherty Field station for the twelve-month period from July 2005 through June 2006. Upper air data from the San Diego Miramar Naval Air Station (NAS) was used in AERMET processing for Wilmington (ENVIRON 2006).

4.4.2 Surface Parameters

Prior to running AERMET, it is necessary to specify the surface characteristics for the meteorological monitoring site and/or the project area. The surface parameters include surface roughness, Albedo, and Bowen ratio, and are used to compute fluxes and stability of the atmosphere (USEPA 2004a) and require the evaluation of nearby land use and temporal impacts on these surface parameters. Surface parameters supplied to the model were specified for the area surrounding the surface meteorological monitoring site (i.e., St. Peter and Paul School station), rather than the project area (rail yard), as recommended by USEPA (USEPA 2005a) and ARB[4]. Because the selected meteorological station is in very close proximity to the Wilmington Yard and the land use surrounding the meteorological station is very similar to the land use surrounding the Wilmington Yard, surface parameters calculated for the meteorological station should be representative of the Wilmington Yard.

In general, ENVIRON determined land-use sectors around the meteorological station using USGS land cover maps in conjunction with recent aerial photographs. ENVIRON then specified surface parameters for each using default seasonal values adjusted for the local climate. When a land-use sector consists of multiple land use types, ENVIRON used an area-weighted average of each surface parameter as recommended by USEPA (2004a). The locale-specific surface parameters used in this evaluation were described in ENVIRON's previous report to ARB (ENVIRON 2006). Figure 4-5 shows the sectors ENVIRON selected around the meteorological station for use in the AERMET processing and the USEPA land-use types within each sector. Table 4-5 summarizes the sector-specific surface parameters (surface roughness, Albedo, and Bowen ratio) determined for each of these sectors.

4.5 Building Downwash

Building downwash is the effect of structures on the dispersion of emissions from nearby point (stack) sources. As several point sources at Wilmington were identified as adjacent to buildings, ENVIRON considered building downwash in this assessment. ENVIRON estimated building dimensions (i.e., location of building corners) based on information provided by BNSF personnel and contractors. Figure 4-6 shows the buildings evaluated as part of the building downwash analysis at Wilmington. In addition to the Trainmaster Office building, three off-site buildings were considered in the building downwash analysis as they are immediately adjacent to the east boundary of the Facility and located within 10 meters of stationary locomotive switching and line-haul emission sources. ENVIRON input building dimension information, summarized in Table 4-6, into USEPA's Building Profile Input Program - Plume Rise Model Enhancements (BPIP-PRIME) to account for potential building-induced aerodynamic downwash effects. The electronic input and output files for BPIP are provided in Appendix E. A sensitivity analysis was conducted in ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b) to estimate the impact of building downwash from locomotive engines on stationary locomotive sources. This sensitivity analysis indicated that, at receptor distances close to the sources (i.e., within 100 meters), building downwash may have a large impact on the modeled concentrations. However,

[4] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

at distances further away from the sources (i.e., 400 to 700 meters), receptor concentrations for model runs with and without building downwash were similar (i.e., within 10% of each other). Based on the results of the sensitivity analysis, and the uncertainty in placing structures corresponding to stationary locomotives in areas where stationary locomotives occur, and the inherent uncertainty in concentration predictions near to stationary and mobile sources, as discussed in Section 5.0, building downwash effects from stationary locomotives were not considered in this assessment. The results of the sensitivity analysis are discussed in more detail in the Appendix F of ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b).

4.6 Terrain

Another important consideration in an air dispersion modeling analysis is whether the terrain in the modeling area is simple or complex (i.e., terrain above the effective height of the emission point). ENVIRON used the following USGS 7.5 Minute digital elevation model (DEMs) information to identify terrain heights within the modeling domain:

- Long Beach (digital)
- Long Beach OES
- San Pedro
- Torrance

The electronic DEM files in the North American Datum (NAD) 1983 projection are provided in Appendix F. ENVIRON provided terrain elevation data to the AERMOD model using version 04300 of AERMAP, AERMOD's terrain preprocessor. Due to discontinuities at the boundaries between some of the DEMs, AERMAP was not able to estimate the terrain elevations for 17 receptor locations. Using the known terrain elevation at adjacent receptors, ENVIRON estimated the terrain elevations at these 17 receptors using a linear interpolation methodology.

4.7 Land Use

AERMOD can evaluate heat island effects from urban areas to atmospheric transport and dispersion using an urban boundary layer option. ENVIRON used Auer's method of classifying land-use as either rural or urban to analyze the urban nature of the region in which the primary project area is located (Auer 1978). This method calls for analysis of the land within a three-kilometer radius from the primary project area to determine if the majority of the land can be classified as either rural (i.e. undeveloped) or urban. If more than fifty percent of the area circumscribed by this three-kilometer radius circle consists of Auer land-use industrial, commercial or residential urban land types, then the urban boundary layer option is used in modeling. ENVIRON used both the USGS National Land Cover Data and the most recent USGS aerial photograph of the area surrounding the facility to determine that more than fifty percent of the area within three kilometers of Wilmington Yard is urban, see Figure 4-7. Therefore, ENVIRON selected the urban boundary layer option for this analysis.

Selection of the urban boundary layer option in AERMOD requires also requires an estimate of the population of the urban area in order to make adjustments to the urban boundary layer. ENVIRON used published census data for the City of Long Beach to determine population values as recommended by USEPA (USEPA 2005a). ENVIRON also provided electronic census data for the modeling domain (described in the next section) as an electronic attachment in Appendix G, as required in the draft Guidelines.

4.8 Receptor Locations

ENVIRON used gridded receptor points surrounding the BNSF Wilmington Yard in the air dispersion analysis. These gridded receptor points represent the general population in the vicinity of the BNSF Wilmington Yard, which includes both residential and commercial populations. However, these receptors do not necessarily represent the specific locations of the residential and commercial populations in the vicinity of the BNSF Wilmington Yard. ENVIRON used three sets of discrete Cartesian receptor grid points around the Facility in the air dispersion modeling. The spacing and sizes of the Cartesian receptor grids were determined based on a screening sensitivity analysis, discussed in more detail in Appendix H. The Cartesian receptors included a fine receptor grid with spacing of 50 meters out to a distance of approximately 500 meters from the Facility boundary, a medium receptor grid with spacing of 250 meters out to a distance of approximately 1,000 meters from the Facility boundary, and a coarse receptor grid with spacing of 500 meters out to six kilometers from the Facility boundary. ENVIRON used Facility plot plans and other information provided by BNSF facility personnel to locate the Facility boundary. Receptors inside the facility boundary and over water in the San Pedro Bay were removed prior to the air dispersion modeling analysis. The locations of the coarse, medium, and fine receptor grid points are shown in Figures 4-Sa, 4-Sb, and 4-Sc, respectively. Discrete receptor points were generated from each of the grids shown in Figures 4-Sa, 4-Sb, and 4-Sc. The air dispersion modeling analysis did not include receptors at the Facility boundary.

In accordance with the draft Guidelines (ARB 2006a), ENVIRON also evaluated individual receptor points at off-site locations within one mile of the Facility corresponding to sensitive receptors, including schools, hospitals, and daycare centers. Sensitive receptor locations were identified from searches of the following sources:

- California Department of Education, California School Directory
  http://www.cde.ca.gov/re/sd/
- The Automated Licensing Information and Report Tracking System (Hospitals and Licensed Care Facilities)
  http://alirts.oshpd.ca.gov/AdvSearch.aspx
- Yellow Pages
  http://yp.yahoo.com

These on-line databases were searched for the following zip codes in the cities of Wilmington, Carson, and Long Beach:

90744 90745 90810

The sensitive receptor locations identified from the search of these data sources and within one mile of the Facility are listed in Table 4-7.

Electronic census data was provided for the modeling domain in accordance with the draft Guidelines (ARB 2006a). These data, provided on a census-block level, were obtained from the GeoLytics CensusCD 2000 (GeoLytics 2001), and provided in electronic shapefile format in Appendix G.

4.9 Air Dispersion Modeling Results

ENVIRON calculated the air concentration of each TAC at each of the receptor locations discussed in Section 4.8. ENVIRON modeled DPM and TAC sources using unit emission rates (i.e., one gram per second) to estimate period-average dispersion factors for DPM and TACs corresponding to the meteorological period from July 2005 through June 2006. These period-average dispersion factors for DPM and TACs were combined with source-specific emission rates to generate period-average concentrations for the meteorological period from June 2005 through July 2006. ENVIRON also modeled all non-DPM TAC sources using hourly-maximum evaporative TOG, exhaust TOG, and exhaust PM emission rates in order to estimate one-hour maximum evaporative TOG, exhaust TOG, and exhaust PM concentrations for the meteorological period July 2005 through June 2006. ARB speciation profiles for evaporative TOG, exhaust TOG, and exhaust PM were applied to estimate chemical-specific one-hour maximum concentrations at each receptor. It should be noted that this method results in an over-prediction of maximum one-hour concentrations of individual constituents at each receptor, as discussed in the uncertainty section below. Electronic AERMOD input and output modeling files are included in Appendix I. Electronic database tables containing DPM and gasoline TAC period-average concentrations at each receptor and one-hour maximum gasoline TAC concentrations at each receptor for the meteorological period modeled are contained in Appendix J.

