AIR DISPERSION MODELING ASSESSMENT OF AIR TOXIC EMISSIONS FROM BNSF BARSTOW RAIL YARD

Submitted to:
California Air Resources Board

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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
LMB	Locomotive Maintenance Building
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

UPRR	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 Yard.

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 were submitted in 2006: Commerce/Eastern Intermodal, Commerce/Mechanical, Los Angeles Intermodal (Hobart), Richmond, Stockton, and Watson/Wilmington (the "2006 BNSF Designated Rail Yards"). Emission inventories and air dispersion modeling results for the following BNSF Designated Rail Yards will be submitted in 2007: San Bernardino, Barstow, and San Diego (the "2007 BNSF Designated Rail Yards"). This report presents the methods and results of the air dispersion modeling analysis conducted to evaluate TAC emissions from operations at the Barstow Rail Yard located in Barstow, California ("Barstow").

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 Barstow 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 2007 BNSF Designated Rail Yards (ENVIRON 2007a). ARB approved these aspects of the air dispersion modeling analysis on August 31, 2007.[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).

ENVIRON used the latest American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD version 07026) to estimate airborne concentrations resulting from TAC emissions from the BNSF Barstow Yard. It should be noted that this version of AERMOD (i.e., version 07026) is an updated version to the version of the model used for the 2006 BNSF

[1] Personal communication, H. Holmes of ARB by e-mail to D. Daugherty of ENVIRON on August 31, 2007.

Designated Yards (i.e., version 04300). 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 occurred from November 9, 2005 to November 9, 2006. Following this transition period, all refined, near-field air dispersion modeling following EPA guidance is required to use AERMOD. 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 History: provides a brief description of the Barstow 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.

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 the tables of hourly, daily, and seasonal temporal information for source activities

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

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

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

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

Appendix F: provides the electronic shapefiles containing census data for the Barstow area

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

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

Appendix I: provides the air concentration results in a Microsoft Access database, the methodology for the calculation of air concentrations, and the electronic database files and queries used to perform the calculations

2.0 SITE HISTORY

The Barstow 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

The BNSF Barstow Rail Yard is located at 200 Avenue H in Barstow, California. As shown in Figure 2-1a, the BNSF Barstow Yard is located in a commercial and residential area on the northern edge of the City of Barstow. The Barstow Yard is situated in a valley that runs to the east and west, and mountains that rise several hundred meters are located within five kilometers to the north and south of the Yard, as shown in Figure 2-1b. The Barstow Yard is approximately five miles long and oriented in an east-west direction. The Yard is bordered by a rail "Y" near Highway 58 on the west, the City of Barstow, West Main Street/Historic Route 66 to the south side, Interstate 15 to the east, and the Mojave River and residential streets to the north and northeast, respectively. 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 Barstow, 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 can generally be divided into six operational areas, as shown in Figure 2-3: the locomotive maintenance area, arrival tracks, departure tracks, hump yard, classification yard, and adjacent main line. The locomotive maintenance area, located in the northwest portion of the yard, consists of the diesel, fueling, sanding, service (DSFS) area, diesel engine repair facility, rail car repair building, storage areas, equipment service areas, and an administration building. The locomotive arrival tracks, which receive all trains that enter the Barstow Yard, are located to the south of the locomotive maintenance area in the western portion of the Yard. The departure tracks, from which all outbound trains depart the Yard, are located in the north central part of the Yard. The hump yard and classification yard where locomotive switchers configure trains, are located east of the arrival tracks. The hump yard begins at the east end of the arrival tracks and parallels the departure tracks to approximately the central area of the departure tracks. The classification consists of a west yard and an east yard and extends from the east end of the hump yard to the east boundary of the Yard. The adjacent main line, which runs east-west along the northern boundary of the Yard is used for commuter rail (i.e., Amtrak) and freight services. ENVIRON included this segment of the adjacent main line in the air dispersion modeling analysis as per the draft Guidelines.

2.2 Facility Operations

Activities at the Barstow Yard include locomotive maintenance (e.g., sanding, refueling, and inspections), switching, line-haul, and passenger locomotives, material handling equipment, track maintenance equipment, on-road fleet vehicles, on-road refueling truck, transportation refrigeration units (TRUs), and permitted stationary source activities. The approximate locations of these activities at the Facility are shown in Figures 2-4 through 2-15.

The primary objectives of the Barstow Yard are to perform locomotive maintenance services and to reconfigure or assemble trains. As shown in Figure 2-3, the Barstow Yard consists of a maintenance area, arrival/departure tracks, hump yard, east/west classification yards, and the adjacent main line. Trains arriving from the west enter the Yard directly onto the arrival tracks at the west end of the Yard, while trains arriving from the east follow a specific set of tracks west through the Yard to the arrival tracks. Locomotive engines enter the maintenance areas from the west portion of the arrival tracks at the west end of the Yard where a variety of maintenance activities may be performed (e.g., sanding and refueling, engine inspections, and engine load and opacity testing). After receiving service in the maintenance area the locomotives proceed east to the departure tracks located in the north central portion of the facility. Once the locomotives are detached from the arriving trains, switcher locomotives push individual rail cars or sets of rail cars from the trains to the top of the hump in the hump yard. New trains are configured by rolling the rail cars eastward down the hump and switching them onto specific tracks in the western classification yard. Once the new trains have been created in the western part of the classification yard, switcher engines pull the newly configured trains into the eastern classification yard and then push the trains back onto the departure tracks. The locomotive consists are added to the trains and the trains then depart either to the east or west by moving onto the adjacent main line which runs along the northern boundary of the Yard.

A number of activities occur at the Barstow Yard in support of or as a result of the primary yard activities (i.e., locomotive maintenance and train reconfiguration operations). These include material handling equipment operations near the arrival tracks, track maintenance equipment operations to repair and maintain tracks throughout the Yard, on-road fleet vehicle travel into, out of, and within the Yard, TRUs on trains, and permitted stationary source activities such as emergency generators and gasoline dispensing equipment operations.

The emission activities, described in further detail in ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c), occurring in these operational areas are outlined below:

Facility Operational Areas and Activities

Locomotive Maintenance Area

A. Basic Locomotive Services
B. Engine Test Inspection
C. Full Service Inspection
I. Refueling Truck
J. On-Road Fleet
L. Permitted Stationary Sources

Arrival Tracks

E. Arriving Line-Haul
H. Material Handling Equipment
K1a. Boxcar/Freight and Container TRUs
K2. Track Maintenance

Departure Tracks

E. Departing Line-Haul
I. Refueling Truck
K1a. Boxcar/Freight and Container TRUs
K2. Track Maintenance

Hump Yard

D. Switching
E. Arriving Line-Haul
J. On-Road Fleet
K1a. Boxcar/Freight and Container TRUs
K2. Track Maintenance
L. Permitted Stationary Sources

Classification Yard

D. Switching
E. Arriving Line-Haul
J. On-Road Fleet

K1a. Boxcar/Freight and Container TRUs
K2. Track Maintenance

Adjacent Main Line

A2b. DTL Refueling
F. Passing Line-Haul
G. Passenger Locomotives
K1a. Boxcar/Freight and Container TRUs
K2. Track Maintenance

2.2.1 Locomotive Maintenance Area Activities

As discussed above and indicated in Figure 2-3, the locomotive maintenance area is situated in the northwest portion of the Yard and consists of buildings and facilities that support locomotive maintenance operations, as well as the administration buildings and diesel fuel storage tanks. The locomotive maintenance area includes basic locomotive services, locomotive engine test services, full locomotive service inspections, refueling truck, on-road fleet, and permitted stationary source activities. Locomotives enter the maintenance area from the arrival tracks at the west end of the maintenance area and are washed at the locomotive wash area. All locomotives then proceed to the DSFS area for sanding and refueling. After leaving the DSFS area, locomotives may take a number of different paths within the maintenance area to reach the various service locations (e.g., inspection areas, engine test areas), depending on the level of service required, the order of the maintenance activities, and the locations of other locomotives already in the maintenance area. In order to reduce model complexity and based on discussions with BNSF personnel, ENVIRON assumed a general set of travel paths for each type of locomotive maintenance service (i.e., basic locomotive services, engine test, and full service inspection).

After refueling and sanding at the DSFS, locomotives that receive only basic services then proceed to the in-consist area and then east out of the maintenance area to the departure tracks. Figure 2-4 shows the service areas within the maintenance area and general travel paths for trains receiving basic service only. Locomotives that receive basic services and an engine test follow the same path to the DSFS area, and then move within the maintenance area to the engine test and in-consist areas and then east out of the maintenance area to the departure tracks, as indicated by the general travel paths in Figure 2-5. Locomotives that receive basic services and full service inspection follow the same path to the DSFS area, and then move within the maintenance area to the engine test, load test, opacity test, and final load test areas. After the full service test is complete, these locomotives travel to the in-consist area and then east out of the maintenance area to the departure tracks. The general travel paths for locomotives that receive basic services and a full service inspection are indicated in Figure 2-6.

A single on-site refueling truck delivers fuel from the diesel storage tanks located north of the DSFS area to the two DTL areas along the adjacent main line near the east and west ends of the departure tracks. In addition, a very small number of DTL fueling events occur at three locations near the arrival and departure tracks. The truck is staged in the parking lot west of the waste-water treatment plant in the locomotive maintenance area and travels along a defined path through the locomotive maintenance area and departure tracks area to the diesel storage tanks and DTL areas. The on-site refueling truck travel path and the locations of truck idling activities are shown in Figure 2-7. BNSF on-road fleet vehicles operate between the Yard entrance and exits in the northwest part of the Yard (i.e., near the Administration Building) and the south central portion of the Yard (i.e., south of the top of the hump in the hump yard) and Administration Building, Locomotive Maintenance Building (LMB), Car Department Administration Office, Fabrication Shed, Facility Air Compressors, and Bowl Tower. The locations of the BNSF on-road fleet travel paths in the locomotive maintenance area are shown in Figure 2-8. Three permitted stationary sources are located in the maintenance area, including a gasoline dispensing and storage facility, an emergency generator, and an internal combustion engine powering a fire suppression system. The gasoline dispensing and storage facility is located near the southwest corner of the LMB, the emergency generator is located on the south side of the LMB, and the internal combustion engine for the fire suppression system is located near the diesel fuel storage tanks, as shown in Figure 2-9.

2.2.2 Arrival Tracks Activities

The area designated as the arrival tracks is located to the south of the locomotive maintenance area in the southwest portion of the Yard, as indicated in Figure 2-3. The arrival tracks area consists of approximately ten rail lines that run in parallel for approximately two kilometers and converge at the east and west ends. The arrival tracks area includes arriving line-haul, material handling equipment, boxcar/freight and container TRUs, and track maintenance equipment activities. Arriving line-haul locomotives, boxcar/freight and container TRUs, and track maintenance equipment activities may occur anywhere along rail lines in the arrival tracks area. The locations of arriving line-haul locomotive activities in the arrival tracks area are shown in Figure 2-10, and the locations of boxcar/freight and container TRUs and track maintenance equipment activities in the arrival tracks area are shown in Figure 2-11. Material handling equipment operations occur south of the rail lines in the arrival tracks area between the arrival tracks and the southern boundary of the Yard, as indicated in Figure 2-12.

2.2.3 Departure Tracks Activities

The area designated as the departure tracks is located to the east of the locomotive maintenance area in the north-central portion of the Yard, as indicated in Figure 2-3. The departure tracks area consists of approximately fifteen rail lines that run in parallel for approximately two kilometers and converge at the east and west ends. The departure tracks area includes departing line-haul, boxcar/freight TRUs, refueling truck, and track maintenance equipment activities. As discussed in Section 2.2.2, a single on-site refueling truck delivers fuel from the diesel storage tanks located north of the DSFS area to the two DTL areas along the adjacent main line near the east and west ends of the departure tracks. The truck is staged in the parking lot west of the waste-water treatment plant in the locomotive maintenance area and travels along a defined path through the locomotive maintenance area and departure tracks area to the diesel storage tanks and DTL areas. The on-site refueling truck travel path and the locations of truck idling activities are shown in Figure 2-7. Departing line-haul locomotives, boxcar/freight and container TRUs, and track maintenance equipment activities may occur anywhere along rail lines in the departure tracks area. The locations of departing line-haul locomotive activities in the departure tracks area are shown in Figure 2-10, and the locations of boxcar/freight and container TRUs and track maintenance equipment activities in the departure tracks area are shown in Figure 2-11.

2.2.4 Hump Yard Activities

The hump yard is located in the south central portion of the Yard to the east of the arrival tracks, as indicated in Figure 2-3. At its widest point at the east end, the hump yard consists of approximately 45 rail lines that converge into one line that spans to the east end of the arrival tracks. The hump yard includes on-road fleet vehicle, permitted stationary sources, arriving line-haul, boxcar/freight and container TRUs, track maintenance equipment, and locomotive switching activities. As discussed in Section 2.2.1, BNSF on-road fleet vehicles operate between the Yard entrance and exits in the northwest part of the Yard (i.e., near the Administration Building) and the south central portion of the Yard (i.e., south of the top of the hump in the hump yard) and Administration Building, Locomotive Maintenance Building (LMB), Car Department Administration Office, Fabrication Shed, Facility Air Compressors, and Bowl Tower. The locations of the BNSF on-road fleet travel paths in the hump yard are shown in Figure 2-8. Three permitted stationary sources are located in the hump yard, including a gasoline dispensing and storage facility and two emergency generators. The gasoline dispensing and storage facility is located near the east side of the Fabrication Shed, and the emergency generators are located in the southeast part of the hump yard, as shown in Figure 2-9. Trains entering the Barstow Yard from the east follow a specific rail line west through the facility to the arrival tracks, following the southern edge of the hump yard. The locations of arriving line-haul locomotive activities along this rail line through the hump yard are shown in Figure 2-10. Boxcar/freight and container TRUs and track maintenance equipment activities may occur anywhere along rail lines in the hump yard, as shown in Figure 2-11. Locomotive switching activities in the hump yard occur only along the rail lines leading from the east end of the arrival tracks to the top of the hump, as shown in Figure 2-13.

2.2.5 Classification Yard Activities

The classification yard is located to the south of the departure tracks and adjacent main line and extends from the east edge of the hump yard to the east boundary of the Barstow Yard and consists of an east and west yard, as shown in Figure 2-3. At its widest point at the west end, the classification yard consists of approximately 45 rail lines that run in parallel for approximately one kilometer before they converge at the east end of the west classification yard. The east classification yard consists of approximately 10 rail lines that run in parallel and converge at both the east and west end. The classification yard includes on-road fleet vehicle, arriving line-haul, boxcar/freight and container TRUs, track maintenance equipment, and locomotive switching activities. As discussed in Section 2.2.1, BNSF on-road fleet vehicles operate between the Yard entrance and exits in the northwest part of the Yard (i.e., near the Administration Building) and the south central portion of the Yard (i.e., south of the top of the hump in the hump yard) and Administration Building, Locomotive Maintenance Building (LMB), Car Department Administration Office, Fabrication Shed, Facility Air Compressors, and Bowl Tower. The locations of the BNSF on-road fleet travel paths in the classification yard are shown in Figure 2-8. Trains arriving into Barstow from the east end of the Yard follow a specific rail line through the east and west classification yard as indicated in Figure 2-9. Boxcar/freight and container TRU, track maintenance equipment, and locomotive switching activities may occur anywhere in the classification yard. The locations of boxcar/freight and container TRUs and track maintenance equipment activities are indicated in Figure 2-11. The locations of locomotive switching activities are shown in Figure 2-13.

2.2.6 Adjacent Main Line Activities

The adjacent main line consists of two parallel rail lines and runs immediately north of the northern boundary of the Facility, as shown in Figure 2-3. The adjacent main line considered for this project is approximately 7.4 kilometers in length and runs east-west along the Facility boundary. Its activity may or may not be considered part of the Facility. The adjacent main line includes locomotive DTL refueling, boxcar/freight and container TRUs, track maintenance equipment, passing line-haul, and passenger locomotive activities. Locomotive idling during DTL refueling occurs at two locations on the adjacent main line at the east and west ends of the departure tracks, as shown in Figure 2-7. Boxcar/freight and container TRUs, track maintenance equipment, passing line-haul, and passenger locomotive activities can occur anywhere along the adjacent main line. The locations of boxcar/freight and container TRUs, track maintenance equipment activities are shown in Figure 2-11. The locations of passing line-haul and passenger locomotive activities occurring on the adjacent main line are shown in Figures 2-14 and 2-15, respectively.

3.0 EMISSION INVENTORY SUMMARY

ENVIRON estimated emissions for BNSF Barstow Yard activities and provided this to ARB previously (ENVIRON 2007a). 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 also included. The remainder of this section provides a brief summary of the Barstow activities for which TAC emissions were estimated.

3.1 Locomotive DPM Emissions

ENVIRON described Barstow locomotive operations by dividing the emissions activities into seven emissions categories:

A. Basic Locomotive Services
B. Basic Locomotive Services plus Engine Test
C. Basic Locomotive Services plus Full Inspection
D. Switching
E. Arriving and Departing Trains
F. Adjacent Freight Movements
G. Passenger Rail Operations

Category designations (i.e., A, B, C, D, E, F, and G) for each locomotive activity were assigned in ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c).

From data provided by BNSF and through discussions with BNSF operations staff, ENVIRON determined the overall activity of locomotive operations. The locomotive operations data included the number of engines and the typical time in notch setting for those engines active at the facility. ENVIRON inferred locomotive movements and time in engine notch settings based on information provided by BNSF. ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c) provides a detailed description of the information and estimates used to define operations and resulting emissions within activity categories A through G. Temporal emission profiles were developed for locomotive activities based on operating schedules provided by BNSF. Variable hourly 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 A.

The passenger locomotive activities (i.e., Amtrak activities, designated as activity category G) on the adjacent main line could be considered as separate sources from the Facility operational areas as these activities operate by and large independent of the Facility. ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c) contains the details of the methods used to estimate emissions from this activity category. Temporal emission profiles were developed for passenger rail activities based on hourly schedule information for Amtrak activities. Variable hourly, daily, and seasonal emission factors were applied in the air dispersion modeling, as discussed in Section 4.3, to approximate the temporal variations in emissions for passenger locomotive activities. These temporal emission factors are presented in electronic tables in Appendix A.

3.2 DPM Emissions from Material Handling Equipment

Material handling equipment (designated as activity category H) consisted of a single side pick that was used to handle intermodal freight at the Barstow Yard. DPM emissions due to material handling equipment activities were estimated using the emission factor determined using the equipment population list and default activity data from the draft EMFAC2005 model provided by ARB (2006c). Additional details regarding the emission calculation methodology are discussed in ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c).

3.3 DPM Emissions from On-Site Refueling Truck

The on-site refueling trucks category (designated as activity category I) included a single refueling truck that was staged to the west of the waste-water treatment plant and delivered fuel from the diesel fuel storage tanks in the locomotive maintenance area to locomotives at the two DTL fueling sites near the adjacent main line. In addition, a very small number of DTL fueling events occur at three locations near the arrival and departure tracks shown in Figure 2-7. However, because the refueling events at the three locations near the arrival and departure tracks occur infrequently and are not scheduled or predictable, the DPM emissions due to truck travel and idling associated with these DTL locations were assumed to be negligible. DPM emissions due to on-road refueling truck travel at Barstow were estimated using emission factors from the draft EMFAC2005 model provided by ARB (2006c) and an average on-site travel distance. On-site refueling truck trip counts and idling times the diesel fuel storage tanks and DTL sites were estimated by Facility personnel. Average travel speed on site was determined from a sample chase truck study at the Barstow Yard. Additional details regarding the emission calculation methodologies are discussed in ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c).

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

On-road fleet vehicles (designated as activity category J) included BNSF-owned employee vehicles and road-legal vehicles (i.e., passenger vehicles and small trucks) used for both on-site and off-site travel. DPM and gasoline TAC emissions due to 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. ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c) presents additional details regarding the methods used to estimate emissions from these vehicle activities.

3.5 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). TRUs are used to regulate temperatures during the transport of products with temperature requirements. For BNSF operations at Barstow, temperatures are regulated by TRUs in boxcars and freight cars 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 (i.e., railcar/freight car) 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. An additional factor of 0.6 was used to account for the only temporary use of TRU units. All TRUs are assumed to use diesel fuel. Additional details regarding the emission calculation methodologies are discussed in ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c).