5.0 UNCERTAINTIES

Understanding the degree of uncertainty associated with each component of a risk assessment is critical to interpreting the results of the risk assessment. As recommended by the National Research Council (NRC 1994), [a risk assessment should include] "a full and open discussion of uncertainties in the body of each EPA risk assessment, including prominent display of critical uncertainties in the risk characterization." The NRC (1994) further states that "when EPA reports estimates of risk to decision-makers and the public, it should present not only point estimates of risk, but also the sources and magnitude of uncertainty associated with these estimates." Similarly, recommendations to CalEPA on risk assessment practices and uncertainty analysis from the Risk Assessment Advisory Committee (RAAC) were adapted from NRC recommendations (RAAC 1996). Thus, to ensure an objective and balanced characterization of risk and to place the risk assessment results in the proper perspective, the results of a risk assessment should always be accompanied by a description of the uncertainties and critical assumptions that influence the key findings of the risk assessment.

In accordance with the recommendations described above and as required in the draft Guidelines (ARB 2006a), ENVIRON has evaluated the uncertainties associated with the first two steps of an HRA: (1) emissions estimation and (2) air dispersion modeling. The uncertainties and critical assumptions associated with these steps are described below. Consistent with the Agreement, ARB will complete the third major part of the HRA which consists of estimating the risks for each of the designated rail yards and evaluating the uncertainties associated with the risk characterization component of the HRA (ARB 2005b). As noted in the Agreement, specific objectives of the HRAs to be conducted by ARB include developing a basis for risk communication, including describing the uncertainties associated with the key findings of the risk assessment. At the request of ARB, ENVIRON will assist ARB in identifying the critical assumptions and uncertainties associated with the risk characterization step of the HRA. This uncertainty evaluation will be conducted concurrent with the ARB risk characterization activities and will be provided to ARB in a separate submittal.

The following section summarizes the critical uncertainties associated with the emissions estimation and air dispersion modeling components of the risk assessment.

5.1 Estimation of Emissions

The uncertainties associated with emissions estimates and projections include uncertainties in activity and emission rates for the base year as well as projected future years. Although future year emissions were not evaluated in this assessment, the residential and worker risk scenarios will be evaluated for 70-year and 40-year periods, respectively, at a minimum by ARB. Thus, uncertainty due to future changes in activity and emission rates will be generally discussed. The uncertainty in activity and emissions estimates applies to both locomotive and non-locomotive sources.

For locomotive sources, the activity rates include primarily the number of engines operating and time in modes. The number of engines operating at the facility are accurately measured and counted at readers, but the readers are not necessarily located exactly at the site under study, and can under certain circumstances produce erroneous duplicate readings that could only be accounted for via rough approximation. A separate and less accurate dataset was used to estimate the number of engines arriving and departing from a site. These data, however, often do not produce matching arrivals and departures. ENVIRON adopted a conservative approach based on using the higher of the arrival or departure numbers, which may have resulted in overestimates of the number of engines arriving.

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 between idling with the engine on and idling with the engine off. As a result, ENVIRON used professional judgment to distinguish between these two modes. In addition, no idle time reduction was assumed in the future year scenarios, despite the fact that BNSF has initiated programs to reduce idling through installation of automatic start/stop devices and other operational changes to reduce idling. So 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.

The most significant non-locomotive sources at the Wilmington Rail Yard are transportation refrigeration units and track maintenance equipment. Activity levels of this equipment are estimated relatively accurately, however the duty cycles (engine load demanded) are less well characterized. Default estimates of the duty cycle may not accurately reflect the typical duty demanded from this equipment at the Wilmington Yard. New emissions models for these sources have recently been provided for use in this study by ARB. In many cases, these revised models reflect a dramatic change in emission factors from previous versions of the models and it is therefore reasonable to expect that future revisions to these models may result in further changes to emission estimates for on-road and off-road engines. 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. The effects of these regulations have, for the most part, not been incorporated in the emission estimates, and so estimated emissions are greater than those expected for future years at the same activity level.

5.2 Estimation of Exposure Concentrations

5.2.1 Estimates from Air Dispersion Models

As discussed in Section 4.0, USEPA-recommended dispersion model AERMOD was used to estimate annual average off-site chemical exposure concentrations at the various off-site receptor locations. This model uses the Gaussian plume equation to calculate ambient air concentrations from emission sources. For this model, the magnitude of error for the maximum concentration is estimated to range from 10 to 40% (USEPA 2005b). Therefore, off-site exposure concentrations used in this assessment represent approximate off-site exposure concentrations.

5.2.2 Source Placement

Uncertainty exists in the placement of emission sources at the Facility. As a large amount of locomotive and on- and off-road engine activity at a rail yard is engaged in movement, the distribution of emissions during movement in the yards is an important source of uncertainty. Unlike fixed stationary sources, emissions from movement would occur over a continuum rather than as discrete points. However, regulatory approved models were originally developed for the evaluation of fixed stationary sources and the use of a continuum of source locations to model emissions during movement of sources results in an unacceptably large number (in the tens of thousands) of sources that would result in unwieldy post-processing data needs and unacceptable modeling run times (on the order of months rather than hours or days).

In this assessment, point and volume sources were spaced evenly at approximately 50-meter and 85-meter intervals, respectively, similar to ARB's Roseville Study (ARB 2004) over rail locations where locomotive and on- and off-road activities occurred. Closer spacing between point and volume sources may impact the predicted concentrations at receptor locations near the Facility boundary. Sensitivity analyses performed to determine the potential impact of source placement on predicted concentrations at receptors near the Facility boundary (see Appendix C of ENVIRON's BNSF Commerce/Mechanical Report [ENVIRON 2006b]) indicated that concentrations at receptors nearest to the specific emission sources could be over-predicted by at least 10 percent.

5.2.3 Source Representation

The source parameters (i.e., release velocity and release temperature) used to model stationary locomotive activities are sources of uncertainty. Following ARB guidance (ARB 2006a), fleet-average source parameters were calculated to reduce the large number of potential source parameter configurations related to stationary locomotive activities at Wilmington. The specific methodology used for calculating fleet-averaged source parameters is presented in Section 4.3.1.1. The use of fleet-average source parameters for stationary locomotive activities resulted in approximate predictions for these sources.

The release heights and vertical dimensions used for movement sources at the Facility are also sources of uncertainty. ARB calculated adjustments to the release height and vertical dimension for movement sources for individual engine models based on locomotive notch settings (i.e., locomotive travel speeds) and using two different stability classes for their Roseville study (ARB 2004). This methodology resulted in several uncertainties. ARB's methodology assumed that the wind speed was equal to the locomotive speed and did not account for variability in either the locomotive speed or hourly wind speeds. In addition, ARB's methodology assumed only two stability classes (i.e., class "D" for daytime and class "F" for nighttime), and did not account for potential variability in stability class during these time periods based local meteorological data. Nevertheless, ENVIRON calculated plume rise adjustments using a methodology similar to ARB's, described in more detail in Section 4.3.1.2, for locomotive movement activities and on-road diesel and gasoline vehicle movement sources at the Facility. Thus, the use of plume rise adjustments resulted in approximate predictions of receptor concentrations for these sources.

The use of area sources to represent emissions sources operating in areas where travel paths are not well defined or equipment usage may occur over the entire operating area are additional sources of uncertainty related to source representation. At the BNSF Wilmington Yard, area sources were used to represent transportation refrigeration units, on-road fleet vehicle movement activities, and track maintenance equipment, which account for approximately two percent of total DPM emissions from the Rail Yard. Based on guidance in the draft Guidelines (ARB 2006a), these source activities may be modeled as either area or volume sources. The AERMOD model uses very different methodologies to estimate dispersion from area and volume sources (USEPA 2004c), and the use of area sources generally results in higher (more conservative) concentration estimates. Thus, the use of area sources to represent transportation refrigeration units, on-road fleet vehicle movement activities, and track maintenance equipment at Wilmington generally resulted in over-predictions of receptor concentrations for these source activities.

5.2.4 Meteorological Data Selection

Uncertainty also exists in the meteorological data used in the AERMOD air dispersion model. These uncertainties are related to the use of meteorological data that is not site-specific, combination of surface data from two meteorological stations, substitution of missing meteorological data, and use of surface parameters for the meteorological station as opposed to the rail yard.

ENVIRON selected meteorological data for air dispersion modeling based upon their spatial and temporal representativeness of conditions in the immediate vicinity of the rail yard. On-site meteorological data was not available for the rail yard. Therefore, the meteorological data used in this analysis was based on surface meteorological data from the Port of Los Angeles' (POLA's) St. Peter and Paul School station (approximately three kilometers from the rail yard) and the NCDC/NWS station at Long Beach Daugherty Field (approximately nine kilometers from the rail yard) and upper air data from San Diego-Miramar Naval Air Station. A complete set of surface meteorological data was not available at the St. Peter and Paul School station, therefore wind speed, wind direction, temperature, and pressure data from the St. Peter and Paul School station were combined with cloud cover data from Long Beach Daugherty Field. Meteorological surface measurements from the St. Peter and Paul School and Long Beach Daugherty Field stations were not 100% complete for all modeled years, therefore missing data were substituted using procedures outlined in Atkinson & Lee (1992). Surface parameters supplied to AERMET, the meteorological preprocessor to AERMOD, were specified for the area surrounding the meteorological monitoring site (St. Peter and Paul School station), rather than the project area (rail yard), as recommended by USEPA (USEPA 2005a) and ARB.[5] However, because the selected meteorological station is in very close proximity to Wilmington and the land use surrounding the meteorological station is very similar to the land use surrounding Wilmington, surface parameters calculated for the meteorological station should be representative of Wilmington. The uncertainties due to the use of non-site-specific meteorological data, combination of surface data from different stations, substitution of missing surface data, and use of surface parameters for the meteorological station resulted in approximate exposure concentrations.