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 ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c).

3.6 DPM and Gasoline TAC Emissions from Permitted Stationary Sources

Permitted stationary sources at the Facility included two gasoline dispensing and storage facilities, three emergency generators, and one emergency internal combustion engine (designated as activity category L).

TAC emissions from the two gasoline dispensing and storage facilities were estimated based upon the emissions methodology in the Mojave Desert Air Quality Management District (MDAQMD) permit applications (Permit # N002733 and Permit # N002734) for these emissions sources. The MDAQMD methodology contained emission factors and followed guidance from the Gasoline Service Station Industry-Wide Risk Assessment Guidelines (CAPCOA 1997) prepared by the Toxics Committee of the California Air Pollution Control Officers Association (CAPCOA). This methodology accounted for TAC emissions from filling/working, dispensing, spillage, and breathing. Additional details regarding the emission calculation methodologies are discussed in ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c).

DPM emissions from the three emergency generators and the internal combustion engine were estimated based on maximum permitted operating hours of 1 hour per week (Permits # E004379, # E007694, #E007922, and #E007923), maximum state- or district-permitted PM certification levels, and engine horsepower. As the actual hours of operation and engine PM certification levels were not available from BNSF personnel, Facility records, engine manufacturer information, or district permits or permit applications, ENVIRON's emissions calculations resulted in conservative estimates (i.e., over-predictions) of emissions for the emergency generators and internal combustion engine. In addition, source parameter information was not available for the emergency generators and internal combustion engine from BNSF personnel, Facility records, the engine manufacturers, or district permit applications and permits. Based on the conservative emission estimates, the emergency generators and internal combustion engine accounted for less than 0.4% of the total DPM emissions from the Facility. Due to the lack of source parameter information and the relatively low levels of emissions from this source, the emergency generators and emergency internal combustion engine were not included in the air dispersion modeling.

3.7 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. ENVIRON performed air dispersion modeling to estimate hourly maximum gasoline concentrations using maximum hourly TOG emission rates. 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 the Barstow Yard. 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 ENVIRON used in the air dispersion modeling for Barstow 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 07026) to estimate airborne concentrations resulting from DPM and TAC emissions from the BNSF Barstow 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). Starting in November 2006, ISC was no longer 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 period-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 ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c). 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 ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c), 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 the Barstow Yard, as described above. In general, ENVIRON 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 off-road equipment). 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 locomotive refueling, locomotive engine testing (i.e., load and opacity testing), in-consist, switching, arriving-departing line-haul, passing line-haul, and passenger locomotive 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 Barstow in areas where stationary idling activities occur, staggering point sources on parallel railway lines. Point sources were placed in areas of parallel railway lines such that spacing between points was approximately equal both vertically and horizontally along the rail lines. The locations of point sources representing stationary locomotive activities are shown in Figures 4-1a through 4-1e. ENVIRON distributed emissions uniformly among the point sources comprising each stationary idling activity. Based on information from BNSF personnel, ENVIRON assumed that emissions from stationary locomotive refueling, engine testing (i.e., load and opacity testing), in-consist, switching, arriving-departing line-haul and passing line-haul activities occur 24 hours per day, seven days per week. Stationary locomotive switching activities occur in two areas of the yard 24 hours a day, seven days per week with activity levels varying over three shifts per day. Stationary passenger locomotive activities (i.e., Amtrak) generally occur less than 24 hours per day and seven days per week. Detailed temporal profiles for switching and passenger locomotive activities are presented in Appendix A. 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 A.

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 8515 to 1886) related to the stationary locomotive activities at Barstow. 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 Barstow.

4.3.1.2 Locomotive Movement

ENVIRON represented DPM emissions from locomotive movement activities, including maintenance (i.e., movement into, within, and out of the maintenance area), switching, arriving-departing line-haul, passing line-haul, and passenger locomotives, by individual volume sources spaced approximately every 50 to 150 meters similar to ARB's Roseville Study (ARB 2004). Figures 4-2a through 4-2g show the locations of modeled volume (movement) sources at the Facility. 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. 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 A.

Locomotive movement activities for each of the three maintenance activities (basic services, engine test, and full service inspection) include movement into the maintenance yard, movement within the maintenance yard, and movement out of the maintenance yard, as shown in Figures 4-2a, 4-2b and 4-2c, respectively. Volumes sources for movement into the maintenance area and movement out of the maintenance area have the same locations for basic services, engine test, and full service inspection as the travel paths for these activities cover the same rail lines. However, because the travel paths for locomotive movement within the maintenance area are different for different levels of service (i.e., basic inspection, engine test, or full service inspection), volume sources for movement within the maintenance area are specific to each source group. As discussed in Section 2.2.1, after leaving the DSFS area, locomotives may take a number of different paths within the maintenance area to reach the various service locations (e.g., inspection areas, engine test areas), depending on the level of service required, the order of the maintenance activities, and the locations of other locomotives already in the maintenance area. In order to reduce model complexity, and based on discussions with BNSF personnel ENVIRON assumed a general set of travel paths for each type of locomotive maintenance service (i.e., basic locomotive services, engine test, and full service inspection). Based on information from BNSF personnel and using these general sets of travel paths, ENVIRON apportioned emissions for movement within the maintenance area based on the amount of locomotive traffic through each specific service area.

Locomotive movement switching activities occur in two distinct areas of the Yard, the hump yard in the east and the classification yard in the west, as shown in Figure 4-2d. Emissions were calculated separately for each yard. Based on information from BNSF personnel, ENVIRON apportioned the total locomotive movement switching emissions within the classification yard evenly across the volume sources within the classification yard. Similarly, ENVIRON apportioned the total locomotive movement switching emissions within the hump yard evenly across the volume sources within the hump yard. Switching activities in the hump yard occur between 8 a.m. and 12 a.m. (midnight). Switching activities in the classification yard occur 24 hours per day, seven days per week, but the emissions vary throughout the day. Temporal profiles for all locomotive movement activities are summarized in Appendix A.

Figure 4-2e shows the modeled movement locomotive sources for arriving-departing line-haul. Emissions for arriving and departing line-haul movement activities were apportioned based on the distances traveled by the fraction of locomotive in each area. Based on information from BNSF personnel, ENVIRON assumed that the number of locomotives arriving at the Yard was approximately equal to the number of locomotives departing from the Yard. According to BNSF personnel, 50% of all locomotives arrive from the east, travel across the yard to the arrival tracks area, and pull through to the west end of the arrival tracks. In addition, 50% of locomotives arrive from the west and pull halfway through the arrival tracks area. Based on information from BNSF personnel, ENVIRON also assumed that all (i.e., 100% of) locomotives travel within the departure tracks, with 50% departing to the east and 50% departing to the west, traveling half of the total distance of the departure tracks. Based on these data and assumptions, locomotive movement emissions for arriving and departing line haul were apportioned among the arrival tracks from the east (i.e., source group E1V), the arrival tracks area (i.e., source group E2V), and the departure tracks (i.e., source group EV3).

Figures 4-2f and 4-2g show the modeled volume sources representing locomotive movement emissions for passing line-haul and passenger rail emissions, respectively, along the adjacent main line. Passing line-haul emissions are apportioned evenly across all volume sources and emissions occur 24 hours per day, seven days per week. Passenger rail emissions are also apportioned evenly across all volume sources, but emissions occur less than 24 hours per day, seven days per week. Detailed temporal profiles for passing line-haul and passenger locomotive activities are presented in Appendix A.

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 Barstow. Electronic SCREEN3 input and output files used to determine plume rise adjustments are attached in Appendix B.

4.3.2 Material Handling Equipment

The BNSF Barstow Yard material handling operations are limited to emergency operations carried out by a side pick. Because operations do not occur on a specific path within the Facility, ENVIRON conservatively represented DPM emissions from the side pick as an area source, as shown in Figure 4-3. ENVIRON placed an area source over the area where side pick activities occur. According to BNSF facility personnel, all material handling equipment activity occurs south of the arrival tracks, between the arrival tracks and southern boundary of the Yard. The location of the area source representing material handling equipment is shown in Figure 4-3.

Emissions within this operating area were distributed evenly based on information from BNSF personnel. ENVIRON assumed that emissions from side pick activities can occur 24 hours per day, seven days per week based on information from BNSF personnel, with average operations occurring 20 hours per month throughout the year. Table 3-1a summarizes the DPM emissions and operating hours for material handling equipment at the Barstow Yard.

Model-specific source parameter information (i.e., release height) was not available for material handling equipment at the Barstow Yard. In addition, source parameter information for cargo handling equipment at other BNSF Yards (e.g., the BNSF Hobart Yard) obtained from BNSF personnel varied considerably. Therefore, ENVIRON assumed a release height of 10 ft (3.05 m), based on the height of a side-pick operating at the Port of Los Angeles (Starcrest 2007), for use in the air dispersion modeling. ENVIRON calculated the corresponding initial vertical dimension of the area source from USEPA (USEPA 2004b) guidance. Table 4-3 summarizes the modeling source parameters for material handling equipment activities at Barstow.

4.3.3 On-Site Refueling Truck

As described in Section 3.3, on-site refueling truck activity at Barstow is limited to one refueling truck that delivers fuel daily to the two DTL refueling sites on the adjacent main line. In addition, a very small number of DTL fueling events occur at three locations near the arrival and departure tracks, as shown in Figure 2-7. However, because the refueling events at the three locations near the arrival and departure tracks occur infrequently and are not scheduled or predictable, the DPM emissions due to truck travel and idling associated with these DTL locations were assumed to be negligible and truck travel to and idling at these locations were not modeled. ENVIRON represented DPM emissions from the on-site refueling truck by a combination of volume and area sources as recommended by the draft Guidelines (ARB 2006a) and in discussions with ARB staff. ENVIRON used volume sources to represent refueling truck travel along specific pathways within the Yard. ENVIRON used area sources to represent on-site refueling truck idling at the two DTL refueling areas on-site. The use of area sources to represent on-site refueling truck idling emissions at the Facility is similar to methodology used for on-site refueling truck idling emissions at the BNSF San Bernardino Yard

(ENVIRON 2007b). Because unit emission rates were used in the modeling analysis and all idling emissions from on-site refueling at the Facility were grouped into a single source group, the consistent use of either volume or area sources was required for all operational areas. Because idling emissions in the refueling areas occurred over large areas without well-defined travel paths, area sources were selected for all refueling truck idling. The use of area sources instead of volume sources results in conservative (i.e., higher) predicted concentrations. The locations of volume and area sources representing the on-site refueling truck travel path and idling areas are shown in Figure 4-4.

ENVIRON allocated DPM emissions between the two idling areas based on truck idling times at each DTL refueling. BNSF facility personnel estimated 60 minutes of idling at each of the two DTL refueling areas on the adjacent main line and one truck trip per day along the designated travel path. ENVIRON assumed that emissions were distributed uniformly along the travel path and within each idling area. ENVIRON also assumed that emissions from the on-site refueling truck occur 24 hours a day, seven days per week based on information from BNSF personnel. Table 3-1a summarizes the DPM emissions and operating hours for the on-site refueling truck.

Model-specific source parameter information (i.e., release height, velocity, temperature, and diameter) for the on-site refueling truck was not available from BNSF personnel. Based on information from a previous ARB study (ARB 2000) and recommendations by ARB staff in 2006, ENVIRON used a release height of 4.0 meters for on-site refueling truck idling and travel during the daytime (i.e., 6 a.m. to 6 p.m.) and a release height of 6.0 meters for nighttime (i.e., 6 p.m. to 6 a.m.) to account for plume rise. ENVIRON calculated the corresponding initial vertical dimension of each volume and area source from USEPA (USEPA 2004b) guidance. Table 4-3 summarizes the modeling source parameters for on-site refueling truck activities at Barstow.

4.3.4 On-Road Fleet Vehicles

ENVIRON represented DPM and gasoline TAC emissions from BNSF on-road fleet vehicles by a combination of volume and area sources as recommended by the draft Guidelines (ARB 2006a) and in discussions with ARB staff. ENVIRON used volume sources to represent on-road vehicle travel along specific pathways within the Facility. ENVIRON used area sources to represent on-road fleet vehicle travel in areas of the Facility where the travel path(s) and areas were not well-defined (e.g., parking lots at building destinations). The locations of volume and area sources representing on-road fleet vehicle travel pathways and areas are shown in Figure 4-5.

According to BNSF personnel, on-road fleet vehicles travel to five destinations on-site. These destinations and the percentage of vehicle trips associated with each destination were provided by BNSF personnel as follows: BNSF Administration Building (i.e., Building 7, 40% of vehicle trips), Locomotive Maintenance Building (i.e., Building 10, 10% of vehicle trips), Car Department Administration Office (Buildings 15/16, 20% of vehicles trips), Facility Air Compressors (i.e., Building 20, 20% of vehicle trips), and Bowl Tower (Building 22, 10% of vehicle trips). ENVIRON used the percentage of vehicles trips associated with each travel destinations provided by BNSF personnel, as well as the distances of the travel paths, to apportion emissions among the vehicle travel paths.

BNSF personnel did not have information indicating the percentage of emissions associated with specific travel paths versus travel areas for on-road fleet vehicles. In order to apportion emissions between travel paths and travel areas for each destination, ENVIRON estimated an average travel path length within each travel area (i.e., travel area at each destination) and assumed that total travel emissions were spread uniformly over the travel path and travel area for a given destination based on the travel path length. Movement emissions along a given travel path or within a given travel area were also distributed uniformly. ENVIRON assumed that emissions from all on-road vehicles occur weekdays (i.e., Monday through Friday) from 7 a.m. to 7 p.m. based on information from BNSF personnel, except for at the Bowl Tower (i.e. Building 22), where operations occur 24 hours per day, seven days a week. Tables 3-1a and 3-1b summarize the DPM and gasoline emissions, respectively, and operating hours for BNSF on-road fleet vehicles.

Model-specific source parameter information (i.e., release height, velocity, temperature, and diameter) for 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, ENVIRON used a release height of 0.6 meters for all 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 the Barstow Yard.

4.3.5 Off-Road Equipment

4.3.5.1 Track Maintenance Equipment

According to BNSF personnel, track maintenance equipment operations typically occur over the majority of rail lines at the facility (i.e., on rail lines in the classification yard, hump yard, arrival tracks, and departure tracks). Because track maintenance operations occur over such large areas, 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 over these areas by area sources as recommended by the draft Guidelines (ARB 2006a). ENVIRON placed area sources over rail lines where track maintenance activities occur. The locations of area sources representing track maintenance equipment are shown in Figure 4-6a. ENVIRON assumed that total track maintenance equipment emissions were spread uniformly over the rail lines where track maintenance operations typically occur. ENVIRON assumed that emissions from track maintenance activities occur seven days a week 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) 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 Barstow.

4.3.5.2 Boxcar/Freight and Container TRUs

As boxcar/freight and container TRUs may be located throughout the Yard, and as specific modeling source parameters were not available for boxcar/freight and container TRUs, ENVIRON conservatively represented DPM emissions from boxcar/freight and container TRUs at the Barstow Yard by area sources as recommended by the draft Guidelines (ARB 2006a). According to BNSF facility personnel, boxcar/freight and container TRUs may be located along all rail lines at the Yard, except those used exclusively for passenger rail and locomotive maintenance activities. The locations of area sources representing boxcar/freight and container TRUs are shown in Figure 4-6b. ENVIRON assumed that total boxcar TRU emissions were spread uniformly over all classification areas and arrival/departure tracks. ENVIRON assumed that emissions from boxcar/freight and container 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 boxcar/freight and container TRUs at Barstow.

Source parameter information (i.e., release height, velocity, temperature, and diameter) for boxcar/freight and container TRUs was not available from BNSF personnel. ENVIRON assumed that the release height of boxcar/freight TRU and a container TRU are approximately equal. ENVIRON conservatively estimated the release height of a container TRU as 1.0 meters, based on photographs of container TRUs, and 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 (i.e., the release height was based on the release point above the base of the container, not above the ground). This conservative assumption resulted 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 boxcar/freight TRUs at the Barstow Yard.

4.3.6 Permitted Stationary Sources

4.3.6.1 Emergency Generators and Internal Combustion Engine

Source parameter information (i.e., release height, velocity, temperature, and diameter) necessary to represent the emergency generators and the internal combustion engine for the fire suppression system was not available from BNSF personnel, the engine manufacturers, or district permit applications and permits. Additionally, using a conservative emissions estimation methodology, the emergency generators and internal combustion engine accounted for less than 0.4% of the total DPM emissions from the Facility. Due to the lack of source parameter information and the low percentage of total emissions from this source, the emergency generators and internal combustion engine were not included in the air dispersion modeling.

4.3.6.2 Gasoline Dispensing and Storage Facility

ENVIRON represented gasoline TAC emissions from the gasoline dispensing and storage facilities as volume sources as recommended by the draft Guidelines (ARB 2006a). The locations of the volume sources representing the gasoline dispensing and storage facilities are shown in Figure 4-7. ENVIRON assumed that emissions from the gasoline dispensing and storage facilities (from fueling activities and breathing and working losses) occur 24 hours per day, seven days per week based on information from BNSF personnel. Table 3-1b summarizes the gasoline emissions and operating hours for the two gasoline dispensing and storage facilities.

Source parameter information (i.e., release height for evaporative losses from the storage tank and dispensing equipment) was not available for emission sources at the gasoline dispensing and storage facilities. However, based on aerial photographs and discussions with BNSF personnel, the storage tanks and dispensing equipment are both located above ground. In addition, the filling areas and equipment are very similar to the equipment at a typical commercial filling station. Although evaporative emissions from the storage tanks and dispensing equipment occur above ground level, the exact height of the release points for the emissions is unknown. Therefore, ENVIRON assumed a conservative release height of 1.0 meter for emissions from the gasoline storage and dispensing facilities ENVIRON calculated the corresponding initial vertical dimension of the area source from USEPA (USEPA 2004b) guidance. Table 4-5 summarizes the modeling source parameters for the gasoline dispensing and storage facilities at the Barstow Yard.

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 previously 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 Barstow. ENVIRON has provided the raw meteorological data and the AERMOD model-ready meteorological data files as an electronic attachment in Appendix C.

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 the Barstow Yard. 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 2007a), ENVIRON selected the wind speed, wind direction, and temperature data from the CARB-operated Barstow station for the five years from 2001 to 2002 and 2004 to 2006 as the most representative available wind speed, wind direction, and temperature data for use in the air dispersion analysis of the BNSF Barstow Rail Yards. ENVIRON used cloud cover, temperature, and pressure data (as Barstow did not have a record of complete temperature measurements for 2005 and 2006 or complete pressure measurements for 2001, 2005, and 2006) from the National Weather Service's (NWS's) Barstow-Daggett Airport from 2001 to 2002 and 2004 to 2006. Upper air data from the Desert Rock, Nevada station was used in AERMET processing for the Barstow Yard (ENVIRON 2007a).

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., Barstow meteorological station), rather than the project area (rail yard), as recommended by USEPA (USEPA 2005a) and ARB.[2] Because the selected meteorological station is in very close proximity to the Barstow Yard and the land use surrounding the meteorological station is very similar to the land use surrounding the Barstow Yard, surface parameters calculated for the meteorological station should be representative of the Barstow Yard.

In general, ENVIRON determined land-use sectors around the Barstow station using USGS land cover maps in conjunction with recent aerial photographs. ENVIRON then specified surface

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

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 2007a). Figure 4-8 shows the sectors ENVIRON selected around the Barstow meteorological station for use in the AERMET processing and the USEPA land-use types within each sector. Table 4-6 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 the Barstow Yard 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 4-9 shows the buildings evaluated as part of the building downwash analysis at Barstow. ENVIRON input building dimension information, summarized in Table 4-7, 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 D. 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, 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:

- Barstow
- Barstow SE
- Daggett
- Hinkley
- Hodge
- Nebo
- Lane Mountain
- Water Valley
- Mud Hills

As discussed in Section 2.1, the Barstow Yard is situated in a valley with mountains that rise several hundred meters located within five kilometers to the north and south of the Yard. These significant variations in terrain in close proximity to the Yard will likely impact AERMOD model predictions near these terrain features. The electronic DEM files in the North American Datum (NAD) 1983 projection are provided in Appendix E. ENVIRON provided terrain elevation data to the AERMOD model using version 07026 of AERMAP, AERMOD's terrain preprocessor.

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 analyzed the urban nature of the area in the vicinity of the Barstow Rail Yard using two different methods: Auer's method and population density calculations. The Auer method of classifying land use 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 (Auer 1978). 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 Barstow Yard is rural, classifying Barstow as an area with no urban boundary layer, as shown in Figure 4-10a. Consistent with AERMOD guidance (USEPA 2005a), ENVIRON also used population density calculations to determine whether the urban boundary layer option would be appropriate for BNSF Barstow. USEPA guidance calls for analysis of the population density within a three-kilometer radius from the primary project area to determine if the land can be classified as an urban (i.e., the average population density is greater than 750 people/km2). Using year 2000 census data (Geolytics 2001), ENVIRON determined that the average population density for the area within three kilometers of the Barstow Yard is less than 750 people/km^2 (see Figure 4-10b and Table 4-8) and that the area in the vicinity of the Barstow Yard should not be considered urban. Based on the results of the Auer analysis and the population density analysis, ENVIRON did not select the urban boundary layer option.

ENVIRON also provides electronic census data for the modeling domain (described in the next section) as an electronic attachment in Appendix F, as required in the draft Guidelines.

4.8 Receptor Locations

ENVIRON used gridded receptor points surrounding the BNSF Barstow Yard in the air dispersion analysis. These gridded receptor points represent the general population in the vicinity of the BNSF Barstow 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 Barstow Yard. ENVIRON used four 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 G. The Cartesian receptors included a fine receptor grid with spacing of 50 meters within an approximately 150-meter buffer region directly around the Facility boundary, an intermediate receptor grid with a spacing of 100 meters out to a distance of approximately 750 meters from the Facility boundary, a medium receptor grid with spacing of 250 meters out to a distance of approximately 1,500 meters from the Facility boundary, and a coarse receptor grid with spacing of 500 meters over a 20-kilometer by 20-kilometer square area around the Facility. ENVIRON used Facility plot plans and other information provided by BNSF facility personnel to locate the Facility boundary. Receptors inside the facility boundary were removed prior to the air dispersion modeling analysis. The locations of the coarse, medium, intermediate and fine receptor grid points are shown in Figures 4-11a, 4-11b, 4-11c, and 4-11d respectively. Discrete receptor points were generated from each of the grids shown in Figures 4-11a, 4-11b, 4-11c and 4-11d. 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 92311 zip code in the city of Barstow. The sensitive receptor locations identified from the search of these data sources and within one mile of the Facility are listed in Table 4-9.

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 F.

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 meteorological years 2001 through 2002 and 2004 through 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 2001 through 2002 and 2004 through 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 2001 through 2002 and 2004 through 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 H. The methodology used to calculate period-average DPM and gasoline TAC air concentrations and hourly-maximum gasoline TAC air concentrations, and the electronic database tables used in these calculations are provided in Appendix I. Appendix I also contains the 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 modeled meteorological period modeled.

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 in the facility and on the main line 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 Barstow Facility are off road equipment sources (i.e. track maintenance equipment and transportation refrigeration units). In sum the non-locomotive activities account for less than 3% of DPM emissions, but over 99% of the TAC Exhaust, Evaporative, and Gasoline PM emissions. 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 Barstow Facility. 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 off-road engines. In addition, national and state regulations have targeted these sources for emission reductions. Implementation of these rules and 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). For example, as discussed in Section 2.2.1, in order to reduce model complexity, and based on discussions with BNSF personnel, ENVIRON assumed a general set of travel paths for each type of locomotive maintenance service (i.e., basic locomotive services, engine test, and full service inspection). Actual locomotive movements through the maintenance area may deviate from these assumed general travel paths. The use of a general set of travel paths contributes to uncertainty in off-site exposure concentrations, and off-site exposure concentrations should be considered approximate.

In this assessment, most point and volume sources were spaced evenly at approximately 50-meter intervals, 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 Barstow. 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 Barstow Yard, area sources were used to represent material handling equipment, on-site refueling truck idling and movement, on-road fleet movement, track maintenance equipment, and transportation refrigeration units, which account for approximately 2.5 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 material handling equipment, on-site refueling truck idling and movement, on-road fleet movement, track maintenance equipment, and transportation refrigeration units at Barstow 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 ARB's Barstow station (approximately two kilometers from the rail yard) and the NCDC/NWS station at Barstow-Daggett Airport (approximately 24 kilometers from the rail yard) and upper air data from Desert Rock, Nevada NCDC/NWS station. A complete set of surface meteorological data was not available at ARB's Barstow station; therefore wind speed, wind direction, temperature, and pressure data from Barstow were combined with temperature, pressure and cloud cover data from Barstow-Daggett Airport. Meteorological surface measurements from the Barstow and Barstow-Daggett Airport 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 (ARB Barstow station), rather than the project area (rail yard), as recommended by USEPA (USEPA 2005a) and ARB. However, because the selected meteorological station is in very close proximity to the Barstow Yard and the land use surrounding the meteorological station is very similar to the land use surrounding Barstow, surface parameters calculated for the meteorological station should be representative of Barstow. 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.

5.2.5 Building Downwash

The spacing and placement of point sources relative to buildings or structures result 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 most stationary 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-Hour 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 ENVIRON's Barstow TAC Emissions Inventory (ENVIRON 2007c). 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 Barstow TAC Emissions Inventory) 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 Barstow Rail Yard
Barstow, California

Land Use Category [1]	Percentage (%)
Open Water	0.04%
Developed, Open Space	1.47%
Developed, Low Intensity	1.76%
Developed, Medium Intensity	0.71%
Developed, High Intensity	0.17%
Barren Land (Rock/Sand/Clay)	5.71%
Deciduous Forest	0.00%
Evergreen Forest	0.00%
Mixed Forest	0.00%
Shrub/Scrub	89.51%
Grassland/Herbaceous	0.03%
Pasture/Hay	0.17%
Cultivated Crops	0.39%
Woody Wetlands	0.03%
Emergent Herbaceous Wetlands	0.01%

Notes:
1. Land use data are based on National Land Cover Data 2001 from US Geological Survey.

Table 3-1a
Summary of Emissions and Operating Hours for Modeled DPM Emission Sources[1]
BNSF Barstow Rail Yard
Barstow, California

Emission Source	Activity Category	Activity Category Description	Activity Sub-Category	Activity Sub-Category Description	Modeling Source Type	Operation Mode	Modeling Source Group[2]	Source Group in Database	Total Emissions (g)	Days of Operation per week[3]	Hours of Operation per day[3]	Hours of Operation per year	Modeled Area (m^2)	Total Emission Rate[4,5] (g/s) or ($g/m^2/s$)	Number of Modeled Sources[6]	Emission Rate Applied to Period-Average Dispersion Factors[7] (g/s)
Locomotives	A	Basic Services	A1	Movement Into Service Area	Volume	Notch 1	A1V	A1V	140,707	7	24	8,760	--	4.46E-03	35	1.275E-04
			A2	Idling While Refueling - DSFS	Point	Idle	A2aI	A2aI	653,282	7	24	8,760	--	2.07E-02	8	2.589E-03
				Idling While Refueling - DTL	Point	Idle	A2bI	A2bI	74,816	7	24	8,760	--	2.37E-03	2	1.186E-03
			A3	Movement Within Service Area	Volume	Notch 1	A3V	A3V	146,336	7	24	8,760	--	4.64E-03	62	7.484E-05
			A4	In-Consist	Point	Idle	A4I	A4I	326,641	7	24	8,760	--	1.04E-02	26	3.984E-04
			A5	Movement Out of Service Area	Volume	Notch 2	A5V	A5V	482,120	7	24	8,760	--	1.53E-02	36	4.247E-04
	B	Engine Test	B1	Movement Into Service Area	Volume	Notch 1	B1V	B1V	2,776	7	24	8,760	--	8.80E-05	35	2.515E-06
			B2	Idling While Refueling - DSFS	Point	Idle	B2I	B2I	18,318	7	24	8,760	--	5.81E-04	8	7.261E-05
			B3	Movement Within Service Area	Volume	Notch 1	B3V	B3V	3,591	7	24	8,760	--	1.14E-04	76	1.498E-06
			B4	In-Consist	Point	Idle	B4I	B4I	9,159	7	24	8,760	--	2.90E-04	26	1.117E-05
			B5	Engine Load Test	Point	Notch 8	B5I	B5I	253,675	7	24	8,760	--	8.04E-03	10	8.044E-04
			B6	Movement Out of Service Area	Volume	Notch 2	B6V	B6V	11,593	7	24	8,760	--	3.68E-04	36	1.021E-05
	C	Full Inspection: GE Locomotives	C1	Movement Into Service Area	Volume	Notch 1	C1aV	C1aV	9,256	7	24	8,760	--	2.94E-04	35	8.386E-06
			C2	Idling While Refueling - DSFS	Point	Idle	C2aI	C2aI	27,362	7	24	8,760	--	8.68E-04	8	1.085E-04
			C3	Movement Within Service Area	Volume	Notch 1	C3aV	C3aV	13,699	7	24	8,760	--	4.34E-04	94	4.621E-06
			C4	Preloaded Test	Point	Notch 8	C4aI	C4aI	156,657	7	24	8,760	--	4.97E-03	10	4.968E-04
			C5	Opacity Test	Point	Idle	C5aI	C5aI	2,037	7	24	8,760	--	6.46E-05	10	6.459E-06
					Point	Notch 1	C5aN1	C5aN1	4,594	7	24	8,760	--	1.46E-04	10	1.457E-05
					Point	Notch 2	C5aN2	C5aN2	8,869	7	24	8,760	--	2.81E-04	10	2.812E-05
					Point	Notch 3	C5aN3	C5aN3	16,946	7	24	8,760	--	5.37E-04	10	5.374E-05
					Point	Notch 4	C5aN4	C5aN4	20,194	7	24	8,760	--	6.40E-04	10	6.403E-05
					Point	Notch 5	C5aN5	C5aN5	30,778	7	24	8,760	--	9.76E-04	10	9.759E-05
					Point	Notch 6	C5aN6	C5aN6	30,638	7	24	8,760	--	9.72E-04	10	9.715E-05
					Point	Notch 7	C5aN7	C5aN7	30,617	7	24	8,760	--	9.71E-04	10	9.709E-05
					Point	Notch 8	C5aN8	C5aN8	35,340	7	24	8,760	--	1.12E-03	10	1.121E-04
			C6	Final Load Test	Point	Notch 8	C6aI	C6AI	318,060	7	24	8,760	--	1.01E-02	6	1.681E-03
			C7	In-Consist	Point	Idle	C7aI	C7AI	13,681	7	24	8,760	--	4.34E-04	26	1.669E-05
			C8	Movement Out of Service Area	Volume	Notch 2	C8aV	C8AV	25,733	7	24	8,760	--	8.16E-04	36	2.267E-05
		Full Inspection: Non-GE Locomotives	C1	Movement Into Service Area	Volume	Notch 1	C1bV	C1BV	1,204	7	24	8,760	--	3.82E-05	35	1.091E-06
			C2	Idling While Refueling - DSFS	Point	Idle	C2bI	C2BI	7,993	7	24	8,760	--	2.53E-04	8	3.168E-05
			C3	Movement Within Service Area	Volume	Notch 1	C3bV	C3BV	1,782	7	24	8,760	--	5.65E-05	94	6.013E-07

Table 3-1a
Summary of Emissions and Operating Hours for Modeled DPM Emission Sources[1]
BNSF Barstow Rail Yard
Barstow, California

Emission Source	Activity Category	Activity Category Description	Activity Sub-Category	Activity Sub-Category Description	Modeling Source Type	Operation Mode	Modeling Source Group[2]	Source Group in Database	Total Emissions (g)	Days of Operation per week[3]	Hours of Operation per day[3]	Hours of Operation per year	Modeled Area (m^2)	Total Emission Rate[4,5] (g/s) or ($g/m^2/s$)	Number of Modeled Sources[6]	Emission Rate Applied to Period-Average Dispersion Factors[7] (g/s)
Locomotives	C	Full Inspection: Non-GE Locomotives	C5	Opacity Test	Point	Idle	C5bI	C5BI	595	7	24	8,760	--	1.89E-05	10	1.887E-06
					Point	Notch 1	C5bN1	C5BN1	598	7	24	8,760	--	1.90E-05	10	1.895E-06
					Point	Notch 2	C5bN2	C5BN2	1,739	7	24	8,760	--	5.52E-05	10	5.516E-06
					Point	Notch 3	C5bN3	C5BN3	3,302	7	24	8,760	--	1.05E-04	10	1.047E-05
					Point	Notch 4	C5bN4	C5BN4	4,017	7	24	8,760	--	1.27E-04	10	1.274E-05
					Point	Notch 5	C5bN5	C5BN5	5,087	7	24	8,760	--	1.61E-04	10	1.613E-05
					Point	Notch 6	C5bN6	C5BN6	8,107	7	24	8,760	--	2.57E-04	10	2.571E-05
					Point	Notch 7	C5bN7	C5BN7	9,948	7	24	8,760	--	3.15E-04	10	3.154E-05
					Point	Notch 8	C5bN8	C5BN8	12,284	7	24	8,760	--	3.90E-04	10	3.895E-05
			C6	Final Load Test	Point	Notch 8	C6bI	C6BI	110,559	7	24	8,760	--	3.51E-03	6	5.843E-04
			C7	In-Consist	Point	Idle	C7bI	C7BI	3,997	7	24	8,760	--	1.27E-04	26	4.874E-06
			C8	Movement Out of Service Area	Volume	Notch 2	C8bV	C8BV	5,047	7	24	8,760	--	1.60E-04	36	4.445E-06
	D	Switching	D1	Switching West	Point	Idle	D1I	D1I	401,553	7	24	8,760	--	1.27E-02	113	1.127E-04
					Volume	Dynamic Brake	D1V	D1VD	22	7	24	8,760	--	6.89E-07	31	2.222E-08
					Volume	Notch 1	D1V	D1V1	23,399	7	24	8,760	--	7.42E-04	31	2.393E-05
					Volume	Notch 2	D1V	D1V2	60,233	7	24	8,760	--	1.91E-03	31	6.161E-05
					Volume	Notch 3	D1V	D1V3	130,447	7	24	8,760	--	4.14E-03	31	1.334E-04
					Volume	Notch 4	D1V	D1V4	85,619	7	24	8,760	--	2.71E-03	31	8.758E-05
					Volume	Notch 5	D1V	D1V5	50,191	7	24	8,760	--	1.59E-03	31	5.134E-05
					Volume	Notch 6	D1V	D1V6	36,582	7	24	8,760	--	1.16E-03	31	3.742E-05
					Volume	Notch 7	D1V	D1V7	27,570	7	24	8,760	--	8.74E-04	31	2.820E-05
					Volume	Notch 8	D1V	D1V8	89,997	7	24	8,760	--	2.85E-03	31	9.206E-05
			D2	Switching East	Point	Idle	D2I	D2I	1,472,361	7	24	8,760	--	4.67E-02	444	1.052E-04
					Volume	Dynamic Brake	D2V	D2VD	80	7	24	8,760	--	2.53E-06	46	5.492E-08
					Volume	Notch 1	D2V	D2V1	85,796	7	24	8,760	--	2.72E-03	46	5.914E-05
					Volume	Notch 2	D2V	D2V2	220,855	7	24	8,760	--	7.00E-03	46	1.522E-04
					Volume	Notch 3	D2V	D2V3	478,307	7	24	8,760	--	1.52E-02	46	3.297E-04
					Volume	Notch 4	D2V	D2V4	313,938	7	24	8,760	--	9.95E-03	46	2.164E-04
					Volume	Notch 5	D2V	D2V5	184,034	7	24	8,760	--	5.84E-03	46	1.269E-04
					Volume	Notch 6	D2V	D2V6	134,134	7	24	8,760	--	4.25E-03	46	9.246E-05
					Volume	Notch 7	D2V	D2V7	101,089	7	24	8,760	--	3.21E-03	46	6.968E-05
					Volume	Notch 8	D2V	D2V8	329,990	7	24	8,760	--	1.05E-02	46	2.275E-04
	E	Arriving and Departing Trains	E1	BNSF Arriving Line Haul East	Point	Idle	E1I	E1I	3,186,010	7	24	8,760	--	1.01E-01	102	9.905E-04
					Volume	Dynamic Brake	E1V	E1VD	547,368	7	24	8,760	--	1.74E-02	102	1.702E-04
					Volume	Notch 1	E1V	E1V1	636,667	7	24	8,760	--	2.02E-02	102	1.979E-04
					Volume	Notch 2	E1V	E1V2	601,225	7	24	8,760	--	1.91E-02	102	1.869E-04
					Volume	Notch 3	E1V	E1V3	530,757	7	24	8,760	--	1.68E-02	102	1.650E-04
					Volume	Notch 4	E1V	E1V4	179,795	7	24	8,760	--	5.70E-03	102	5.589E-05
					Volume	Notch 5	E1V	E1V5	63,342	7	24	8,760	--	2.01E-03	102	1.969E-05
			E2	BNSF Arriving Line Haul West	Point	Idle	E2I	E2I	2,340,896	7	24	8,760	--	7.42E-02	184	4.034E-04
					Volume	Dynamic Brake	E2V	E2VD	402,174	7	24	8,760	--	1.28E-02	26	4.905E-04
					Volume	Notch 1	E2V	E2V1	467,786	7	24	8,760	--	1.48E-02	26	5.705E-04
					Volume	Notch 2	E2V	E2V2	441,745	7	24	8,760	--	1.40E-02	26	5.388E-04
					Volume	Notch 3	E2V	E2V3	389,969	7	24	8,760	--	1.24E-02	26	4.756E-04
					Volume	Notch 4	E2V	E2V4	132,103	7	24	8,760	--	4.19E-03	26	1.611E-04
					Volume	Notch 5	E2V	E2V5	46,540	7	24	8,760	--	1.48E-03	26	5.676E-05
			E3	BNSF Departing Line Haul	Point	Idle	E3I	E3I	1,919,283	7	24	8,760	--	6.09E-02	280	2.174E-04
					Volume	Dynamic Brake	E3V	E3VD	329,740	7	24	8,760	--	1.05E-02	26	4.022E-04
					Volume	Notch 1	E3V	E3V1	383,534	7	24	8,760	--	1.22E-02	26	4.678E-04
					Volume	Notch 2	E3V	E3V2	362,184	7	24	8,760	--	1.15E-02	26	4.417E-04
					Volume	Notch 3	E3V	E3V3	319,733	7	24	8,760	--	1.01E-02	26	3.899E-04
					Volume	Notch 4	E3V	E3V4	108,310	7	24	8,760	--	3.43E-03	26	1.321E-04
					Volume	Notch 5	E3V	E3V5	38,158	7	24	8,760	--	1.21E-03	26	4.654E-05

Table 3-1a
Summary of Emissions and Operating Hours for Modeled DPM Emission Sources[1]
BNSF Barstow Rail Yard
Barstow, California