[5] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

5.2.5 Building Downwash

The spacing and placement of point sources relative to buildings or structures results in impacts to building downwash parameters and resulting modeling concentrations. Based on the results of ENVIRON's sensitivity analyses discussed in Appendix G of ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b), the uncertainty in placing locomotive structures in areas where stationary locomotives occur, and the fact that many of the stationary locomotive activities occur in the interior of the rail yard, ENVIRON did not include building downwash effects due to locomotives in this assessment. Also, because specific locations for stationary switching and line-haul locomotive activities were not available, point sources representing these activities were distributed evenly over the areas where these operations occurred, as described in Section 4.3.1.1. These assumptions and modeling techniques resulted in approximate predictions of receptor concentrations near the facility boundary, as described in further detail below.

5.2.6 Uncertainty in Points of Maximum Impact

Receptor concentration estimates in close proximity to the facility, such as any potential point of maximum impact (PMI), are highly dependent on air dispersion modeling assumptions. That is, different modeling assumptions regarding the spatial and temporal distributions of the emission sources can greatly influence the resulting concentration estimates in proximity to the emission sources, including the magnitude and location of the PMI. As discussed in Section 5.2.2, there is significant uncertainty associated with identification of and estimation of impacts at locations near to a mobile source facility due to the complexity associated with modeling sources that can move (i.e., volume or line sources representing mobile sources). The potential influence of modeling techniques used in this assessment were evaluated in a sensitivity analyses performed for two different movement activities at Commerce/Mechanical, presented in Appendix C of ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b). These two analyses illustrated the particular sensitivities in assessment of receptors near a rail yard's boundary to source representation (i.e., source spacing, and source sizing for approximation of mobile sources) in the modeling and how source simplification assumptions generally result in over-prediction of concentrations near to the rail yards. Other modeling techniques and assumptions used in this assessment, including fleet-averaging of stationary locomotive activity source parameters, plume rise adjustments to locomotive and on-road diesel and gasoline vehicle movement sources, the use of area sources to represent emissions sources operating in areas where travel paths are not well defined or equipment usage may occur over the entire area, as described above, also contribute to uncertainty to modeling predictions for receptors near the boundary of the rail yard.

Focusing on receptor locations at a greater distance (i.e., one to two kilometers) from the facility reduces the overall influence on the proximity to specific site operations. The two sensitivity analyses discussed above, and presented in more detail in ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b), indicated that concentrations were over-predicted by 21% and 17% at the PMI. However, at distances one to two kilometers from the facility, receptor concentrations for the two source configurations were all within one to five percent of each other. Thus, the results of these two sensitivity analyses indicated that concentrations at receptors further from the sources are much less sensitive to air dispersion assumptions regarding the spatial and temporal distributions of emission sources.

5.2.7 Estimation of Maximum One-Iour TAC Concentrations

ENVIRON evaluated a large number of non-DPM TACs in this assessment from non-DPM sources (mainly from gasoline engine emissions) as identified in the speciation profiles discussed in Appendix A. In order to substantially reduce modeling complexity and run time, maximum one-hour TOG exhaust, TOG evaporative, and PM exhaust emission rates (as opposed to maximum one-hour individual TAC emission rates) were input into the air dispersion model. Speciation profiles containing the fractions of individual TACs for TOG exhaust, TOG evaporative, and PM exhaust emissions (discussed in Appendix A) were then applied to the TOG exhaust, TOG evaporative, and PM exhaust concentrations estimated by the dispersion model to calculate concentrations of individual TACs. This methodology resulted in conservative estimates (i.e., over-predictions) of the maximum one-hour concentrations for individual TACs.

5.3 Risk Characterization

As stated previously, ARB will conduct the risk characterization part of the HRA based on the results of the emissions estimation and air dispersion modeling provided by ENVIRON. Consistent with the Agreement and draft Guidelines *(*ARB 2005b, 2006a), the risk characterization activities conducted by ARB will include evaluating and reporting the uncertainties associated with the estimated risks for each designated rail yard. As discussed in detail above, there are many uncertainties associated with the estimation of emissions and exposure point concentrations from rail yard emission sources that would be in addition to the uncertainties associated with the exposure assumptions and toxicity information to be used in ARB's estimation of risks. Many of these uncertainties lead to an over-prediction of the estimated offsite impacts. At the request of ARB, ENVIRON will assist ARB in identifying the critical assumptions and uncertainties associated with the risk characterization step of the HRA.

This evaluation will be conducted concurrent with the ARB risk characterization activities and will be provided to ARB in a separate submittal.

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Table 2-1
Percentages of Land Use Categories Within Twenty Kilometers of Facility
BNSF Wilmington Rail Yard
Wilmington, CA

Land Use Category[1]	Percentage (%)
Open Water	37.65%
Low Intensity Residential	23.83%
High Intensity Residential	10.83%
Commercial/Industrial/Transportation	13.82%
Bare Rock/Sand/Clay	2.08%
Quarries/Strip Mines/Gravel Pits	0.00%
Transitional	0.00%
Deciduous Forest	0.02%
Evergreen Forest	0.51%
Mixed Forest	1.21%
Shrubland	6.03%
Orchards/Vineyards/Other	0.00%
Grassland/Herbaceous	2.34%
Pasture/Hay	0.05%
Row Crops	0.03%
Small Grains	0.01%
Fallow	0.00%
Urban/Recreation Grasses	1.46%
Woody Wetlands	0.02%
Emergent Herbaceous Wetlands	0.11%

Notes:
1. Land use data are based on National Land Cover Data 1992 from the US Geological Survey.

Table 3-1a
Summary of Emissions and Operating Hours for Modeled DPM Emission Sources
BNSF Wilmington
Wilmington, California

Emission Source	Activity Category	Activity Category Description	Activity Sub-Category	Activity Sub-Category Description	Modeling Source Type	Operation Mode	Modeling Source Group[1]	Total Emissions (g)	Days of Operation per week	Hours of operation per day	Modeled Area (m²)	Total Emission rate[2,3,4] (g/s) or (g/m²/s)	Number of Modeled Sources	Emission Rate Applied to Period-Average Dispersion Factors[5] (g/s)
Locomotives		Maintenance	2	Idling while refueling	Point	Idle	A2	50,682	7	24		1.61E-03	3	5.36E-04
	D	Switching	D	Switching	Point	Idle	D	95,384	7	24		3.02E-03	72	4.20E-05
					Volume	Dynamic Braking	Dd	1,494	7	24		4.74E-05	14	3.38E-06
					Volume	Notch 1	D1	16,825	7	24		5.34E-04	14	3.81E-05
					Volume	Notch 2	D2	47,145	7	24		1.49E-03	14	1.07E-04
					Volume	Notch 3	D3	44,009	7	24		1.40E-03	14	9.97E-05
					Volume	Notch 4	D4	27,061	7	24		8.58E-04	14	6.13E-05
					Volume	Notch 5	D5	20,781	7	24		6.59E-04	14	4.71E-05
					Volume	Notch 6	D6	28,994	7	24		9.19E-04	14	6.57E-05
					Volume	Notch 7	D7	16,817	7	24		5.33E-04	14	3.81E-05
					Volume	Notch 8	D8	89,596	7	24		2.84E-03	14	2.03E-04
	E	BNSF Arriving-Departing Line-Haul	E	BNSF Arriving-Departing Line-Haul	Point	Idle	LHN	687,732	7	24		2.18E-02	100	2.18E-04
					Point	Idle	LHS	36,196	7	24		1.15E-03	50	2.30E-05
					Volume	Dynamic Braking	LHND	11,730	7	24		3.72E-04	12	3.10E-05
					Volume	Notch 1	LHN1	96,248	7	24		3.05E-03	12	2.54E-04
					Volume	Notch 2	LHN2	157,002	7	24		4.98E-03	12	4.15E-04
					Volume	Notch 3	LHN3	45,726	7	24		1.45E-03	12	1.21E-04
					Volume	Notch 4	LHN4	26,035	7	24		8.26E-04	12	6.88E-05
					Volume	Notch 5	LHN5	12,128	7	24		3.85E-04	12	3.20E-05
					Volume	Notch 6	LHN6	10,955	7	24		3.47E-04	12	2.89E-05
					Volume	Notch 7	LHN7	9,535	7	24		3.02E-04	12	2.52E-05
					Volume	Notch 8	LHN8	138,743	7	24		4.40E-03	12	3.67E-04
					Volume	Dynamic Braking	LHSD	617	7	24		1.96E-05	5	3.92E-06
					Volume	Notch 1	LHS1	5,066	7	24		1.61E-04	5	3.21E-05
					Volume	Notch 2	LHS2	8,263	7	24		2.62E-04	5	5.24E-05
					Volume	Notch 3	LHS3	2,407	7	24		7.63E-05	5	1.53E-05
					Volume	Notch 4	LHS4	1,370	7	24		4.35E-05	5	8.69E-06
					Volume	Notch 5	LHS5	638	7	24		2.02E-05	5	4.05E-06
					Volume	Notch 6	LHS6	577	7	24		1.83E-05	5	3.66E-06
					Volume	Notch 7	LHS7	502	7	24		1.59E-05	5	3.18E-06
					Volume	Notch 8	LHS8	7,302	7	24		2.32E-04	5	4.63E-05
On Road Fleet[6]	J	On-Road Fleet	J	Non-BNSF On-Road Fleet	Volume		NBORV	224	7	24		7.12E-06	9	7.91E-07
				BNSF On-Road Fleet	Area		BORA	0	7	24	4,820	0.00E 00	1	0.00E 00
Off Road Equipment	K	Off-Road Equipment	K1a	Boxcar TRUs	Area		BOXTRU	21,537	7	24	72,102	9.47E-09	2	6.83E-04
			K1b	Container TRUs	Area		CONTTRU	4,364	7	24	72,102	1.92E-09	2	1.38E-04
			K2	Track Maintenance Equipment	Area		TRACKM	14,066	5	12	73,549	6.06E-09	5	4.46E-04