Emission Source	Activity Category	Activity Category Description	Activity Sub-Category	Activity Sub-Category Description	Modeling Source Type	Operation Mode	Modeling Source Group[2]	Source Group in Database	Total Emissions (g)	Days of Operation per week[3]	Hours of Operation per day[3]	Hours of Operation per year	Modeled Area (m^2)	Total Emission Rate[4,5] (g/s) or ($g/m^2/s$)	Number of Modeled Sources[6]	Emission Rate Applied to Period-Average Dispersion Factors[7] (g/s)
Locomotives	F	Adjacent Freight Movements	F1	BNSF Passing Line Haul	Point	Idle	F1I	F1I	506,985	7	24	8,760	--	1.61E-02	149	1.079E-04
					Volume	Dynamic Brake	F1V	F1VD	335,781	7	24	8,760	--	1.06E-02	149	7.146E-05
					Volume	Notch 1	F1V	F1V1	57,900	7	24	8,760	--	1.84E-03	149	1.232E-05
					Volume	Notch 2	F1V	F1V2	255,921	7	24	8,760	--	8.12E-03	149	5.446E-05
					Volume	Notch 3	F1V	F1V3	403,823	7	24	8,760	--	1.28E-02	149	8.594E-05
					Volume	Notch 4	F1V	F1V4	318,171	7	24	8,760	--	1.01E-02	149	6.771E-05
					Volume	Notch 5	F1V	F1V5	228,339	7	24	8,760	--	7.24E-03	149	4.859E-05
					Volume	Notch 6	F1V	F1V6	133,800	7	24	8,760	--	4.24E-03	149	2.847E-05
					Volume	Notch 7	F1V	F1V7	174,624	7	24	8,760	--	5.54E-03	149	3.716E-05
					Volume	Notch 8	F1V	F1V8	271,670	7	24	8,760	--	8.61E-03	149	5.782E-05
			F2	Non-BNSF Passing Line Haul	Point	Idle	F2I	F2I	227,829	7	24	8,760	--	7.22E-03	149	4.849E-05
					Volume	Dynamic Brake	F2V	F2VD	150,893	7	24	8,760	--	4.78E-03	149	3.211E-05
					Volume	Notch 1	F2V	F2V1	26,019	7	24	8,760	--	8.25E-04	149	5.537E-06
					Volume	Notch 2	F2V	F2V2	115,006	7	24	8,760	--	3.65E-03	149	2.448E-05
					Volume	Notch 3	F2V	F2V3	181,470	7	24	8,760	--	5.75E-03	149	3.862E-05
					Volume	Notch 4	F2V	F2V4	142,979	7	24	8,760	--	4.53E-03	149	3.043E-05
					Volume	Notch 5	F2V	F2V5	102,611	7	24	8,760	--	3.25E-03	149	2.184E-05
					Volume	Notch 6	F2V	F2V6	60,127	7	24	8,760	--	1.91E-03	149	1.280E-05
					Volume	Notch 7	F2V	F2V7	78,472	7	24	8,760	--	2.49E-03	149	1.670E-05
					Volume	Notch 8	F2V	F2V8	122,083	7	24	8,760	--	3.87E-03	149	2.598E-05
	G	Adjacent Passenger Rail Operations	G	Amtrak (Passenger Rail)	Point	Idle	GI	GI	4,641	7	24	8,760	--	1.47E-04	149	9.876E-07
					Volume	Dynamic Brake	GV	GVD	2,726	7	24	8,760	--	8.64E-05	149	5.801E-07
					Volume	Notch 1	GV	GV1	364	7	24	8,760	--	1.16E-05	149	7.755E-08
					Volume	Notch 2	GV	GV2	2,396	7	24	8,760	--	7.60E-05	149	5.100E-07
					Volume	Notch 3	GV	GV3	3,440	7	24	8,760	--	1.09E-04	149	7.321E-07
					Volume	Notch 4	GV	GV4	2,645	7	24	8,760	--	8.39E-05	149	5.629E-07
					Volume	Notch 5	GV	GV5	1,429	7	24	8,760	--	4.53E-05	149	3.042E-07
					Volume	Notch 6	GV	GV6	1,099	7	24	8,760	--	3.49E-05	149	2.340E-07
					Volume	Notch 7	GV	GV7	1,606	7	24	8,760	--	5.09E-05	149	3.418E-07
					Volume	Notch 8	GV	GV8	2,928	7	24	8,760	--	9.28E-05	149	6.231E-07
Cargo Handling Equipment	H	Cargo Handling Equipment Operations	H	Material Handling Equipment	Area	--	HA	HA	24,962	7	24	8,760	#N/A	#N/A	--	7.915E-04
On-Road Container	I	On-Site Refueling Truck Operations	I	On-Site Refueling Truck	Volume	--	IV	IV	5,154	7	24	8,760	--	1.63E-04	105	1.556E-06
					Area	--	IA	IA	2,246	7	24	8,760	2,675	2.66E-08	6	1.187E-05
On-Road Fleet	J	On-Road Fleet	J	BNSF On-Road Fleet	Volume	--	JV	JV	25,812	5	12	3,129	--	8.18E-04	375	2.183E-06
					Area	--	JA	JA	1,408	5	12	3,129	21,517	2.07E-09	5	8.927E-06
Off-Road Equipment	K	Other Off-Road Equipment	K1	Track Maintenance	Area	--	K1A	K1A	103,704	7	12	4,380	1,268,581	2.59E-09	--	6.577E-03
			K2a	Boxcar TRUs	Area	--	K2aA	K2aA	465,201	7	24	8,760	1,268,581	1.16E-08	--	1.475E-02
			K2b	Container TRUs	Area	--	K2bA	K2bA	8,995	7	24	8,760	1,268,581	2.25E-10	--	2.852E-04
Stationary Sources	L	Stationary Sources	L3	Emergency Generators	--	--	--	L3	97,814	--	--	52	--	--	--	6.203E-04

Notes:

1. Stationary Permitted Sources (designated as activity category L) of DPM were not modeled due to negligible emissions and lack of source parameter information for modeling.
2. "Modeling Source Group" corresponds to the modeling source group name in the AERMOD input and output files.
3. "Days of Operation per Week" and "Hours of Operation per Day" indicate general operating schedules. Exact days and hours of operation for each emission activity can be found in the detailed temporal profiles in Appendix A.
4. The "Total Emission Rate" is calculated based on the "Total Emissions" assuming 8760 hours of operation per year. The actual "Hours of Operation per Year" are taken into account in the temporal profiles and are not included in the calculations here to avoid double counting.
5. The "Total Emission Rate" units are "grams per second" for point and volume sources and "grams per meter squared per second" for area sources.
6. The "Number of Modeled Sources" refers to the sum of Chi/Q for each modeling source group. For most groups, this is equal to the number of modeled sources. For some groups, however, the sum of Chi/Q differs based on emissions apportionment and this sum is used for emission rate calculation instead of the number of modeled sources.
7. 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 area.

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

Activity Subcategory	Activity Subcategory Description	Modeling Source Type	Modeling Source Group[1]	Total Emissions (g)	Days of Operation Per Week[2]	Hours of Operation Per Day[2]	Hours of Operation per year	Total Emission Rate[3,4] (g/s) or (g/m^2/s)	Number of Modeled Sources	Modeled Area (m^2)	Emission Rate Applied to Period-Average Dispersion Factors[5] (g/s)	Hourly Maximum Emission Rate[6] (g/s) or (g/m^2/s)
Gasoline PM (ARB Speciate Profile #400)												
JA	BNSF On-Road Fleet	Area	GAS-PM	572	5	12	8,760	1.82E-05	--	21,517	3.91E-01	1.82E-05
JV	BNSF On-Road Fleet	Volume		10,498	5	12	8,760	3.33E-04	375	--	8.88E-07	3.33E-04
K1A	Track Maintenance	Area		81	7	12	8,760	2.57E-06	--	1,268,581	3.26E+00	2.57E-06
TOG Evaporative (ARB Speciate Profile #422)												
JA	BNSF On-Road Fleet	Area	TOG-EVAP	38,771	5	12	8,760	1.23E-03	--	21,517	2.65E+01	1.23E-03
JV	BNSF On-Road Fleet	Volume		710,970	5	12	8,760	2.25E-02	375	--	6.01E-05	2.25E-02
K2aA	Container/Trailer TRU	Area		2,286,467	7	24	8,760	7.25E-02	--	1,268,581	9.20E+04	7.25E-02
K2bA	Boxcar/Freight TRU	Area		44,208	7	24	8,760	1.40E-03	--	1,268,581	1.78E+03	1.40E-03
L2a	Gasoline Dispensing Facility - West	Volume		5,792	7	24	8,760	1.84E-04	1	--	1.84E-04	1.84E-04
L2b	Gasoline Dispensing Facility - East	Volume		22,831	7	24	8,760	7.24E-04	1	--	7.24E-04	7.24E-04
K1A	Track Maintenance	Area		494	7	12	8,760	1.57E-05	--	1,268,581	1.99E+01	1.57E-05
TOG Exhaust (ARB Speciate Profile #2105)												
JA	BNSF On-Road Fleet	Area	TOG-EX	78,260	5	12	8,760	2.48E-03	--	21,517	5.34E+01	2.48E-03
JV	BNSF On-Road Fleet	Volume		1,435,084	5	12	8,760	4.55E-02	375	--	1.21E-04	4.55E-02
K1A	Track Maintenance	Area		2,808	7	12	8,760	8.90E-05	--	1,268,581	1.13E+02	8.90E-05

Notes:

1. "Modeling Source Group" corresponds to the modeling source group name in the AERMOD input and output files.
2. "Days of Operation per Week" and "Hours of Operation per Day" indicate general operating schedules. Exact days and hours of operation for each emission activity can be found in the detailed temporal profiles in Appendix A.
3. The "Total Emission Rate" is calculated based on the "Total Emissions" assuming 8760 hours of operation per year. The actual "Hours of Operation per Year" are taken into account in the temporal profiles and are not included in the calculations here to avoid double-counting.
4. The "Total Emission Rate" units are "grams per second" for point and volume sources and "grams per meter squared per second" for area sources.
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 area.
6. 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 Barstow Rail Yard
Barstow, California

Activity Category	Activity Category Description	Diesel			Gasoline								
		PM Emissions			PM Emissions			TOG Evaporative Emissions			TOG Exhaust Emissions		
		Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)
A	Basic Services	1,823,901	1.82	7.2%	--	--	--	--	--	--	--	--	--
B	Engine Test	299,112	0.30	1.2%	--	--	--	--	--	--	--	--	--
C	Full Inspection	920,721	0.92	3.6%	--	--	--	--	--	--	--	--	--
D	Locomotive Switching	4,226,196	4.23	16.7%	--	--	--	--	--	--	--	--	--
E	Arriving-Departing Line-Haul	13,427,321	13.43	53.0%	--	--	--	--	--	--	--	--	--
F	Adjacent Freight Movements	3,894,502	3.89	15.4%	--	--	--	--	--	--	--	--	--
G	Adjacent Passenger Rail Operations	23,276	0.02	0.1%	--	--	--	--	--	--	--	--	--
H	Cargo Handling Equipment	24,962	0.02	0.1%	--	--	--	--	--	--	--	--	--
I	On-Site Refueling Truck	7,400	0.01	0.0%	--	--	--	--	--	--	--	--	--
J	On-Road Fleet Vehicles	27,219	0.03	0.1%	11,070	0.01	99.3%	749,741	0.75	24.1%	1,513,344	1.51	99.8%
K	Off-Road Equipment	577,900	0.58	2.3%	81	0.00	0.7%	2,331,170	2.33	75.0%	2,808	0.00	0.2%
L	Emergency Generators[1]	97,814	0.10	0.4%	--	--	--	--	--	--	--	--	--
	Gasoline Dispensing Facility	--	--	--	--	--	--	28,623	2.86E-02	0.9%	--	--	--
	TOTAL	25,350,324	25.35	100%	11,152	1.12E-02	100%	3,109,534	3.11E+00	100%	1,516,152	1.52E+00	100%

Notes:
1. Stationary Permitted Sources (designated as activity category L) of DPM were not modeled due lack of source paramater information for modeling and insignificant emissions.

Table 4-1
Fleet-Average Source Parameters for Locomotive Activities
BNSF Barstow Rail Yard
Barstow, 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)**
A1	Movement Into Service Area	Volume	Notch 1	--	--	--	--	0.71 - 2.79	13.28	3.09	21.11	4.91
A2	Idling While Refueling - DSFS	Point	Idle	4.52	379.49	6.64	0.54	--	--	--	--	--
	Idling While Refueling - DTL	Point	Idle	4.52	391.46	3.82	0.59	--	--	--	--	--
A3	Movement Within Service Area	Volume	Notch 1	--	--	--	--	1.40 - 7.91	23.09	5.37	27.62	6.42
A4	In-Consist	Point	Idle	4.52	379.49	6.64	0.54	--	--	--	--	--
A5	Movement Out of Service Area	Volume	Notch 2	--	--	--	--	0.71 - 19.53	15.07	3.50	22.75	5.29
B1	Movement Into Service Area	Volume	Notch 1	--	--	--	--	0.71 - 2.79	36.56	8.50	34.25	7.97
B2	Idling While Refueling - DSFS	Point	Idle	4.52	368.89	9.00	0.50	--	--	--	--	--
B3	Movement Within Service Area	Volume	Notch 1	--	--	--	--	0.71 - 10.70	99.66	23.18	56.85	13.22
B4	In-Consist	Point	Idle	4.52	368.89	9.00	0.50	--	--	--	--	--
B5	Engine Load Test	Point	Notch 8	4.52	628.51	57.76	0.53	--	--	--	--	--
B6	Movement Out of Service Area	Volume	Notch 2	--	--	--	--	0.71 - 19.53	23.48	5.46	28.32	6.59
C1a	Movement Into Service Area (GE Engines)	Volume	Notch 1	--	--	--	--	0.71 - 2.79	10.42	2.42	18.64	4.33
C2a	Idling While Refueling - DSFS (GE Engines)	Point	Idle	4.52	399.63	2.16	0.61	--	--	--	--	--
C3a	Movement Within Service Area (GE Engines)	Volume	Notch 1	--	--	--	--	1.40 - 10.70	105.49	24.53	58.25	13.55
C4a	Preloaded Test (GE Engines)	Point	Notch 8	4.52	694.93	44.33	0.61	--	--	--	--	--
C5a	Opacity Test (GE Engines)	Point	Idle	4.52	399.63	2.16	0.61	--	--	--	--	--
		Point	Notch 1	4.52	471.88	3.14	0.61	--	--	--	--	--
		Point	Notch 2	4.52	567.26	5.36	0.61	--	--	--	--	--
		Point	Notch 3	4.52	652.07	11.14	0.61	--	--	--	--	--
		Point	Notch 4	4.52	704.72	14.25	0.61	--	--	--	--	--
		Point	Notch 5	4.52	703.41	22.16	0.61	--	--	--	--	--
		Point	Notch 6	4.52	694.07	28.09	0.61	--	--	--	--	--
		Point	Notch 7	4.52	689.95	35.15	0.61	--	--	--	--	--
		Point	Notch 8	4.52	694.93	44.33	0.61	--	--	--	--	--
C6a	Final Load Test (GE Engines)	Point	Notch 8	4.52	694.93	44.33	0.61	--	--	--	--	--
C7a	In-Consist (GE Engines)	Point	Idle	4.52	399.63	2.16	0.61	--	--	--	--	--
C8a	Movement Out of Service Area (GE Engines)	Volume	Notch 2	--	--	--	--	0.71 - 19.53	36.56	8.50	34.25	7.97
C1b	Movement Into Service Area (Non-GE Engines)	Volume	Notch 1	--	--	--	--	0.71 - 2.79	36.56	8.50	34.25	7.97
C2b	Idling While Refueling - DSFS (Non-GE Engines)	Point	Idle	4.52	368.89	9.00	0.50	--	--	--	--	--
C3b	Movement Within Service Area (Non-GE Engines)	Volume	Notch 1	--	--	--	--	1.40 - 10.70	32.95	7.66	32.86	7.64

Table 4-1
Fleet-Average Source Parameters for Locomotive Activities
BNSF Barstow Rail Yard
Barstow, 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)**
C5b	Opacity Test (Non-GE Engines)	Point	Idle	4.52	368.89	9.00	0.50	--	--	--	--	--
		Point	Notch 1	4.52	402.29	9.48	0.52	--	--	--	--	--
		Point	Notch 2	4.52	447.09	13.86	0.50	--	--	--	--	--
		Point	Notch 3	4.52	508.13	20.30	0.52	--	--	--	--	--
		Point	Notch 4	4.52	568.51	25.86	0.53	--	--	--	--	--
		Point	Notch 5	4.52	606.44	31.88	0.53	--	--	--	--	--
		Point	Notch 6	4.52	619.41	39.06	0.53	--	--	--	--	--
		Point	Notch 7	4.52	617.32	50.46	0.54	--	--	--	--	--
		Point	Notch 8	4.52	628.11	57.84	0.53	--	--	--	--	--
C6b	Final Load Test (Non-GE Engines)	Point	Notch 8	4.52	628.11	57.84	0.53	--	--	--	--	--
C7b	In-Consist (Non-GE Engines)	Point	Idle	4.52	368.89	9.00	0.50	--	--	--	--	--
C8b	Movement Out of Service Area (Non-GE Engines)	Volume	Notch 2	--	--	--	--	0.71 - 19.53	23.48	5.46	28.32	6.59
D1	Switching West	Point	Idle	4.52	361.60	15.56	0.29	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
		Volume	Notch 1	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
		Volume	Notch 2	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
		Volume	Notch 3	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
		Volume	Notch 4	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
		Volume	Notch 5	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
		Volume	Notch 6	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
		Volume	Notch 7	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
		Volume	Notch 8	--	--	--	--	1.42 - 16.28	12.77	2.97	16.40	3.81
D2	Switching East	Point	Idle	4.52	361.60	15.56	0.29	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81
		Volume	Notch 1	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81
		Volume	Notch 2	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81
		Volume	Notch 3	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81
		Volume	Notch 4	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81
		Volume	Notch 5	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81
		Volume	Notch 6	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81
		Volume	Notch 7	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81
		Volume	Notch 8	--	--	--	--	1.42 - 34.88	12.77	2.97	16.40	3.81

Table 4-1
Fleet-Average Source Parameters for Locomotive Activities
BNSF Barstow Rail Yard
Barstow, California

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)	Day Release Height (m)	Day Initial Vertical Dimension (m)	Night Release Height (m)	Night Initial Vertical Dimension (m)
E1	BNSF Arriving Line Haul East	Point	Idle	4.52	391.48	3.82	0.59	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	0.71	4.63	1.08	8.90	2.07
		Volume	Notch 1	--	--	--	--	0.71	4.63	1.08	8.90	2.07
		Volume	Notch 2	--	--	--	--	0.71	4.63	1.08	8.90	2.07
		Volume	Notch 3	--	--	--	--	0.71	4.63	1.08	8.90	2.07
		Volume	Notch 4	--	--	--	--	0.71	4.63	1.08	8.90	2.07
		Volume	Notch 5	--	--	--	--	0.71	4.63	1.08	8.90	2.07
		Volume	Notch 6	--	--	--	--	0.71	4.63	1.08	8.90	2.07
		Volume	Notch 7	--	--	--	--	0.71	4.63	1.08	8.90	2.07
		Volume	Notch 8	--	--	--	--	0.71	4.63	1.08	8.90	2.07
E2	BNSF Arriving Line Haul West	Point	Idle	4.52	391.48	3.82	0.59	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
		Volume	Notch 1	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
		Volume	Notch 2	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
		Volume	Notch 3	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
		Volume	Notch 4	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
		Volume	Notch 5	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
		Volume	Notch 6	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
		Volume	Notch 7	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
		Volume	Notch 8	--	--	--	--	0.93 - 17.67	4.63	1.08	8.90	2.07
E3	BNSF Departing Line Haul	Point	Idle	4.52	391.48	3.82	0.59	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
		Volume	Notch 1	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
		Volume	Notch 2	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
		Volume	Notch 3	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
		Volume	Notch 4	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
		Volume	Notch 5	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
		Volume	Notch 6	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
		Volume	Notch 7	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
		Volume	Notch 8	--	--	--	--	7.91 - 25.58	4.63	1.08	8.90	2.07
F1	BNSF Passing Line Haul	Point	Idle	4.52	391.48	3.82	0.59	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 1	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 2	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 3	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 4	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 5	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 6	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 7	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 8	--	--	--	--	3.49	5.52	1.28	13.87	3.23

Table 4-1
Fleet-Average Source Parameters for Locomotive Activities
BNSF Barstow Rail Yard
Barstow, California

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)	Day Release Height (m)	Day Initial Vertical Dimension (m)	Night Release Height (m)	Night Initial Vertical Dimension (m)
F2	Non-BNSF Passing Line Haul	Point	Idle	4.52	391.48	3.82	0.59	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 1	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 2	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 3	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 4	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 5	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 6	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 7	--	--	--	--	3.49	5.52	1.28	13.87	3.23
		Volume	Notch 8	--	--	--	--	3.49	5.52	1.28	13.87	3.23
G	Amtrak (Passenger Rail)	Point	Idle	4.52	373.22	5.48	0.62	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	3.49	--	--	13.35	3.11
		Volume	Notch 1	--	--	--	--	3.49	--	--	13.35	3.1057351
		Volume	Notch 2	--	--	--	--	3.49	--	--	13.35	3.1057351
		Volume	Notch 3	--	--	--	--	3.49	--	--	13.35	3.1057351
		Volume	Notch 4	--	--	--	--	3.49	--	--	13.35	3.1057351
		Volume	Notch 5	--	--	--	--	3.49	--	--	13.35	3.1057351
		Volume	Notch 6	--	--	--	--	3.49	--	--	13.35	3.1057351
		Volume	Notch 7	--	--	--	--	3.49	--	--	13.35	3.1057351
		Volume	Notch 8	--	--	--	--	3.49	--	--	13.35	3.1057351

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

Activity Subcategory	Activity Subcategory Description	Modeled Notch Setting[2]	Locomotive Speed (mph)	Locomotive Speed (m/s)	Modeled Locomotive Type	Plume Height[3] (m)			Initial Vertical Dimension (m)		
						Stability D	Stability F	Adjusted F[4]	Stability D	Stability F	Adjusted F[4]
A1	Movement Into Service Area	1	5.00	2.24	LH	13.30	21.12	--	3.09	4.91	--
A3	Movement Within Service Area	1	5.00	2.24	LH	13.30	21.12	--	3.09	4.91	--
A5	Movement Out of Service Area	2	5.00	2.24	LH	23.16	27.66	--	5.39	6.43	--
B1	Movement Into Service Area	1	5.00	2.24	LH	15.12	22.78	--	3.52	5.30	--
B3	Movement Within Service Area	1	5.00	2.24	LH	15.12	22.78	--	3.52	5.30	--
B6	Movement Out of Service Area	2	5.00	2.24	LH	23.52	28.33	--	5.47	6.59	--
C1a	Movement Into Service Area (GE Engines)	1	5.00	2.24	LH	9.17	17.46	--	2.13	4.06	--
C3a	Movement Within Service Area (GE Engines)	1	5.00	2.24	LH	9.17	17.46	--	2.13	4.06	--
C8a	Movement Out of Service Area (GE Engines)	2	5.00	2.24	LH	17.43	23.72	--	4.05	5.52	--
C1b	Movement Into Service Area (Non-GE Engines)	1	5.00	2.24	LH	15.13	22.79	--	3.52	5.30	--
C3b	Movement Within Service Area (Non-GE Engines)	1	5.00	2.24	LH	15.13	22.79	--	3.52	5.30	--
C8b	Movement Out of Service Area (Non-GE Engines)	2	5.00	2.24	LH	23.48	28.32	--	5.46	6.59	--
D1	Switching West	3	10.00	4.47	GS	12.77	24.09	16.40	2.97	5.60	3.81
D2	Switching East	3	10.00	4.47	GS	12.77	24.09	16.40	2.97	5.60	3.81
E1	BNSF Arriving Line Haul East	1	20.00	8.94	LH	4.63	13.61	8.90	1.08	3.17	2.07
E2	BNSF Arriving Line Haul West	1	20.00	8.94	LH	4.63	13.61	8.90	1.08	3.17	2.07
E3	BNSF Departing Line Haul	1	20.00	8.94	LH	4.63	13.61	8.90	1.08	3.17	2.07
F1	BNSF Passing Line Haul	3	30.00	13.41	LH	5.52	26.73	13.87	1.28	6.22	3.23
F2	Non-BNSF Passing Line Haul	3	30.00	13.41	LH	5.52	26.73	13.87	1.28	6.22	3.23
G	Amtrak (Passenger Rail)	3	30.00	13.41	LH	5.25	25.51	13.35	1.22	5.93	3.11

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 emissions 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 Material Handling Equipment, On-Site Refueling Truck, and Off-Road Equipment
BNSF Barstow Rail Yard
Barstow, California

Activity Subcategory	Activity Subcategory Description	Modeling Source Type	Day		Night	
			Release Height[1] (m)	Initial Vertical Dimension[2] (m)	Release Height[1] (m)	Initial Vertical Dimension[2] (m)
H	Material Handling Equipment	Area	3.05	0.71	3.05	0.71
I	On-Site Refueling Truck	Volume	4.00	0.93	6.00	1.40
		Area	4.00	0.93	6.00	1.40
K1	Off-Road: Track Maintenance Equipment	Area	10.15	2.36	--	--
K2a	Off-Road: Container TRUs	Area	1.00	0.23	1.00	0.23
K2b	Off-Road: Boxcar TRUs	Area	1.00	0.23	1.00	0.23

Notes:
1. Assumed release height for track maintenance equipment equal to the lowest plume height from plume rise adjusments for locomotive sources; assumed release height for portable engines equal to 0.6 meter based on ARB Risk Reduction Plan (ARB 2000) and recommendations from ARB staff.
2. Initial vertical dimension calculated as release height divided by 4 .3 based on USEPA guidance (USEPA 2004) for volume sources not on or adjacent to a building.

Sources:

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.
2. 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 Vehicles
BNSF Barstow Rail Yard
Barstow, California

Activity Subcategory	Activity Subcategory Description	Modeling Source Type[1]	Initial Lateral Dimension (m)	Release Height[2] (m)	Initial Vertical Dimension (m)
J	BNSF On-Road Fleet	Area	--	0.60	0.14
		Volume	2.79	0.60	0.14

Notes:
1. On-road fleet modeled as 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
Source Parameters for Permitted Stationary Sources
BNSF Barstow Rail Yard
Barstow, California

Activity Subcategory	Activity Subcategory Description	Modeling Source Type	Release Height[1] (m)	Initial Vertical Dimension (m)
L2	Gasoline Dispensing & Storage Facilities	Volume	1.00	0.23

Notes:
1. Release height for the Gasoline Dispensing Facility conservatively assumed to equal 1.0 meter.

Table 4-6
Sector-Specific Surface Roughness, Bowen Ratio, and Albedo
BNSF Barstow Rail Yard
Barstow, California

Month	Sector No.	2001			2002			2004			2005			2006		
		Albedo	Bowen Ratio	Surface Roughness	Albedo	Bowen Ratio	Surface Roughness	Albedo	Bowen Ratio	Surface Roughness	Albedo	Bowen Ratio	Surface Roughness	Albedo	Bowen Ratio	Surface Roughness
Jan		0.24	4.29	0.60	0.25	8.30	0.50	0.24	4.29	0.60	0.24	1.57	0.60	0.24	7.43	0.60
Feb		0.24	4.29	0.60	0.25	8.30	0.50	0.24	4.29	0.60	0.24	1.57	0.60	0.24	7.43	0.60
Mar		0.23	2.14	0.60	0.25	4.15	0.50	0.23	2.14	0.60	0.23	2.14	0.60	0.23	2.14	0.60
Apr		0.23	3.14	0.60	0.25	5.43	0.50	0.23	3.14	0.60	0.23	3.14	0.60	0.23	3.14	0.60
May		0.23	3.14	0.60	0.25	5.43	0.50	0.23	3.14	0.60	0.23	3.14	0.60	0.23	3.14	0.60
Jun	1	0.23	3.72	0.60	0.25	6.87	0.50	0.23	3.72	0.60	0.23	1.43	0.60	0.23	6.29	0.60
Jul		0.23	3.72	0.60	0.25	6.87	0.50	0.23	3.72	0.60	0.23	1.43	0.60	0.23	6.29	0.60
Aug		0.23	3.72	0.60	0.25	6.87	0.50	0.23	3.72	0.60	0.23	1.43	0.60	0.23	6.29	0.60
Sep		0.23	3.72	0.60	0.25	6.87	0.50	0.23	3.72	0.60	0.23	1.43	0.60	0.23	6.29	0.60
Oct		0.23	3.72	0.60	0.25	6.87	0.50	0.23	3.72	0.60	0.23	1.43	0.60	0.23	6.29	0.60
Nov		0.23	3.72	0.60	0.25	6.87	0.50	0.23	3.72	0.60	0.23	1.43	0.60	0.23	6.29	0.60
Dec		0.24	4.29	0.60	0.25	8.30	0.50	0.24	4.29	0.60	0.24	1.57	0.60	0.24	7.43	0.60
Jan		0.25	4.87	0.50	0.21	5.70	0.80	0.25	4.87	0.50	0.25	1.72	0.50	0.25	8.30	0.50
Feb		0.25	4.87	0.50	0.21	5.70	0.80	0.25	4.87	0.50	0.25	1.72	0.50	0.25	8.30	0.50
Mar		0.25	2.43	0.50	0.19	2.85	0.80	0.25	2.43	0.50	0.25	2.43	0.50	0.25	2.43	0.50
Apr		0.25	3.43	0.50	0.19	4.56	0.80	0.25	3.43	0.50	0.25	3.43	0.50	0.25	3.43	0.50
May		0.25	3.43	0.50	0.19	4.56	0.80	0.25	3.43	0.50	0.25	3.43	0.50	0.25	3.43	0.50
Jun	2	0.25	4.15	0.50	0.20	5.13	0.80	0.25	4.15	0.50	0.25	1.54	0.50	0.25	6.87	0.50
Jul		0.25	4.15	0.50	0.20	5.13	0.80	0.25	4.15	0.50	0.25	1.54	0.50	0.25	6.87	0.50
Aug		0.25	4.15	0.50	0.20	5.13	0.80	0.25	4.15	0.50	0.25	1.54	0.50	0.25	6.87	0.50
Sep		0.25	4.15	0.50	0.20	5.13	0.80	0.25	4.15	0.50	0.25	1.54	0.50	0.25	6.87	0.50
Oct		0.25	4.15	0.50	0.20	5.13	0.80	0.25	4.15	0.50	0.25	1.54	0.50	0.25	6.87	0.50
Nov		0.25	4.15	0.50	0.20	5.13	0.80	0.25	4.15	0.50	0.25	1.54	0.50	0.25	6.87	0.50
Dec		0.25	4.87	0.50	0.21	5.70	0.80	0.25	4.87	0.50	0.25	1.72	0.50	0.25	8.30	0.50
Jan		0.21	3.13	0.80	0.23	6.77	0.67	0.21	3.13	0.80	0.21	1.28	0.80	0.21	5.70	0.80
Feb		0.21	3.13	0.80	0.23	6.77	0.67	0.21	3.13	0.80	0.21	1.28	0.80	0.21	5.70	0.80
Mar		0.19	1.57	0.80	0.21	3.39	0.67	0.19	1.57	0.80	0.19	1.57	0.80	0.19	1.57	0.80
Apr		0.19	2.57	0.80	0.22	4.92	0.67	0.19	2.57	0.80	0.19	2.57	0.80	0.19	2.57	0.80
May		0.19	2.57	0.80	0.22	4.92	0.67	0.19	2.57	0.80	0.19	2.57	0.80	0.19	2.57	0.80
Jun	3	0.20	2.85	0.80	0.22	5.85	0.67	0.20	2.85	0.80	0.20	1.21	0.80	0.20	5.13	0.80
Jul		0.20	2.85	0.80	0.22	5.85	0.67	0.20	2.85	0.80	0.20	1.21	0.80	0.20	5.13	0.80
Aug		0.20	2.85	0.80	0.22	5.85	0.67	0.20	2.85	0.80	0.20	1.21	0.80	0.20	5.13	0.80
Sep		0.20	2.85	0.80	0.22	5.85	0.67	0.20	2.85	0.80	0.20	1.21	0.80	0.20	5.13	0.80
Oct		0.20	2.85	0.80	0.22	5.85	0.67	0.20	2.85	0.80	0.20	1.21	0.80	0.20	5.13	0.80
Nov		0.20	2.85	0.80	0.22	5.85	0.67	0.20	2.85	0.80	0.20	1.21	0.80	0.20	5.13	0.80
Dec		0.21	3.13	0.80	0.23	6.77	0.67	0.21	3.13	0.80	0.21	1.28	0.80	0.21	5.70	0.80

Table 4-6
Sector-Specific Surface Roughness, Bowen Ratio, and Albedo
BNSF Barstow Rail Yard
Barstow, California

Month	Sector No.	2001			2002			2004			2005			2006		
		Albedo	Bowen Ratio	Surface Roughness	Albedo	Bowen Ratio	Surface Roughness	Albedo	Bowen Ratio	Surface Roughness	Albedo	Bowen Ratio	Surface Roughness	Albedo	Bowen Ratio	Surface Roughness
Jan		0.23	3.85	0.67	0.26	8.69	0.45	0.23	3.85	0.67	0.23	1.46	0.67	0.23	6.77	0.67
Feb		0.23	3.85	0.67	0.26	8.69	0.45	0.23	3.85	0.67	0.23	1.46	0.67	0.23	6.77	0.67
Mar		0.21	1.92	0.67	0.27	4.35	0.45	0.21	1.92	0.67	0.21	1.92	0.67	0.21	1.92	0.67
Apr		0.22	2.92	0.67	0.25	5.56	0.45	0.22	2.92	0.67	0.22	2.92	0.67	0.22	2.92	0.67
May		0.22	2.92	0.67	0.25	5.56	0.45	0.22	2.92	0.67	0.22	2.92	0.67	0.22	2.92	0.67
Jun	4	0.22	3.39	0.67	0.26	7.13	0.45	0.22	3.39	0.67	0.22	1.35	0.67	0.22	5.85	0.67
Jul		0.22	3.39	0.67	0.26	7.13	0.45	0.22	3.39	0.67	0.22	1.35	0.67	0.22	5.85	0.67
Aug		0.22	3.39	0.67	0.26	7.13	0.45	0.22	3.39	0.67	0.22	1.35	0.67	0.22	5.85	0.67
Sep		0.22	3.39	0.67	0.26	7.13	0.45	0.22	3.39	0.67	0.22	1.35	0.67	0.22	5.85	0.67
Oct		0.22	3.39	0.67	0.26	7.13	0.45	0.22	3.39	0.67	0.22	1.35	0.67	0.22	5.85	0.67
Nov		0.22	3.39	0.67	0.26	7.13	0.45	0.22	3.39	0.67	0.22	1.35	0.67	0.22	5.85	0.67
Dec		0.23	3.85	0.67	0.26	8.69	0.45	0.23	3.85	0.67	0.23	1.46	0.67	0.23	6.77	0.67
Jan		0.26	5.13	0.45	0.24	7.43	0.60	0.26	5.13	0.45	0.26	1.78	0.45	0.26	8.69	0.45
Feb		0.26	5.13	0.45	0.24	7.43	0.60	0.26	5.13	0.45	0.26	1.78	0.45	0.26	8.69	0.45
Mar		0.27	2.56	0.45	0.23	3.72	0.60	0.27	2.56	0.45	0.27	2.56	0.45	0.27	2.56	0.45
Apr		0.25	3.56	0.45	0.23	5.14	0.60	0.25	3.56	0.45	0.25	3.56	0.45	0.25	3.56	0.45
May		0.25	3.56	0.45	0.23	5.14	0.60	0.25	3.56	0.45	0.25	3.56	0.45	0.25	3.56	0.45
Jun	5	0.26	4.35	0.45	0.23	6.29	0.60	0.26	4.35	0.45	0.26	1.59	0.45	0.26	7.13	0.45
Jul		0.26	4.35	0.45	0.23	6.29	0.60	0.26	4.35	0.45	0.26	1.59	0.45	0.26	7.13	0.45
Aug		0.26	4.35	0.45	0.23	6.29	0.60	0.26	4.35	0.45	0.26	1.59	0.45	0.26	7.13	0.45
Sep		0.26	4.35	0.45	0.23	6.29	0.60	0.26	4.35	0.45	0.26	1.59	0.45	0.26	7.13	0.45
Oct		0.26	4.35	0.45	0.23	6.29	0.60	0.26	4.35	0.45	0.26	1.59	0.45	0.26	7.13	0.45
Nov		0.26	4.35	0.45	0.23	6.29	0.60	0.26	4.35	0.45	0.26	1.59	0.45	0.26	7.13	0.45
Dec		0.26	5.13	0.45	0.24	7.43	0.60	0.26	5.13	0.45	0.26	1.78	0.45	0.26	8.69	0.45

Table 4-7
Approximate Dimensions of Buildings at the Facility
BNSF Barstow Rail Yard
Barstow, California

Building/ Structure ID	Building Name	UTM X (m)	UTM Y (m)	Approximate Footprint Dimensions[1] (m)	Height[2] (m)
1	Auxiliary Diesel Wash	492549.96	3861001.57	12 m x 24 m	14.04
2	Wastewater Treatment Plant	492539.98	3861045.87	25 m x 56 m	14.04
3	WW Equalization Tank	492615.09	3861087.24	14 m (diameter)	21.05
4a	Shop Facility Dry Storage/Shop Extension	492687.01	3861007.57	9 m x 11 m	6.68
4b-1	Power Plant	492696.35	3861019.69	6 m x 5 m	3.35
4b-2	Power Plant	492700.52	3861021.67	13 m x 11 m	6.68
5a	Diesel Fuel Storage Tanks	492791.86	3861191.45	35 m (diameter)	14.04
5b	Diesel Fuel Storage Tanks	492816.46	3861205.03	35 m (diameter)	14.04
6a	Running Repair Building	492807.54	3861100.15	22 m x 140 m	14.04
6b	Sand Truck Shed	492917.56	3861060.83	8 m x 23 m	9.36
7a	BNSF Administration Office	493080.25	3861293.46	40 m x 65 m	6.68
7b	BNSF Administration Office	493052.23	3861253.43	6 m x 14 m	3.35
8-1	Planner's Office/Shop Tower	493050.46	3861175.84	13 m x 44 m	6.68
8-2	Planner's Office/Shop Tower	493056.62	3861175.25	10 m x 10 m	13.35
9	GE Warehouse	493072.46	3861096.63	16 m x 56 m	6.68
10a	Locomotive Maintenance Building	493210.64	3861250.65	73 m x 85 m	14.40
10b	Storehouse	493169.86	3861233.63	10 m x 34 m	6.68
10c	Locomotive Maintenance Building	493221.79	3861201.95	9 m x 30 m	3.35
10d	Locomotive Maintenance Building	493329.16	3861224.54	9 m x 24 m	6.68
11-1	GE Administration Building	493304.61	3861354.67	8 m x 34 m	3.35
11-2	GE Administration Building	493308.57	3861347.93	16 m x 30 m	6.68
12	Shop Work Equipment Maintenance Area	494188.46	3861462.19	7 m x 13 m	3.35
13	Former Maintenance Building	494258.64	3861557.92	14 m x 24 m	3.35
14	Track Maintenance Building	494521.16	3861367.20	20 m x 14 m	3.35
15	Car Department Administration Office	494531.57	3861514.23	13 m x 26 m	3.35
16a	Car Warehouse/Store Area	494566.92	3861572.83	52 m x 50 m	14.04
16b-1	Fab Shed	494664.38	3861545.32	11 m x 9 m	9.36
16b-2	Fab Shed	494656.47	3861550.54	7 m x 23 m	14.04
17a	Trainmen's Assignment Building	494665.42	3861446.07	9 m x 19 m	3.35
17b	Trainmen's Assignment Building	494669.57	3861449.72	7 m x 19 m	3.35
18	Former Refrigerator Car Building	494659.45	3861672.12	6 m x 25 m	3.35
19a-1	Hump Yard Tower	495045.24	3861623.99	18 m x 27 m	3.35
19a-2	Hump Yard Tower	495076.81	3861633.53	10 m x 10 m	10.06
19b	Hump Yard Building	495083.22	3861647.01	10 m x 16 m	3.35
20	Facility Air Compressors	495229.81	3861730.76	9 m x 24 m	5.03
21a	Caboose Building	495640.00	3861896.22	10 m x 30 m	6.68
21b	Caboose Building	495605.80	3861887.00	8 m x 13 m	3.35
22-1	Bowl Tower	496431.98	3862191.46	7 m x 39 m	3.35
22-2	Bowl Tower	496447.73	3862195.13	7 m x 11 m	10.06

Notes:
1. Approximate footprint dimensions estimated based on aerial photograph of facility.
2. Building heights estimated based on previous yards and on aerial photograph of facility.