Notes:
1. "Modeling Source Group" corresponds to the modeling source group name in the AERMOD input and output files.
2. The "Total Emission Rate" is calculated based on the "Total Emissions" divided by the "Days of Operation Per Week" divided by the "Hours of Operation Per Day".
Since the temporal profiles in the model take into account the fluctuations of emission rates throughout the year, we can use 8,760 hours for average emission rates here.
3. The "Total Emission Rate" units are "grams per second" for point and volume sources and "grams per meter squared per second" for area sources
4. Total emission rate is based on 8,760 hours per year. If source is modeled less than 8,760 hours per year, the temporal profile in the model setup accounts for this
with appropriate emission factors. This applies to track maintenance and portable engine sources as well as sources that are modeled for either one of day and night periods.
5. The "Emission Rate Applied to Period Average Dispersion Factors" is the emission rate applied to the modeled period average dispersion factors for each source group to estimate air concentrations.
For point and volume sources, the "Emission Rate Applied to Period Average Dispersion Factors" is equal to the Total Emission Rate" divided by the "Number of Modeled Emission Sources";
For area sources, the "Emission Rate Applied to Period Average Dispersion Factors" is equal to the Total Emission Rate" multiplied by the modeled are
6. On Road Fleet is modeled as volume sources (along distinguishable travel paths) and area sources (for travel in larger areas without distinguishable paths).

Table 3-1b
Summary of Emissions and Operating Hours For Modeled Gasoline Emission Sources
BNSF Wilmington
Wilmington, California

Activity Subcategory	Activity Subcategory Description	Modeling Source Type	Modeling Source Group[1]	Total Emissions (g)	Days of Operation per week	Hours of operation per day	Hours of Operation per year	Modeled Area (m^2)	Total Emission rate[2,3] (g/s) or ($g/m^2/s$)	No. of Emission Sources	Emission Rate Applied to Period-Average Dispersion Factors[4] (g/s)	Hourly Maximum Emission Rate[5] (g/s) or ($g/m^2/s$)
Gasoline PM (Speciate Profile #400)												
J	On-Road Fleet Vehicles	Area	GAS-PM	2	7	24	8,760	4,820	6.52E-08	--	3.14E-04	6.52E-08
K2	Track Maintenance Equipment	Area		11	5	12	3,129	73,549	3.49E-07	--	2.57E-02	3.49E-07
TOG Evaporative (Speciate Profile #422)												
J	On-Road Fleet Vehicles	Area	TOG-EVAP	78	7	24	8,760	4,820	2.48E-06	--	1.20E-02	2.48E-06
K2	Track Maintenance Equipment	Area		67	5	12	3,129	73,549	2.13E-06	--	1.56E-01	2.13E-06
TOG Exhaust (Speciate #2105)												
J	On-Road Fleet Vehicles	Area	TOG-EX	80	7	24 0	8,760	4,820	2.54E-06	--	1.22E-02	2.54E-06
K2	Track Maintenance Equipment	Area		381	5	12	3,129	73,549	1.21E-05	--	8.88E-01	1.21E-05

Notes:
1. "Modeling Source Group" corresponds to the modeling source group name in the AERMOD input and output files.
2. The "Total Emission Rate" is calculated based on the "Total Emissions" divided by the "Days of Operation Per Week" divided by the "Hours of Operation Per Day".
3. The "Total Emission Rate" units are "grams per second" for point and volume sources and "grams per meter squared per second" for area sources.
4. The "Emission Rate Applied to Period Average Dispersion Factors" is the emission rate applied to the modeled period average dispersion factors for each source group to estimate air concentrations.
5. The "Hourly Maximum Emission Rate" is the emission rate used in the air dispersion model. For point and volume sources, the "Hourly Maximum Emission Rate" is equal to the "Emission Rate Applied to Period Average Dispersion Factors). For area sources, the "Hourly Maximum Emission Rate" is equal to the "Total Emission Rate."

Table 3-2
Summary of Activity Category Total Annual DPM and TOG Emissions at the Facility
BNSF Wilmington
Wilmington, California

Activity Category	Activity Category Description	Diesel			Gasoline								
		PM Emissions			PM Emissions			TOG Evaporative Emissions			TOG Exhuast Emissions		
		Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)
A	Locomotive Maintenance	50,682	5.07E-02	2.9%	-	-	-	-	-	-	-	-	-
D	Locomotive Switching	388,107	0.39	22.3%	-	-	-	-	-	-	-	-	-
E	Arriving-Departing Line-Haul	1,258,771	1.26	72.4%	-	-	-	-	-	-	-	-	-
J	On-Road Fleet Vehicles	224	2.24E-04	0.0%	2	2.05E-06	15.7%	78	7.84E-05	53.9%	80	8.00E-05	17.4%
K	Off-Road Equipment	39,967	4.00E-02	2.3%	11	1.10E-05	84.3%	67	6.70E-05	46.1%	381	3.81E-04	82.6%
	TOTAL	1,737,751	1.74	100%	13	1.31E-05	100%	145	1.45E-04	100%	461	4.61E-04	100%

Table 4-1
Fleet-Average Source Parameters for Stationary Locomotive Activities
BNSF Wilmington
Wilmington, California

									Day		Night	
Activity Subcategory	**Activity Subcategory Description**	**Modeling Source Type**	**Operation Mode**	**Stack Height (m)**	**Exit Temperature (K)**	**Exit velocity (m/s)**	**Exit Diameter (m)**	**Initial Lateral Dimension (m)**	**Release Height (m)**	**Initial Vertical Dimension (m)**	**Release Height (m)**	**Initial Vertical Dimension (m)**
A2	Idling while refueling	Point	Idle	4.52	388.14	4.69	0.57	-	-	-	-	-
D	Switching	Point	Idle	4.52	361.60	15.56	0.29	-	-	-	-	-
		Volume	Dynamic Braking	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
		Volume	Notch 1	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
		Volume	Notch 2	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
		Volume	Notch 3	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
		Volume	Notch 4	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
		Volume	Notch 5	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
		Volume	Notch 6	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
		Volume	Notch 7	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
		Volume	Notch 8	-	-	-	-	0.71-19.77	73.15	17.01	49.78	11.58
E	BNSF Arriving-Departing Line-Haul	Point	Idle	4.52	388.15	4.69	0.57	-	-	-	-	-
		Volume	Dynamic Braking	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83
		Volume	Notch 1	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83
		Volume	Notch 2	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83
		Volume	Notch 3	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83
		Volume	Notch 4	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83
		Volume	Notch 5	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83
		Volume	Notch 6	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83
		Volume	Notch 7	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83
		Volume	Notch 8	-	-	-	-	0.71-19.77	5.26	1.22	12.16	2.83

Table 4-2
Plume Rise Adjustments for Locomotive Movement Sources[1]
BNSF Wilmington
Wilmington, California

Activity Subcategory	Activity Subcategory Description	Modeled Notch Setting[2]	Locomotive Speed (mph)	Locomotive Speed (m/s)	Modeled Locomotive Type	Plume Height (meters)[3]			Initial Vertical Dimension (meters)		
						Stability D	Stability F	Adjusted F[4]	Stability D	Stability F	Adjusted F[4]
D	Switching	8	5	2.24	Fleet Average	73.15	49.78	--	17.01	11.58	--
F	BNSF Line-Haul	2	20	8.94		5.26	20.38	12.16	1.22	4.74	2.83

Notes:
1. Plume rise calculated using USEPA's SCREEN3 model using methodology in ARB's Roseville Study (ARB 2004).
2. Due to sensitivity of plume rise to wind speed and locomotive speed, plume rise adjustments calculated for only one notch setting per source subactivity.
For source subactivities with multiple notch settings, the source parameters for the notch setting with the greatest percentage of activity emission were selected.
3. Plume Height = physical height of locomotive plus plume rise.
4. The maximum wind speed for stability category F in SCREEN3 is 4.0 m/s. For locomotive speeds (i e , effective wind speeds) greater than 4.0 m/s, the plume rise for stability category F was adjusted according to the methodology in the ARB Roseville Study (ARB 2004): adjusted plume rise = plume rise x (1/locomotive speed)^(1/3)

Source:
1. Air Resources Board (ARB). 2004. Roseville Rail Yard Study. October 2004

Table 4-3
Source Parameters for Off-Road Equipment
BNSF Wilmington
Wilmington, California

				Day		Night	
Activity Subcategory	**Activity Subcategory Description**	**Modeling Source Type**	**Initial Lateral Dimension (m)**	**Release Height[1] (m)**	**Initial Vertical Dimension (m)**	**Release Height[1] (m)**	**Initial Vertical Dimension (m)**
K1a	TRU Boxcars	Area	-	1.00	0.23	1.00	0.23
K1b	TRU Containers	Area	-	1.00	0.23	1.00	0.23
K2	Track Maintenance Equipment	Area	-	5.26	1.22	5.26	1.22

Notes:
1. Assumed release height for track maintenance equipment equal to the lowest plume height from plume rise adjusments for locomotive sources.

Source:
1. United States Environmental Protection Agency (USEPA) 2004 User's Guide for the AMS/EPA Regulatory Model - AERMOD. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-001. September.