Table 4-8
Population Density Within Three Kilometers of the Facility
BNSF Barstow Rail Yard
Barstow, California

Location	Land Area Within 3 km (m^2)	Water Area Within 3 km (m^2)	Yard Area (m^2)	Total Population Within 3 km	Population Density ($people/km^2$)
Barstow, CA	176,340,737	0	2,045,354	28,463	163
USE URBAN BOUNDARY LAYER?					NO

Table 4-9
Locations of Sensitive Receptors Within One Mile of the Facility
BNSF Barstow Rail Yard
Barstow, California

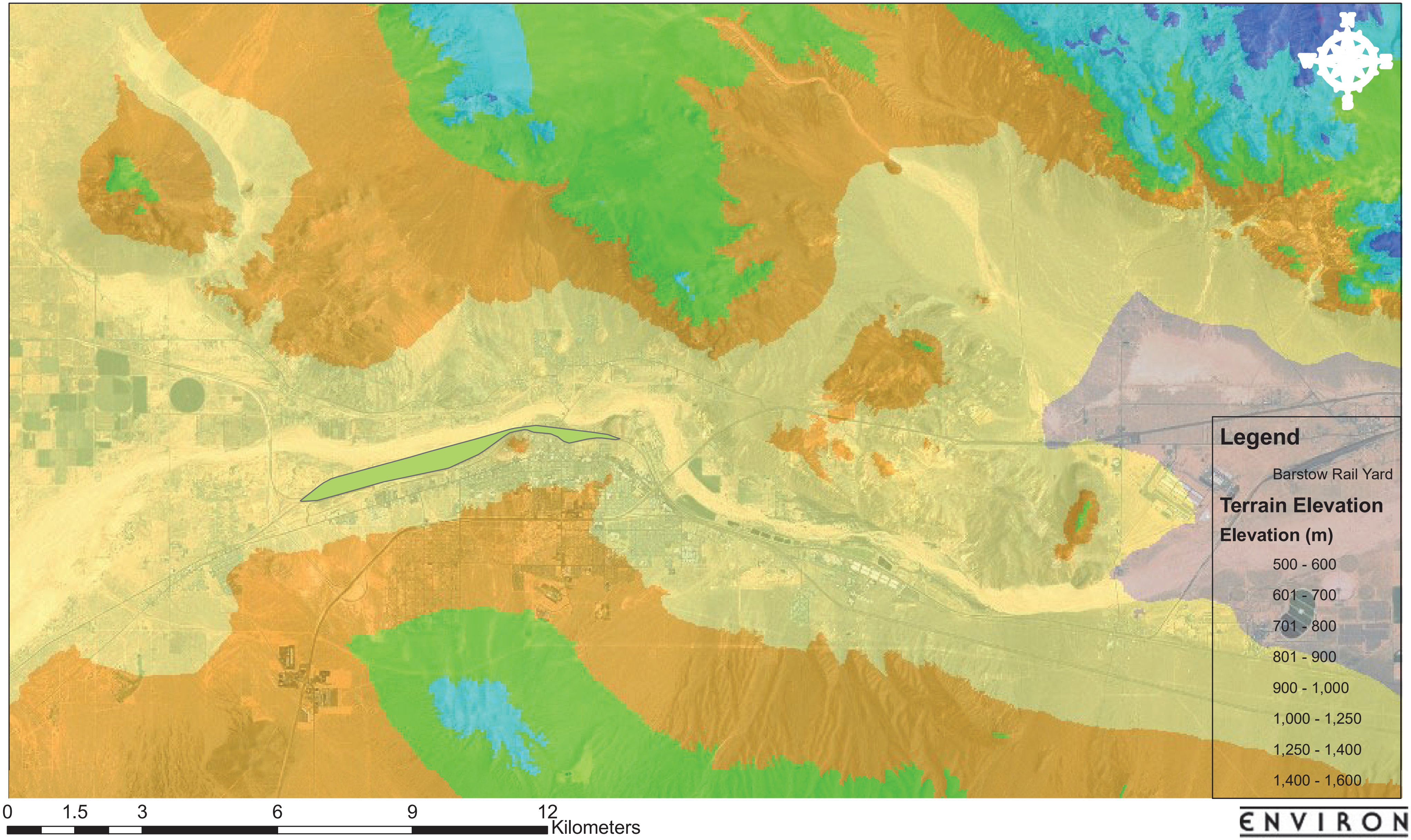
Facility	Address	City	Type	UTM X	UTM Y
Central High (cont.)	551 S. Avenue H	Barstow	Public School	495669.91	3860871.46
Cameron Elementary	801 Muriel Drive	Barstow	Public School	498897.04	3860930.60
Barstow Christian[1]	800 Yucca Avenue	Barstow	Private School	499248.10	3860997.66
Barstow Christian Preschool[1]	800 Yucca Avenue	Barstow	Childcare Center	499248.10	3860997.66
Desert Cities Dialysis of Barstow	655 S. 7th Street	Barstow	Hospital	498222.72	3861001.35
Barstow Middle	500 S. G Street	Barstow	Public School	495990.69	3861011.81
Concordia Christian School	420 Avenue E	Barstow	Childcare Center	496360.14	3861098.16
Henderson Elementary	400 S. Avenue E	Barstow	Public School	496366.27	3861115.56
PSD/Barstow Head Start	25757 Agate Road	Barstow	Childcare Center	490820.61	3861125.66
Visiting Nurse Assn. of the Inland, Co. - Barstow Branch	222 E. Main Street, No. 112	Barstow	Hospital	497640.18	3861173.70
Barstow High	430 S. 1st Street	Barstow	Public School	497454.63	3861260.14
Barstow Community Hospital	555 S. 7th Avenue	Barstow	Hospital	498217.02	3861277.03
Barstow COGIC Christian School[1]	1375 Sage Drive	Barstow	Private School	499984.74	3862044.91
Barstow Cogic Children Center[1]	1375 Sage Drive	Barstow	Childcare Center	499984.74	3862044.91

Note:
1. Although addresses are identical, buildings are modeled as separate sources because they are different service types.

Sources:
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. Community Care Licensing Division, State of California (http://www.ccld.ca.gov/docs/ccld_search/ccld_search.aspx)

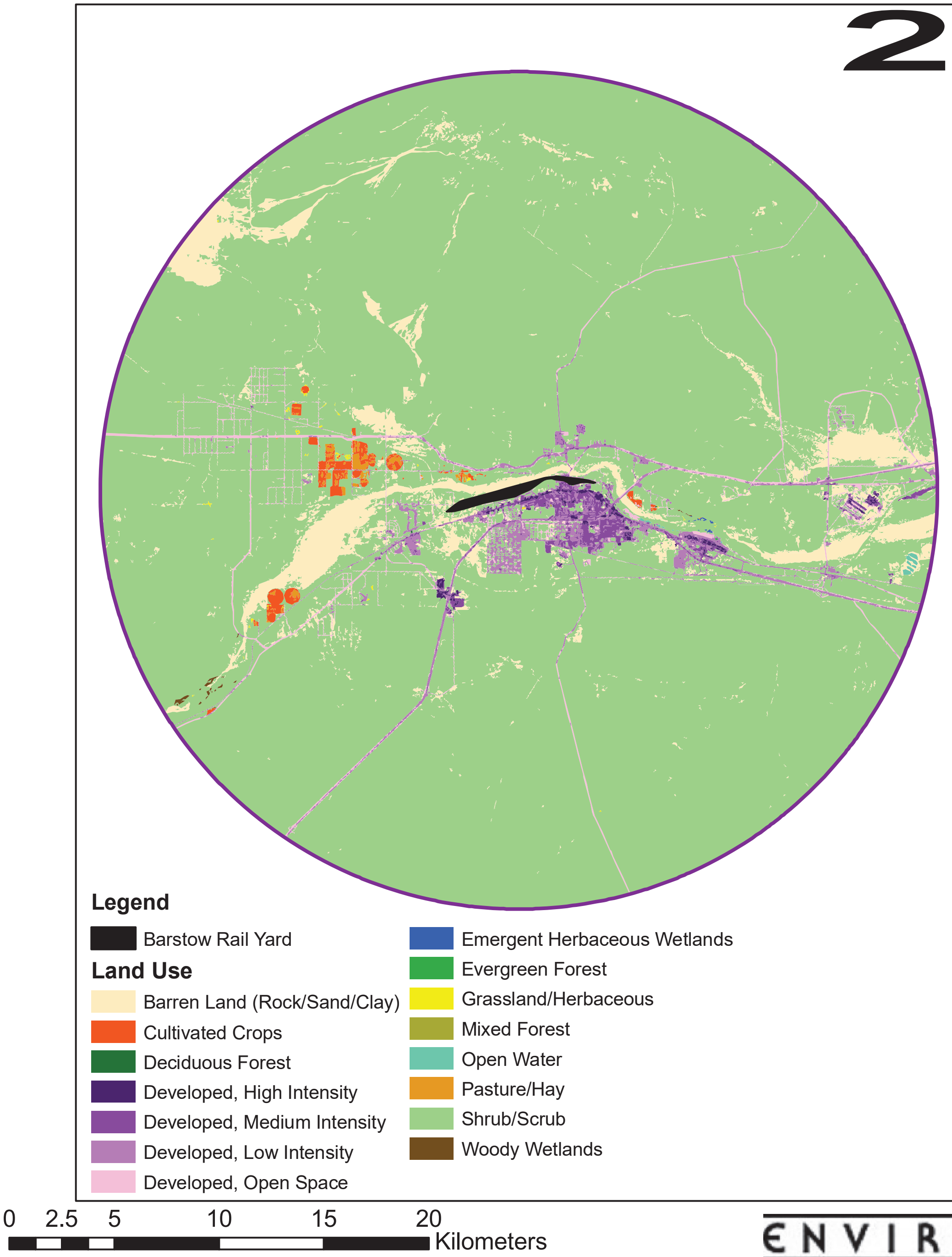
Figure 2-1a: General Facility Location
BNSF Barstow Rail Yard
Barstow, California

Figure 2-1b: Barstow Terrain Map
BNSF Barstow Rail Yard
Barstow, California



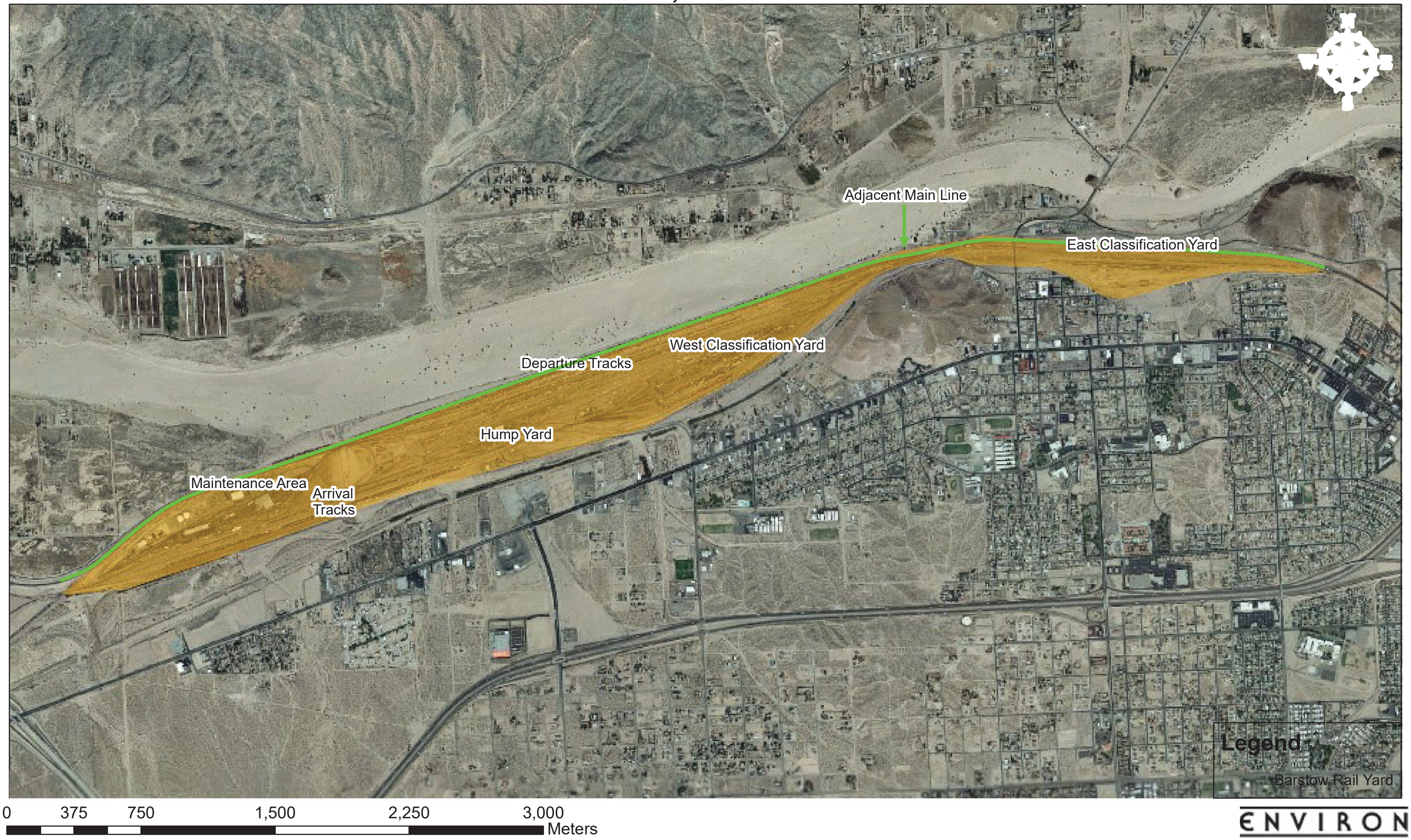
ENVIRON

Figure 2-2: Land Use Within Twenty Kilometers of Facility
BNSF Barstow Rail Yard
Barstow, California



ENVIRON

Figure 2-3: General Locations of Operational Areas at the Facility
BNSF Barstow Rail Yard
Barstow, California



ENVIRON

Figure 2-4: Stationary and Movement Locomotive Activities - Basic Services in Maintenance Area
BNSF Barstow Rail Yard
Barstow, California

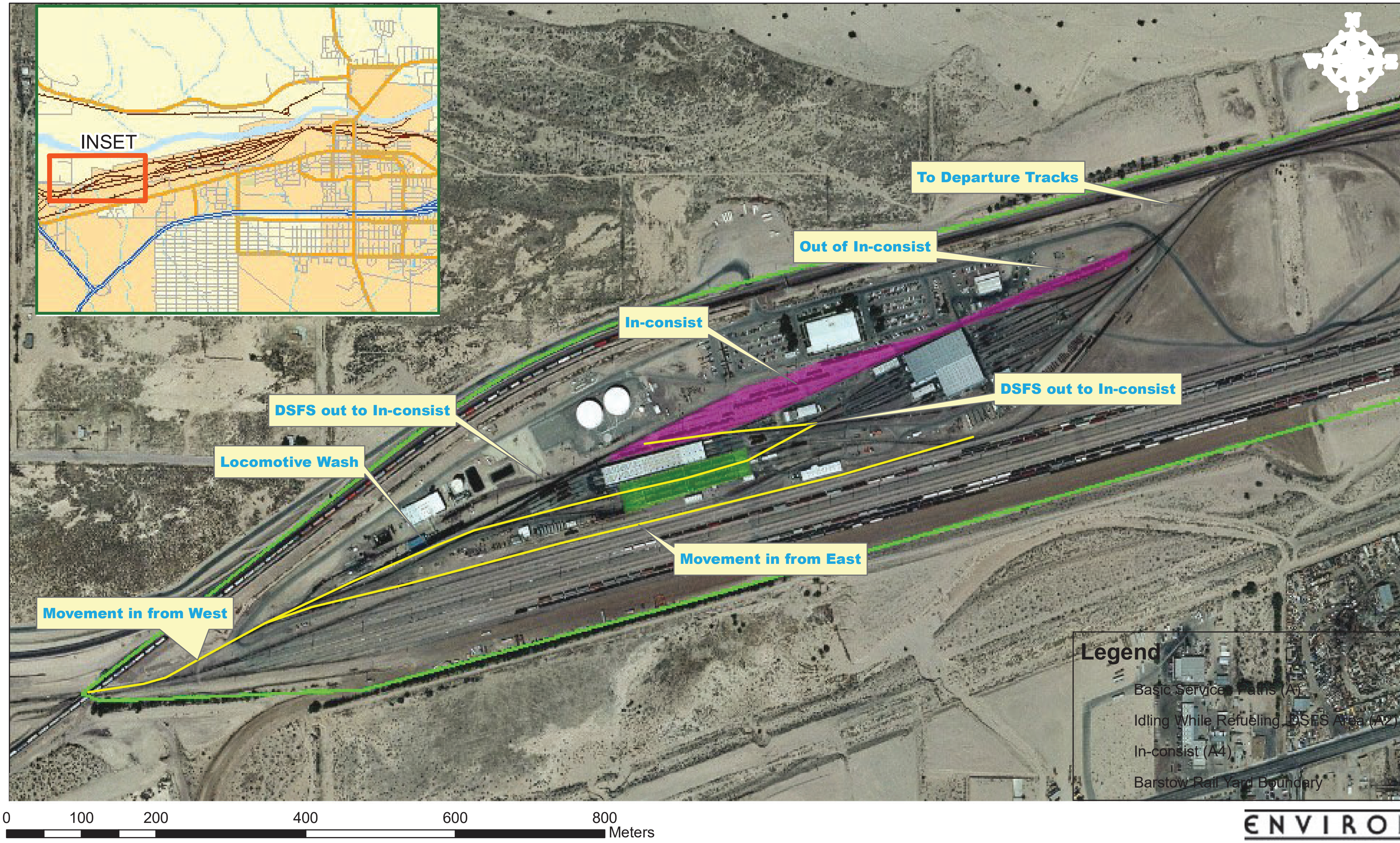


Figure 2-5: Stationary and Movement Locomotive Activities - Engine Test in Maintenance Area
BNSF Barstow Rail Yard
Barstow, California

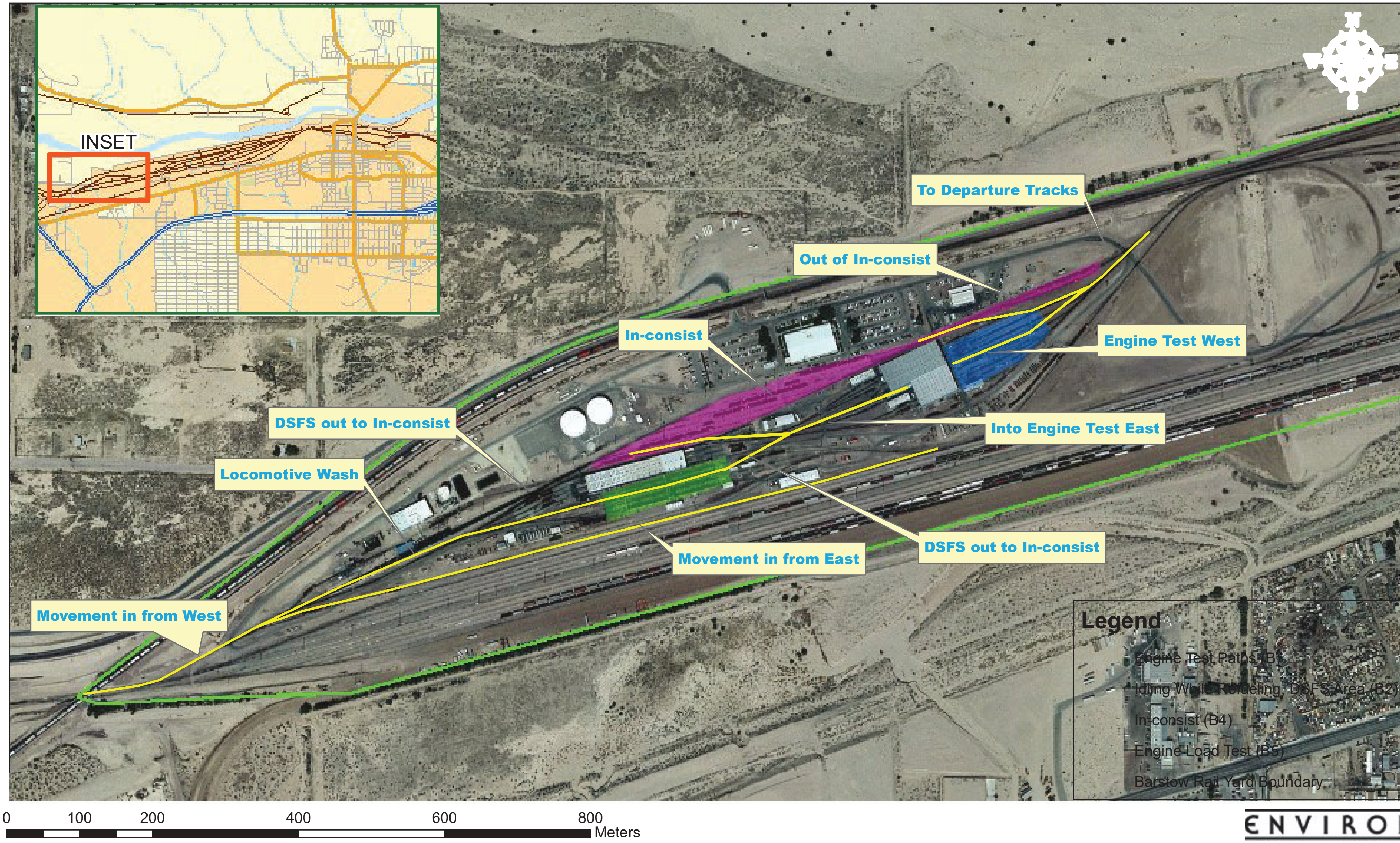


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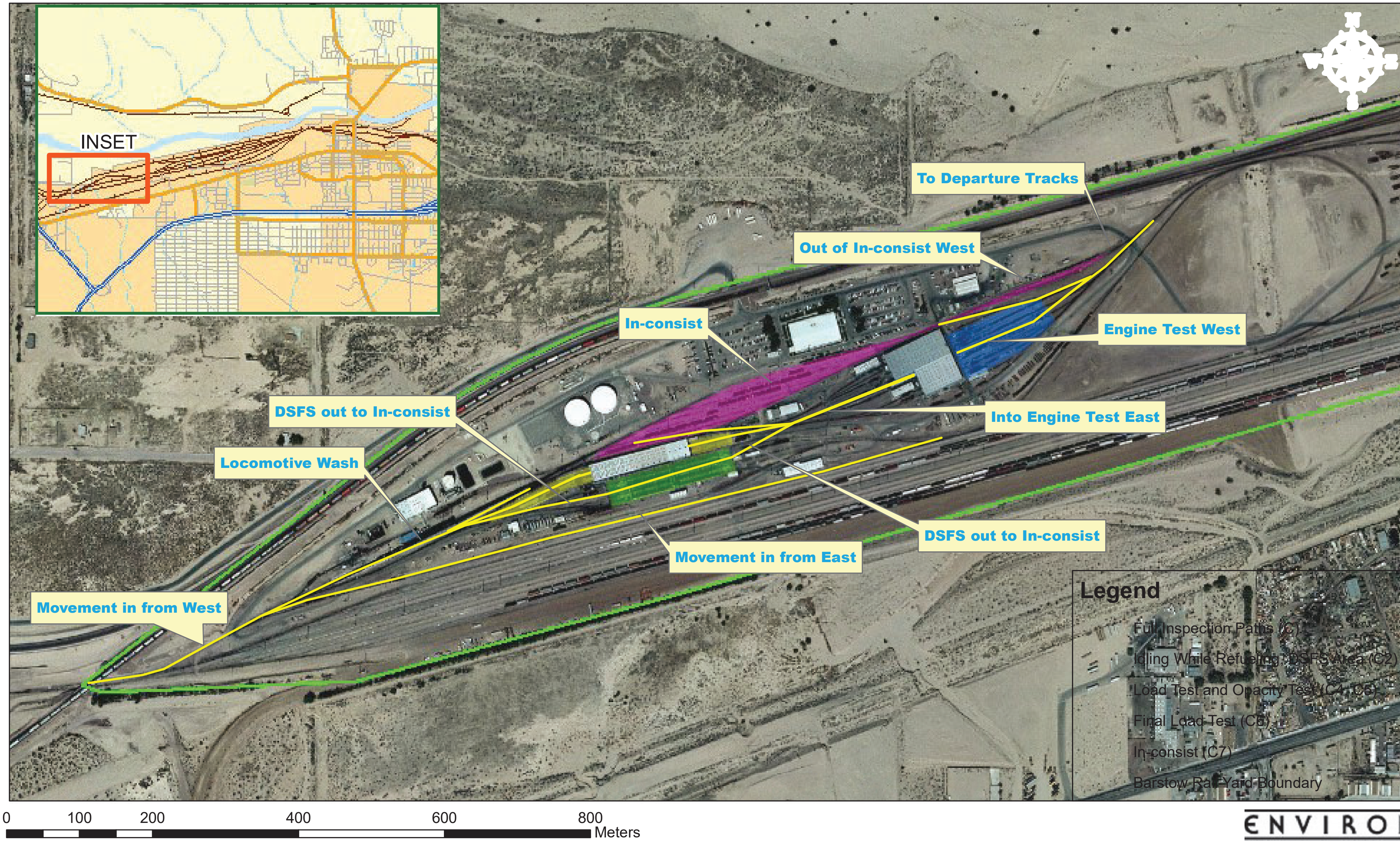
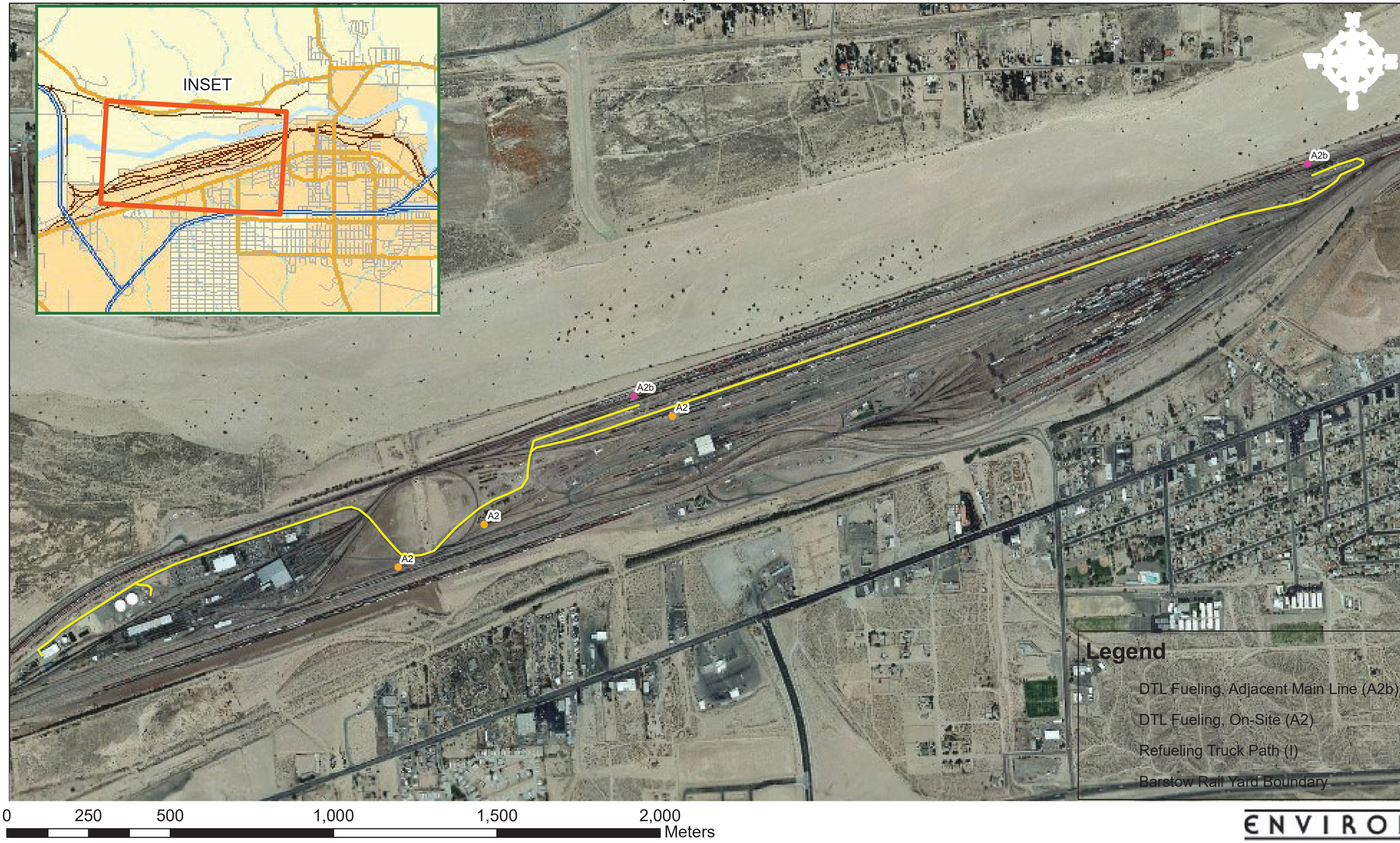
Figure 2-6: Stationary and Movement Locomotive Activities - Full Inspection in Maintenance Area
BNSF Barstow Rail Yard
Barstow, California



ENVIRON

Figure 2-7: Stationary Locomotive Refueling at DTL Areas and On-Site Refueling Truck Activities
BNSF Barstow Rail Yard
Barstow, California



ENVIRON

Figure 2-8: BNSF On-Road Fleet Activity
BNSF Barstow Rail Yard
Barstow, California

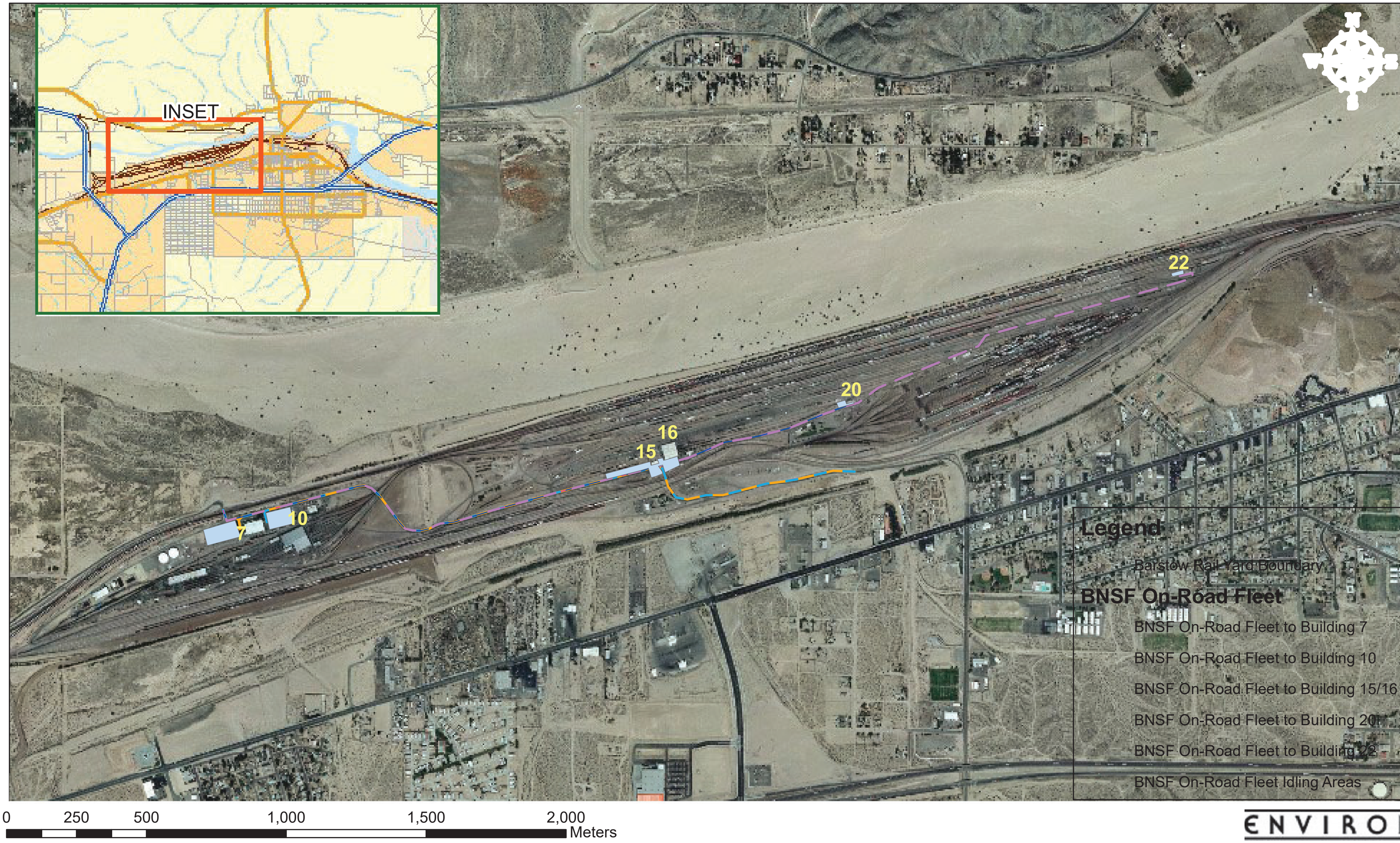


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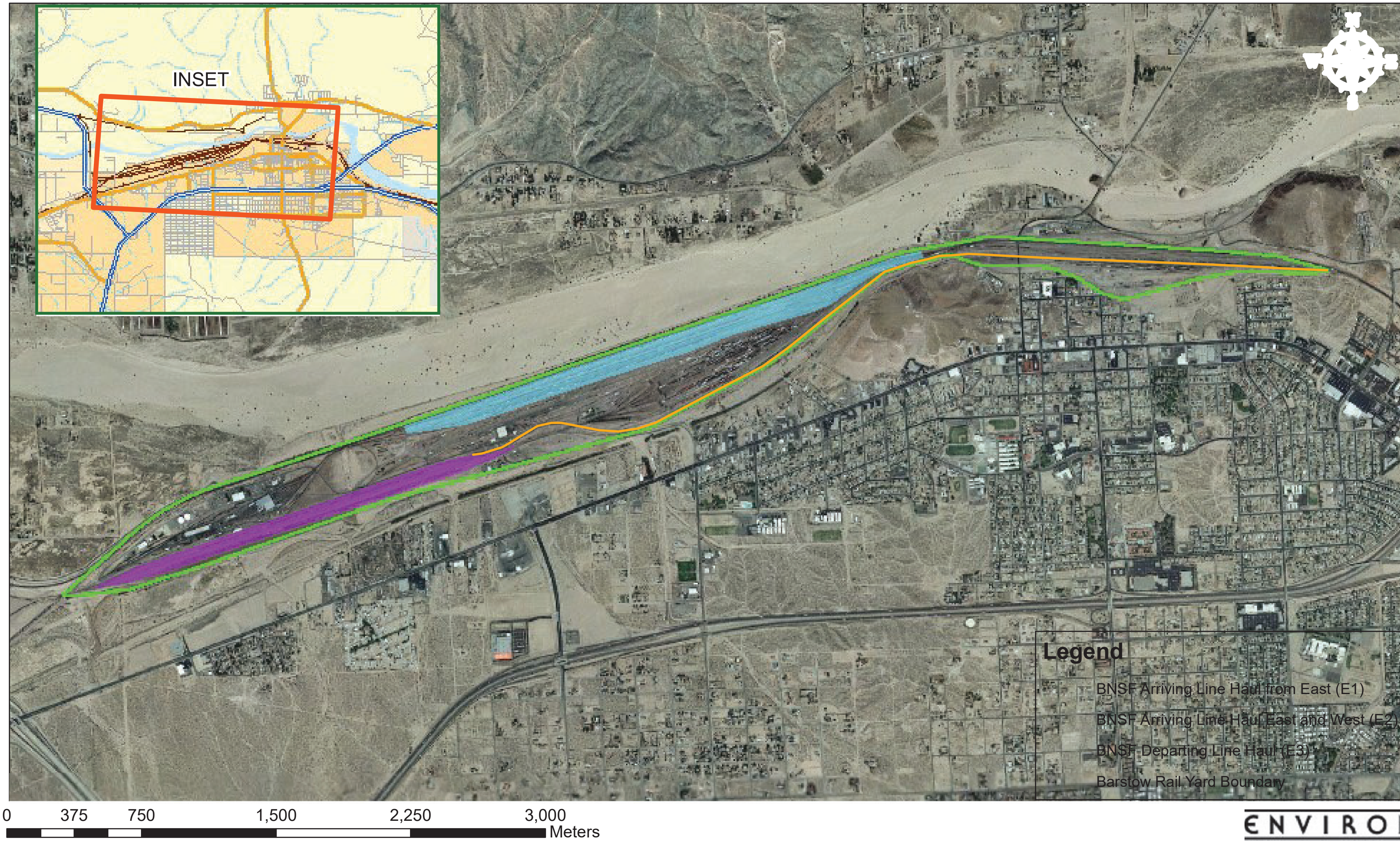
Figure 2-9: Permitted Stationary Sources
BNSF Barstow Rail Yard
Barstow, California

ENVIRON

Figure 2-10: Stationary and Movement Locomotives Activities - BNSF Arriving-Departing Line Haul
BNSF Barstow Rail Yard
Barstow, California



ENVIRON

Figure 2-11: Off-Road Equipment - Track Maintenance Equipment and Transportation Refrigeration Units
BNSF Barstow Rail Yard
Barstow, California

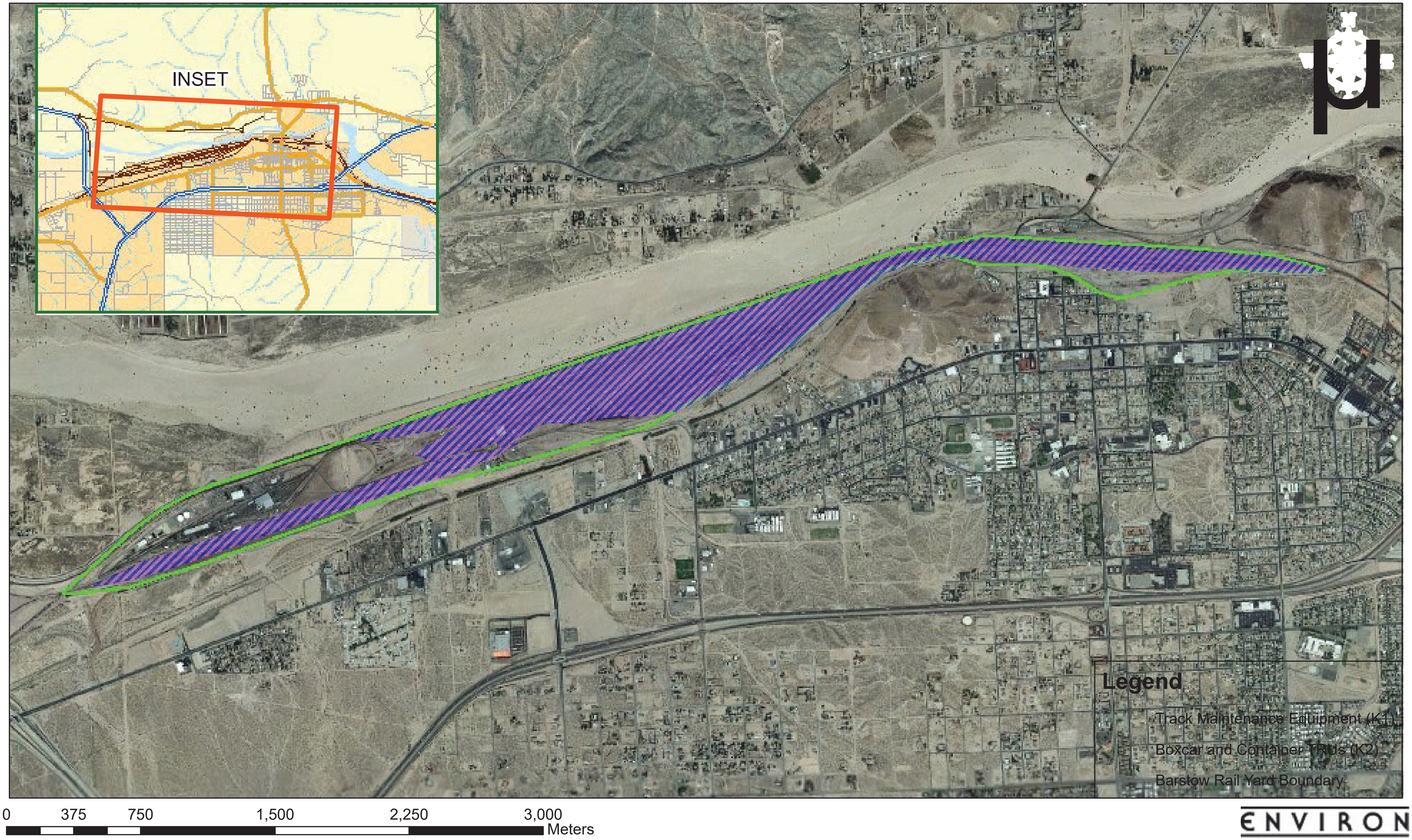


Figure 2-12: Material Handling Equipment
BNSF Barstow Rail Yard
Barstow, California