Table 4-4
Source Parameters for On-Road Fleet
BNSF Wilmington
Wilmington, California

Activity Subcategory	Activity Subcategory Description	Modeling Source Type[1]	Initial Lateral Dimension (m)	Day		Night	
				Release Height[2] (m)	Initial Vertical Dimension[3] (m)	Release Height[2] (m)	Initial Vertical Dimension[3] (m)
J	On-Road Fleet Vehicles	Volume	1.16	0.60	0.14	0.60	0.14
		Area		0.60	0.14	0.60	0.14

Notes:
1. On-Road Fleet modeled as volume sources (along distinguishable travel paths) and area sources (for travel in larger areas without distinguishable paths).
2. Release height based on ARB Risk Reduction Plan (ARB 2000) and recommendations from ARB staff.

Source:
1. Air Resources Board (ARB). 2000. Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel Fueled Engines and Vehicles. Appendix VII: Risk Characterization Scenarios. October.

Table 4-5
Sector-Specific Surface Roughness, Bowen Ratio, and Albedo
BNSF Wilmington
Wilmington, California

Month	SEASON	Sector No.	Albedo (July 2005- June 2006)	Bowen Ratio (July 2005- June 2006)	Surface Roughness (July 2005- June 2006)
January	Autumn	1	0.188	2.305	0.944
February	Spring		0.152	1.153	0.944
March	Spring		0.152	1.153	0.944
April	Summer		0.169	1.037	0.944
May	Summer		0.169	1.037	0.944
June	Summer		0.169	1.037	0.944
July	Summer/Autumn		0.178	1.056	0.944
August	Summer/Autumn		0.178	1.056	0.944
September	Summer/Autumn		0.178	1.056	0.944
October	Summer/Autumn		0.178	1.056	0.944
November	Autumn		0.188	2.305	0.944
December	Autumn		0.188	2.305	0.944
January	Autumn	2	0.188	2.269	0.772
February	Spring		0.159	1.143	0.772
March	Spring		0.159	1.143	0.772
April	Summer		0.168	0.938	0.772
May	Summer		0.168	0.938	0.772
June	Summer		0.168	0.938	0.772
July	Summer/Autumn		0.178	0.972	0.772
August	Summer/Autumn		0.178	0.972	0.772
September	Summer/Autumn		0.178	0.972	0.772
October	Summer/Autumn		0.178	0.972	0.772
November	Autumn		0.188	2.269	0.772
December	Autumn		0.188	2.269	0.772
January	Autumn	3	0.181	1.992	0.711
February	Spring		0.152	1.009	0.711
March	Spring		0.152	1.009	0.711
April	Summer		0.159	0.849	0.711
May	Summer		0.159	0.849	0.711
June	Summer		0.159	0.849	0.711
July	Summer/Autumn		0.170	0.875	0.711
August	Summer/Autumn		0.170	0.875	0.711
September	Summer/Autumn		0.170	0.875	0.711
October	Summer/Autumn		0.170	0.875	0.711
November	Autumn		0.181	1.992	0.711
December	Autumn		0.181	1.992	0.711
January	Autumn	4	0.196	2.562	0.835
February	Spring		0.167	1.276	0.836
March	Spring		0.167	1.276	0.836
April	Summer		0.180	1.040	0.841
May	Summer		0.180	1.040	0.841
June	Summer		0.180	1 040	0.841
July	Summer/Autumn		0.188	1.082	0.838
August	Summer/Autumn		0.188	1.082	0.838
September	Summer/Autumn		0.188	1.082	0.838
October	Summer/Autumn		0.188	1.082	0.838
November	Autumn		0.196	2.562	0.835
December	Autumn		0.196	2.562	0.835
January	Autumn	5	0.183	1.997	0.766
February	Spring		0.153	1.013	0.770
March	Spring		0.153	1.013	0.770
April	Summer		0.170	0.841	0.797
May	Summer		0.170	0.841	0.797
June	Summer		0.170	0.841	0.797
July	Summer/Autumn		0.177	0.876	0.782
August	Summer/Autumn		0.177	0.876	0.782
September	Summer/Autumn		0.177	0.876	0.782
October	Summer/Autumn		0.177	0.876	0.782
November	Autumn		0.183	1.997	0.766
December	Autumn		0.183	1.997	0.766
January	Autumn	6	0.194	2.531	0.873
February	Spring		0.164	1.267	0.875
March	Spring		0.164	1.267	0.875
April	Summer		0.178	1.042	0.878
May	Summer		0.178	1.042	0.878
June	Summer		0.178	1.042	0.878
July	Summer/Autumn		0.186	1.081	0.876
August	Summer/Autumn		0.186	1.081	0.876
September	Summer/Autumn		0.186	1.081	0.876
October	Summer/Autumn		0.186	1.081	0.876
November	Autumn		0.194	2.531	0.873
December	Autumn		0.194	2.531	0.873

Table 4-6
Approximate Dimensions of Buildings at the Facility
BNSF Wilmington
Wilmington, California

Building/ Structure ID	Structure Name	Approximate Footprint Dimensions[1] (meters)	Height[2] (meters)
1	Trainmaster Office	12 x 27	3.7
2	Off-site Building[3]	88 x 128	6.1
3	Off-site Building[3]	82 x 130	6.1
4	Off-site Building[3]	118 x 165	6.1

Notes:
1. Approximate footprint dimensions estimated based on aerial photograph of facility.
2. Building heights not available from BNSF personnel building heights based on heights of similar building and structure types at other BNSF facilities.
3. Three off-site buildings were included in the building downwash analysis due to their proximity to on-site stationary sources.

Table 4-7
Sensitive Receptors within One Mile of the Facility[1]
BNSF Wilmington
Wilmington, CA

Sensitive Receptor Name	Address	UTMx (m)	UTMy (m)	Type
Avalon Continuation	1425 North Avalon Blvd., Wilmington, C	383032.7	3739773.1	Public School
Banning Home	205 E N St, Wilmington, CA	383216.8	3739560.8	Group Home
Banning Recreation Center Latchkey	1331 Eubank St, Wilmington, CA	383694.9	3739587.8	School Age Child Care Center
Broad venue Elementary	24815 Broad Ave, Wilmington, CA	383149.7	3740796.0	Public School
Federation/New Hope Head Start	1417 Sanford, Wilmington, CA	384167.4	3739891.0	Child Care Center
First Baptist Christian School	1360 Broad Ave, Wilmington, CA	383221.7	3739610.9	Private School
Fries Avenue Elementary	1301 Fries Ave, Wilmington, CA	382821.4	3739457.7	Public School
Garden of Wilmington Guest Home	1311 W Anaheim St, Wilmington, CA	384569.3	3738577.2	Adult Residential Facility
Harbor City Children's Foundation, Inc	24507 Marbella Ave, Carson, CA	382398.7	3741028.9	Group Home
Holy Family School	1122 East Robidoux St, Wilmington, CA	384315.4	3739370.3	Private School
Lincoln Home	517 E Lincoln St, Carson, CA	382825.1	3741532.0	Adult Residential Facility
Marbella Home	24633 Marbella Ave, Carson, CA	382395.3	3740900.7	Group Home
Memorial Hospital Of Gardena	1703 N Avalon Blvd, Wilmington, CA	382997.8	3740421.7	General Acute Care Hospital
Morning Star Guest Home	24436 Panama Ave, Carson, CA	382654.6	3741102.0	Residential Care for the Elderly
Neptune Home	24825 Neptune Ave, Carson, CA	382512.4	3743782.7	Group Home
Northeast Community Clinic Wilmington	714 N Avalon Blvd, Wilmington, CA	383139.7	3738341.4	Community Clinic
Phineas Banning Senior High	1527 Lakme Ave, Wilmington, CA	383270.3	3740037.9	Public School
Ravenna Home	24713 Ravenna Ave, Carson, CA	382544.1	3740834.8	Group Home
Seaview Community Clinic	1127 N Avalon Blvd, Wilmington, CA	383070.3	3739064.2	Community Clinic
Small World Learning Ctr No 2	1749 Avalon Blvd, Wilmington, CA	382991.5	3740539.5	Child Care Center
SVS Wilmington	235 L St, Wilmington, CA	383269.3	3739251.0	Adult Residential Facility
VOA/Cesar Chavez Head Start	1269 N Avalon St, Wilmington, CA	383053.4	3739383.2	Child Care Center
Volunteers of America Early Head Start Wilmington	445 N Avalon, Wilmington, CA	383132.5	3737907.3	Infant Center
Wilmington Christian School	24910 South Avalon Blvd, Wilmington, CA	383018.6	3740698.9	Private School
Wilmington Community Clinic	1009 N Avalon Blvd, Wilmington, CA	383083.8	3738815.0	Community Clinic
Wilmington Jaycee Foundation	1148 N Avalon Blvd, Wilmington, CA	383098.2	3739112.8	Adult Day Care
Wilmington Park Elementary	1140 Mahar Ave, Wilmington, CA	384617.2	3739123.5	Public School

Notes:
1. Locations of sensitive receptors were obtained from the following databases:
  a. California Department of Education, California School Directory (http://www.cde.ca.gov/re/sd/)
  b. The Automated Licensing Information and Report Tracking System(Hospitals and Licensed Care Facilities) (http://alirts.oshpd.ca.gov/AdvSearch.aspx)
  c. Yellow pages (http://yp.yahoo.com)
  d. Community Care Licensing Division, State of California (http://www.ccld.ca.gov/docs/ccld_search/ccld_search aspx)

Figure 2-1: General Facility Location
BNSF Wilmington Yard
Wilmington, California

0 0 5 1 2 3 4 Kilometers

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Figure 2-2: Land Use Within Twenty Kilometers of Facility
BNSF Wilmington Rail Yard
Wilmington, CA

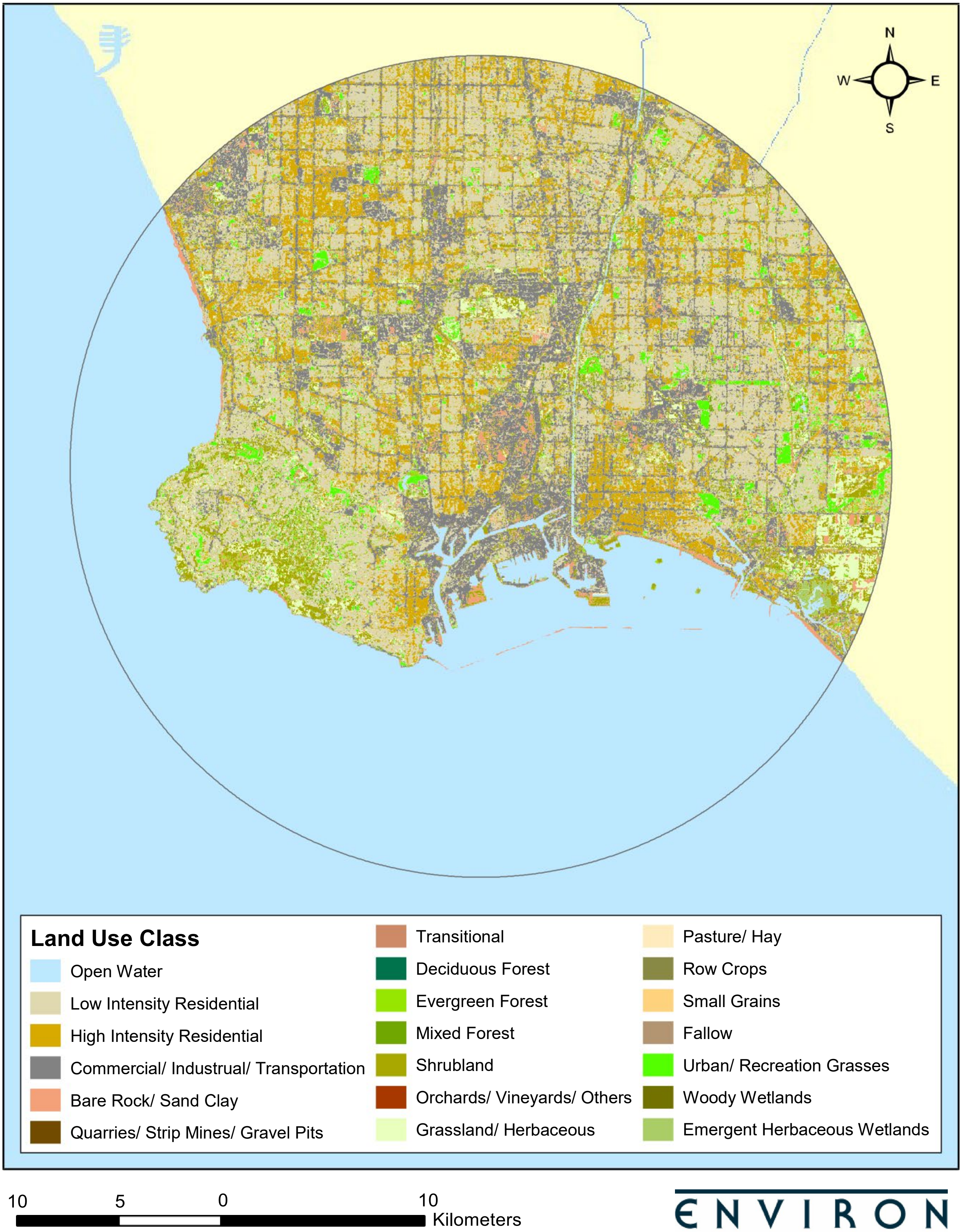

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Figure 2-3a: Stationary and Movement Locomotive Sources - Maintenance and Switching
BNSF Wilmington Yard
Wilmington, California

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Figure 2-3b: Stationary and Movement Locomotive Sources - Line Haul
BNSF Wilmington Yard
Wilmington, California

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Figure 2-4: Off-Road Equipment
BNSF Wilmington Yard
Wilmington, California

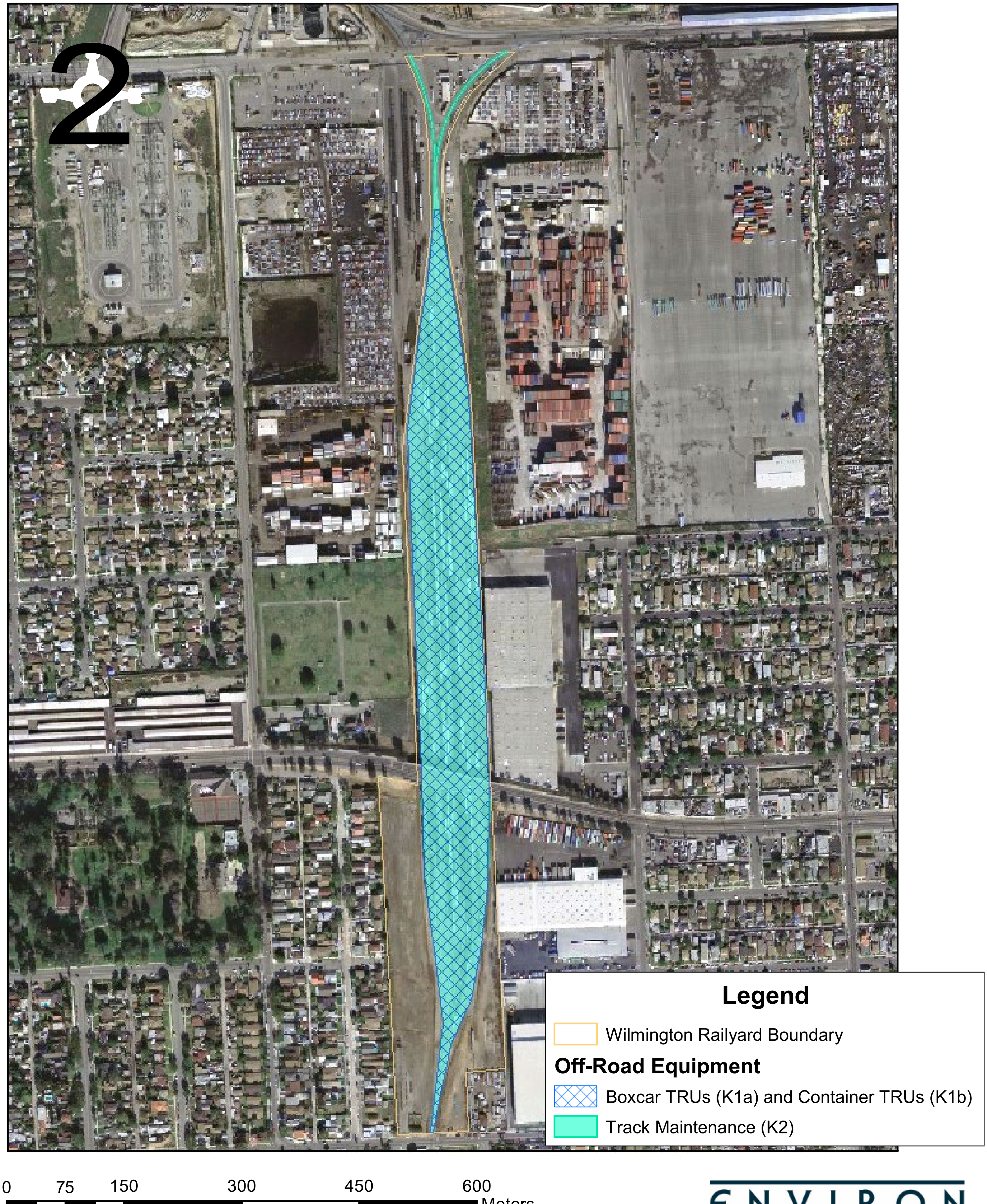

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Figure 2-5: Vehicle Travel Routes and Destinations
BNSF Wilmington Yard
Wilmington, California

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Figure 4-1a: Locations of Modeled Stationary Locomotive Sources - Maintenance and Switching
BNSF Wilmington Yard
Wilmington, California

Figure 4-1b: Locations of Modeled Stationary Locomotive Sources –Line Haul
BNSF Wilmington Yard
Wilmington, California

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Figure 4-2a: Locations of Modeled Movement Locomotive Sources –Switching BNSF Wilmington Yard Wilmington, California

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Figure 4-2b: Locations of Modeled Movement Locomotive Sources –Line Haul
BNSF Wilmington Yard
Wilmington, California

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Figure 4-3: Locations of Modeled Off-Road Equipment Sources
BNSF Wilmington Yard
Wilmington, California

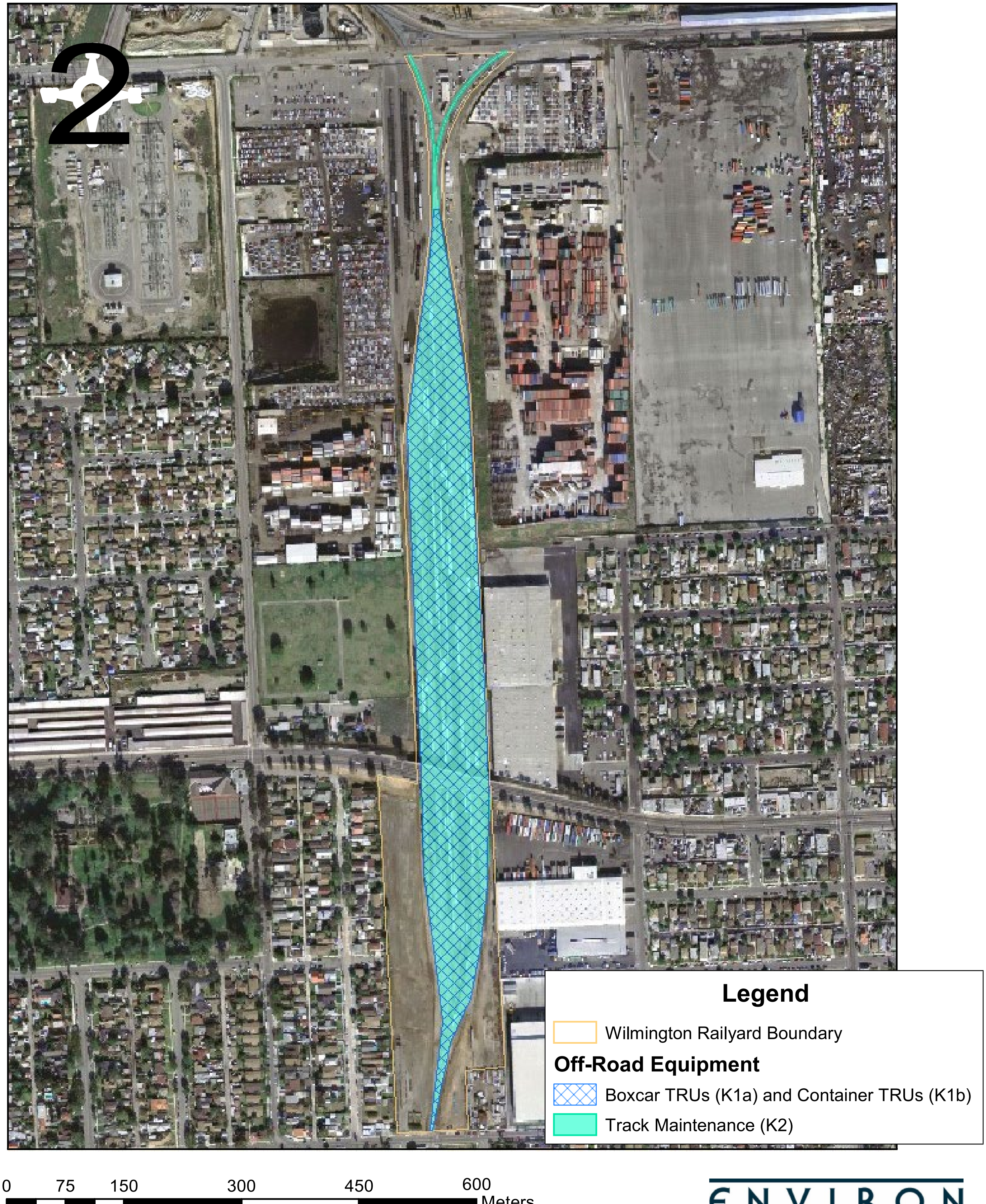

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Figure 4-4: Locations of Modeled On-Road Fleet Vehicle Sources
BNSF Wilmington Yard
Wilmington, California

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Figure 4-5
Selection of Sectors for Surface Parameter Analysis
BNSF Wilmington Yard
Wilmington, California

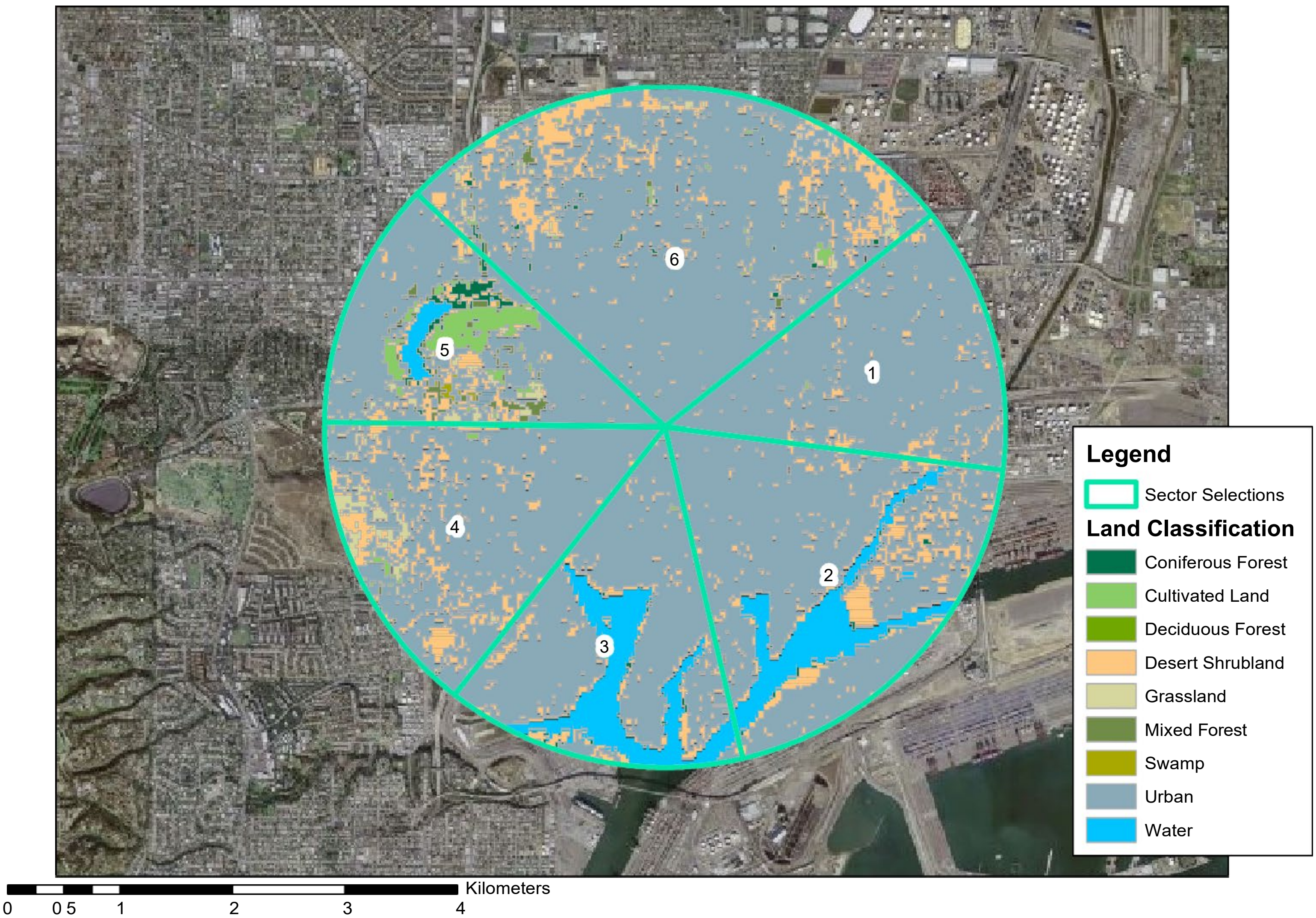

Figure 4-6: Location of Buildings and Structures at the Facility
BNSF Wilmington Yard
Wilmington, California

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Figure 4-7: Land Use Within Three Kilometers of Facility
BNSF Wilmington Yard
Wilmington, California

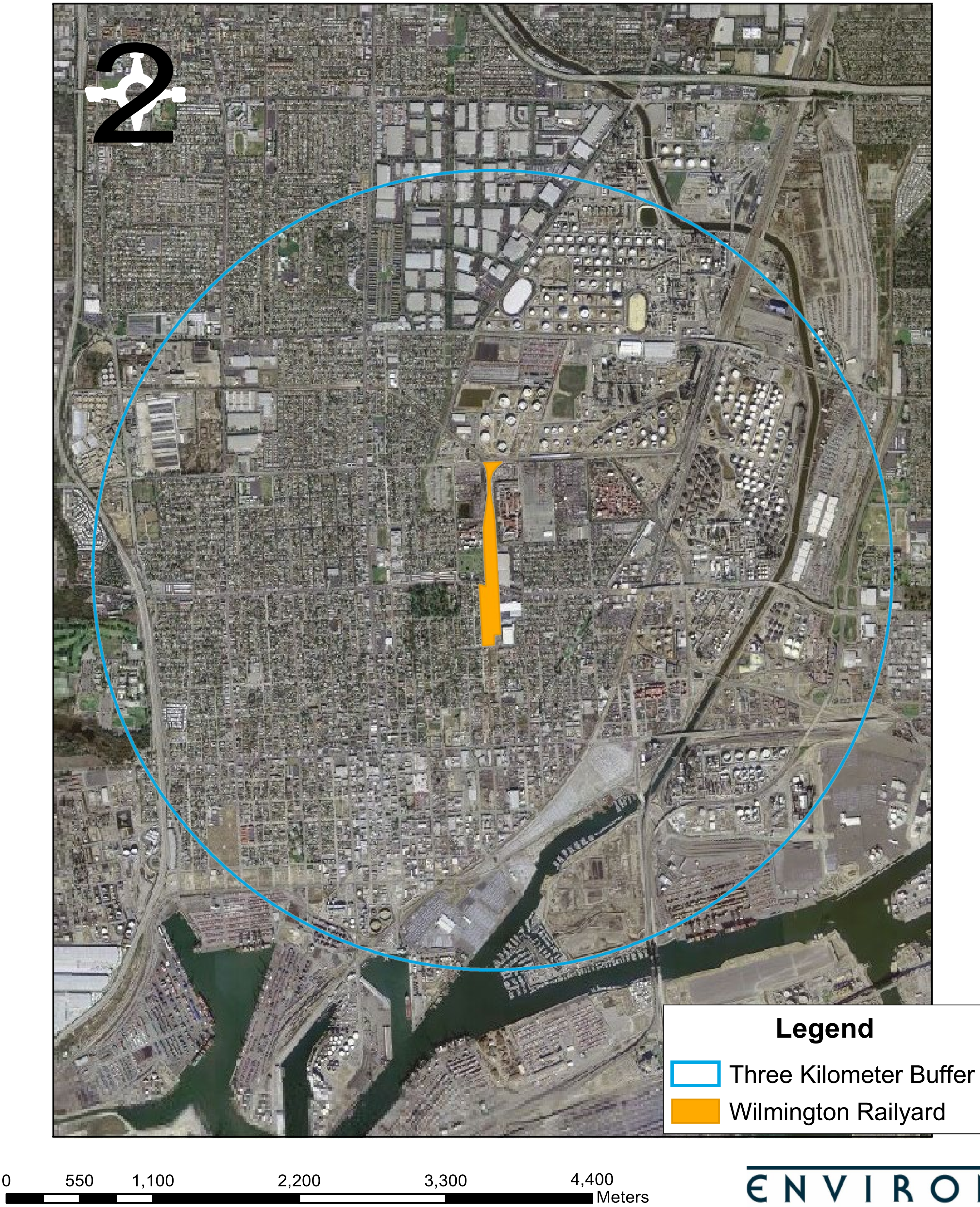

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Figure 4-8a: Locations of Discrete Receptors in Coarse Grid
BNSF Wilmington Yard
Wilmington, California

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Figure 4-8b: Locations of Discrete Receptors in Medium Grid
BNSF Wilmington Yard
Wilmington, California

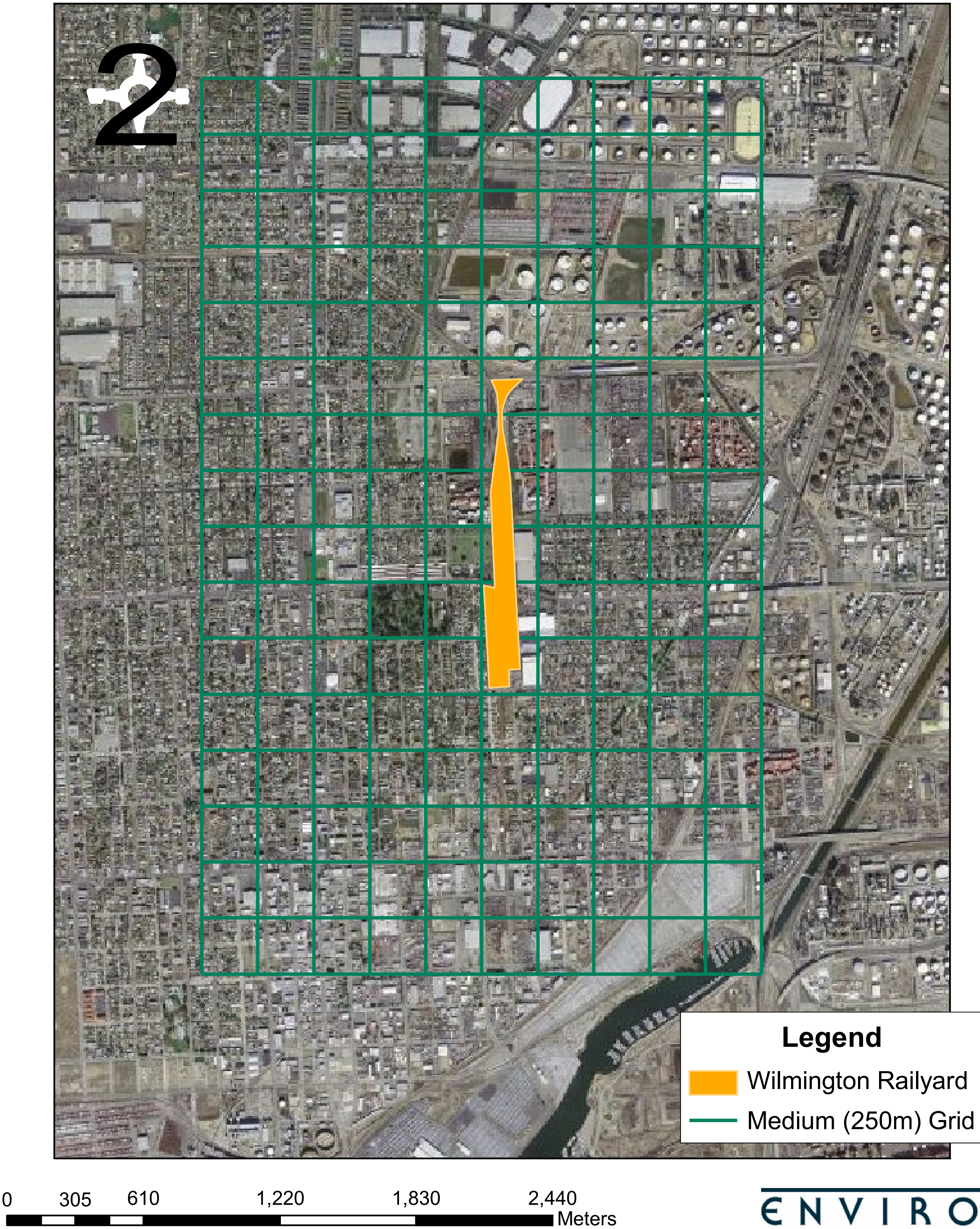

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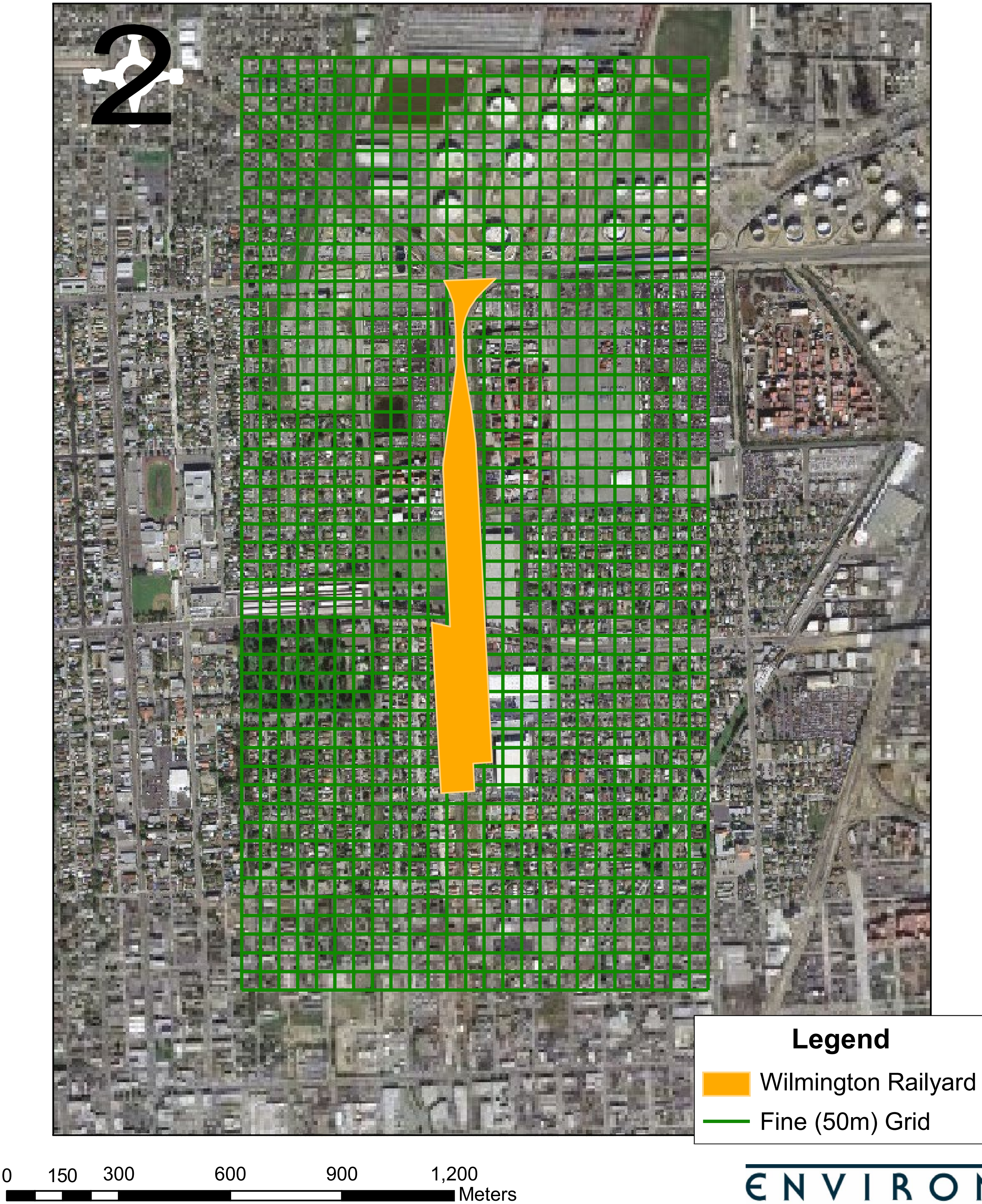
Figure 4-8c: Locations of Discrete Receptors in Fine Grid
BNSF Wilmington Yard
Wilmington, California



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