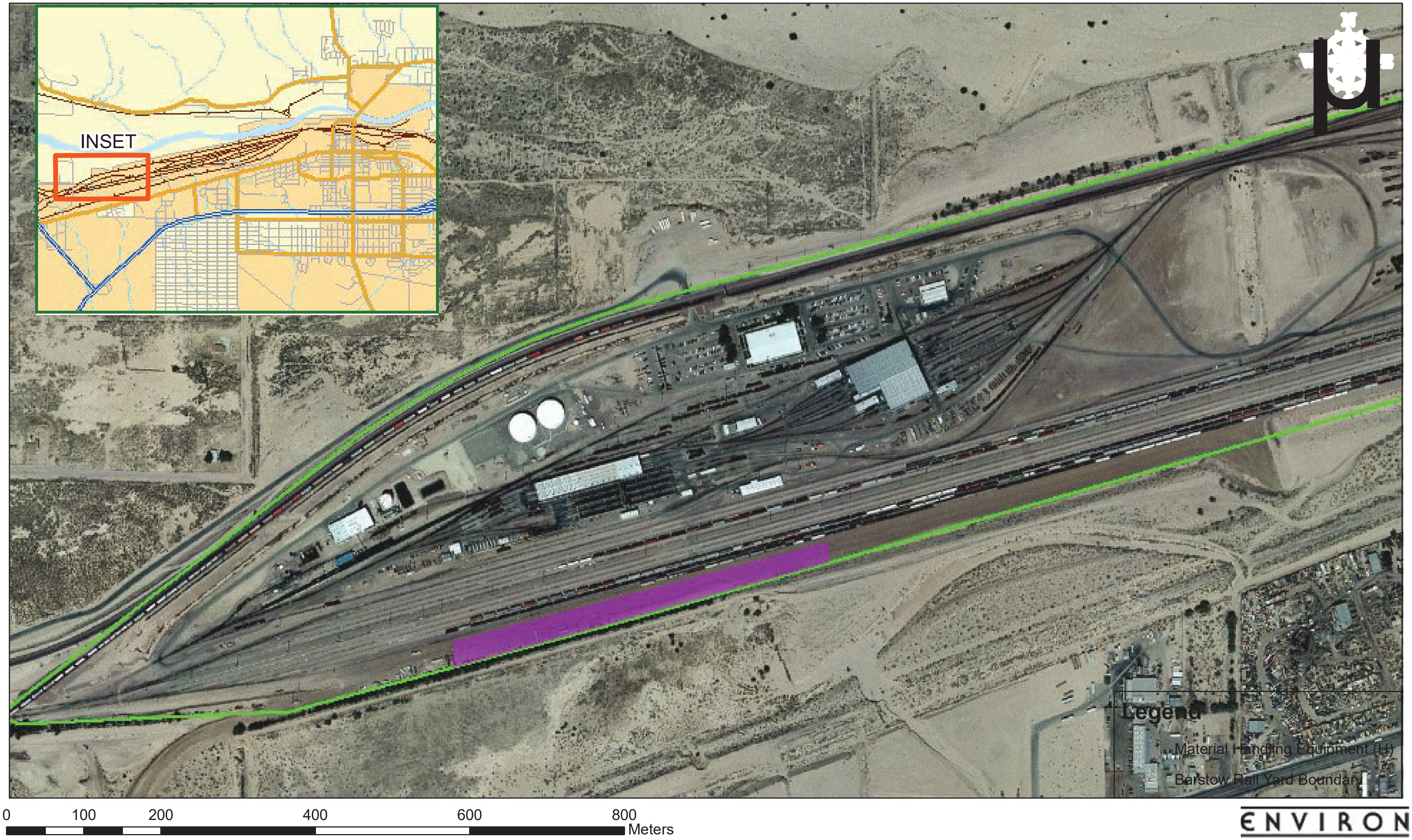


Figure 2-13: Stationary and Movement Locomotives Activities - Switching
BNSF Barstow Rail Yard
Barstow, California

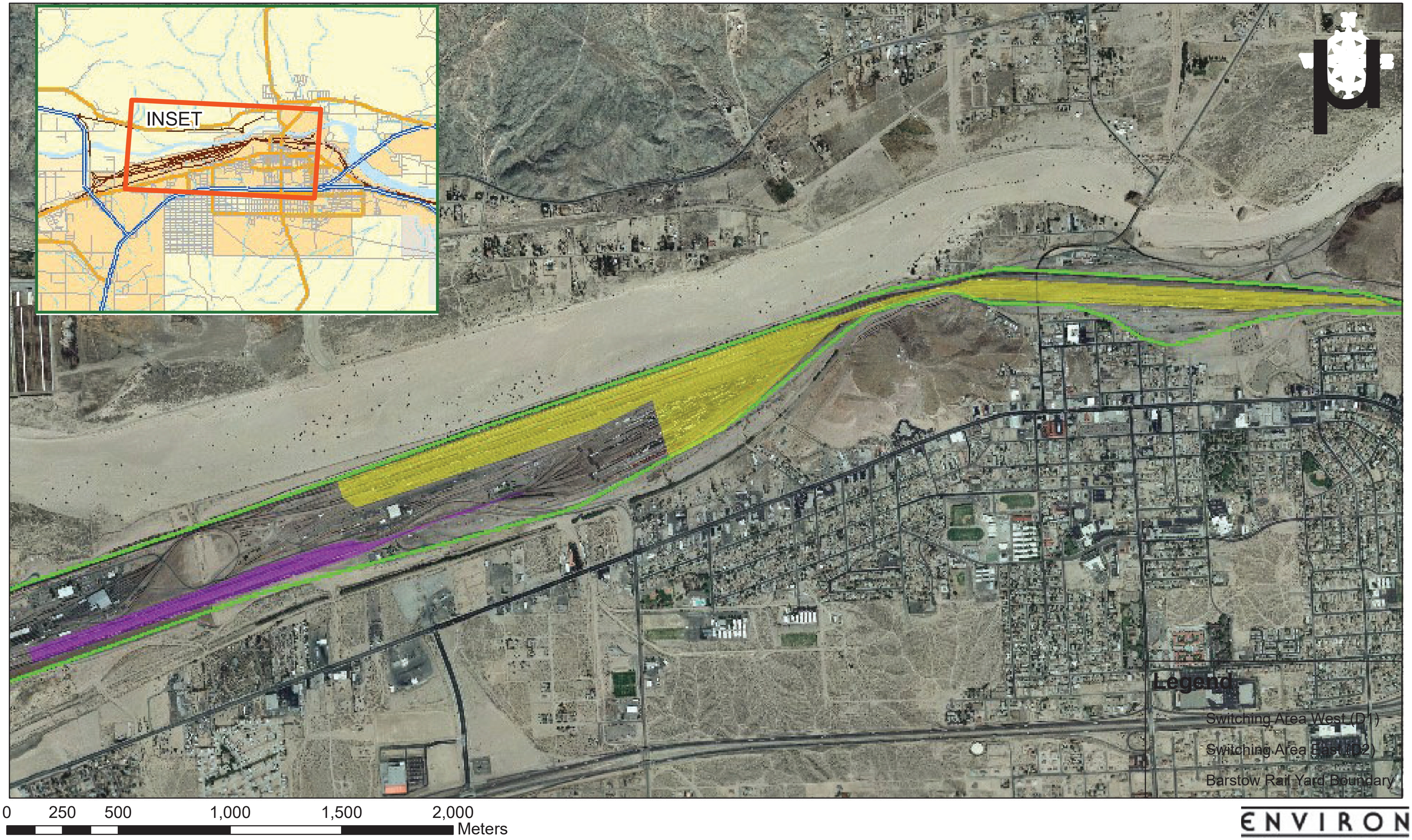


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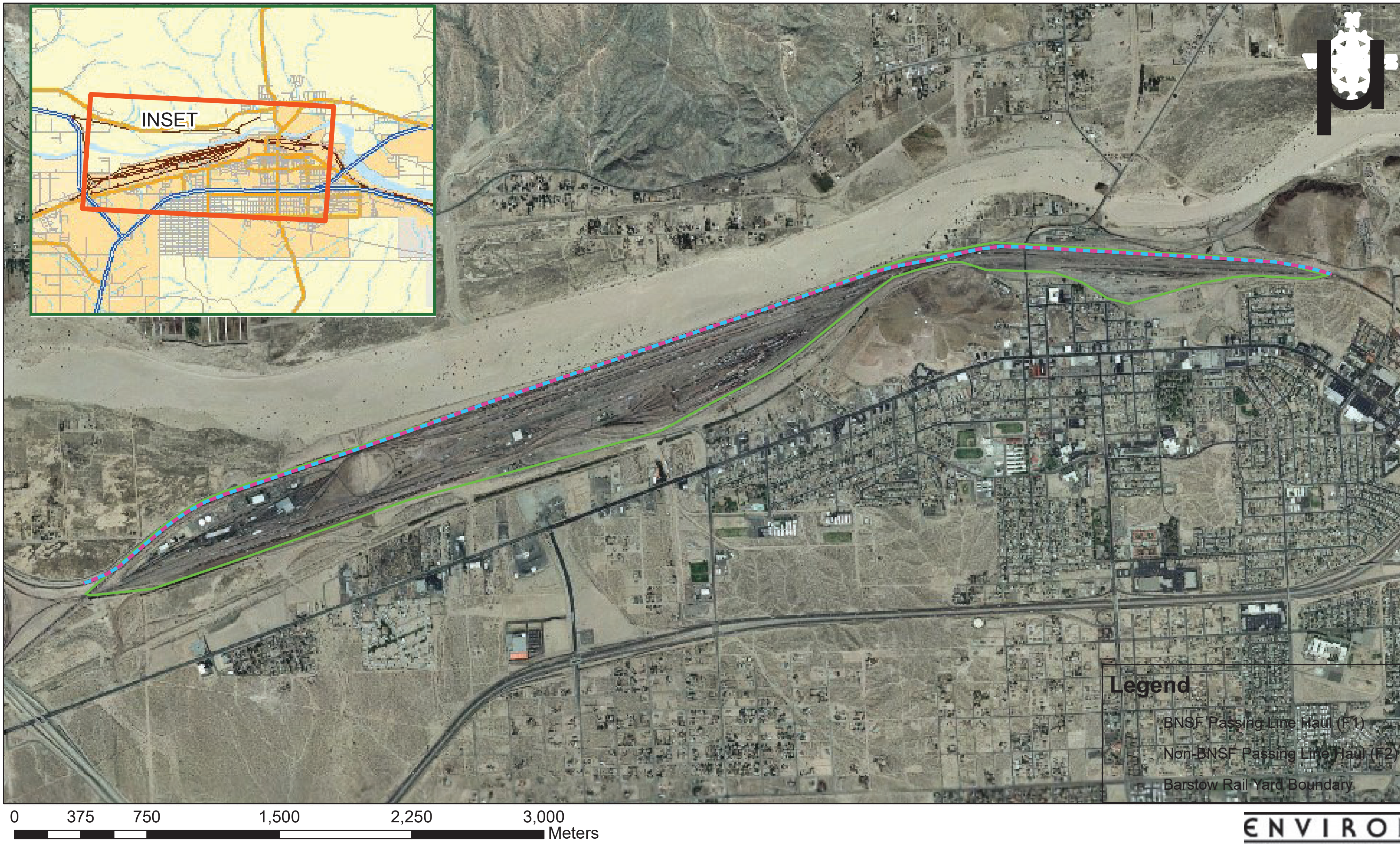
Figure 2-14: Stationary and Movement Locomotives Activities - Passing Line Haul (BNSF and Non-BNSF)
BNSF Barstow Rail Yard
Barstow, California



ENVIRON

Figure 2-15: Stationary and Movement Locomotives Activities - Passenger Rail
BNSF Barstow Rail Yard
Barstow, California

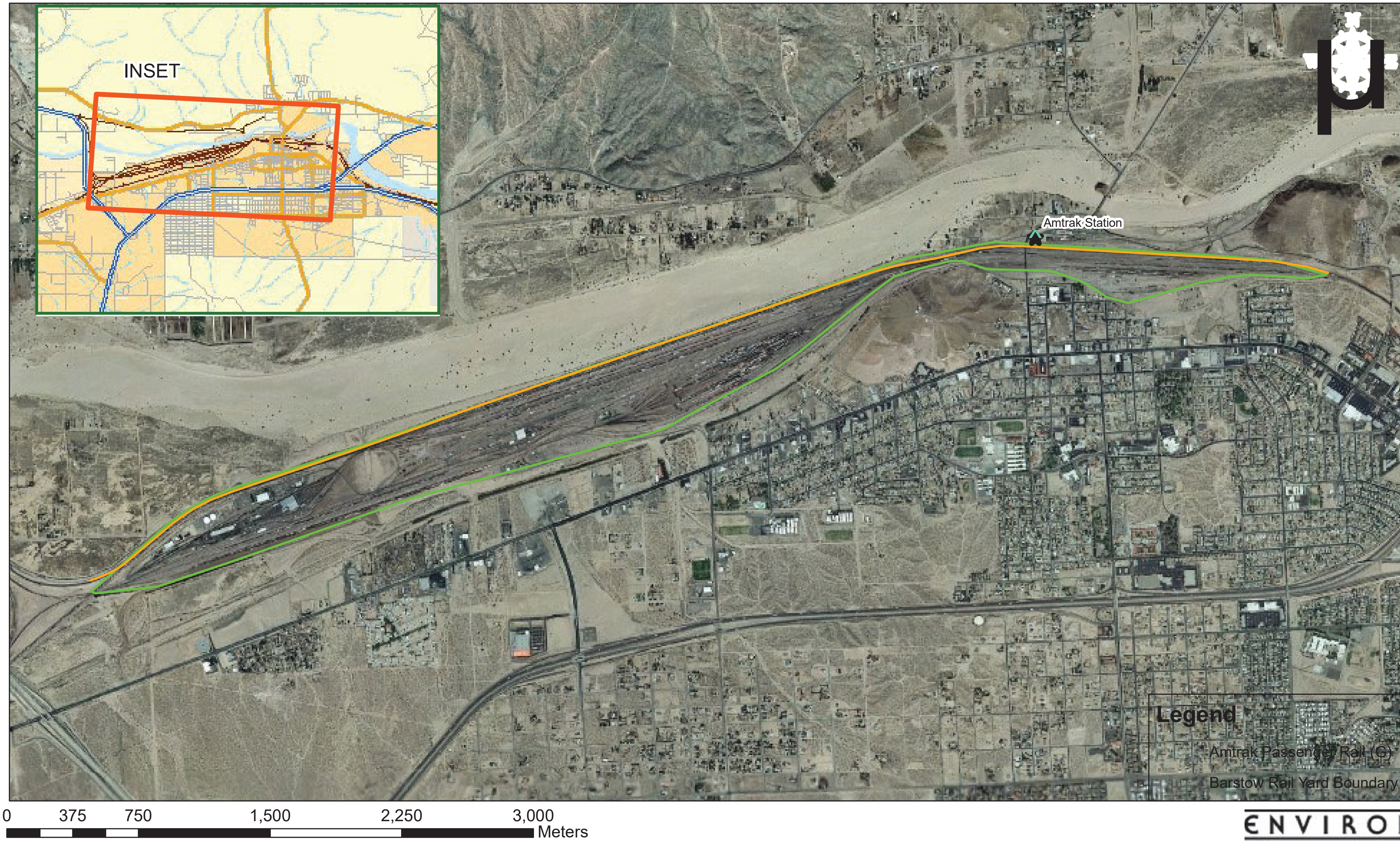


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Figure 4-1a: Locations of Modeled Stationary Locomotive Sources - Idling in Maintenance Yard
BNSF Barstow Rail Yard
Barstow, California

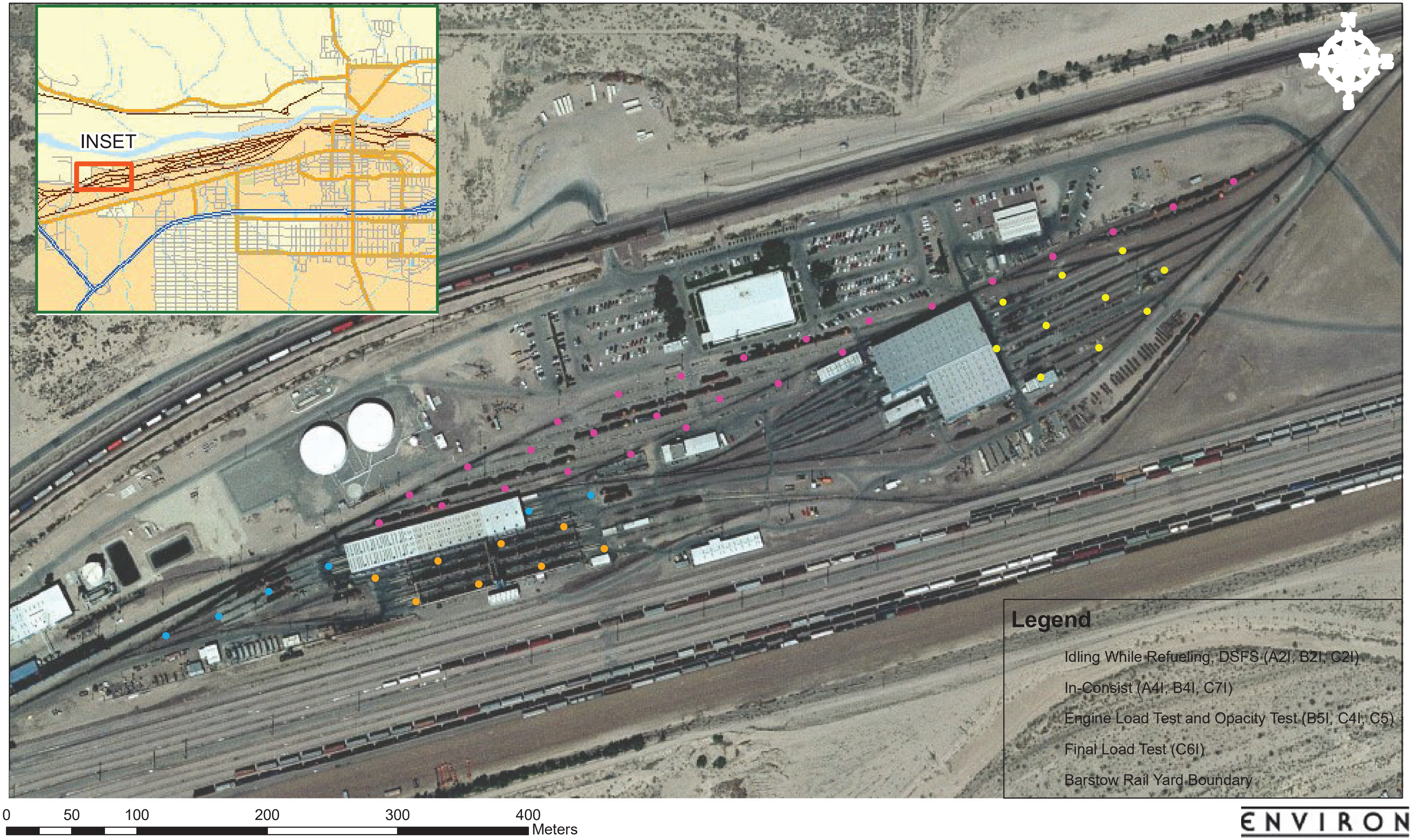

Figure 4-1b: Locations of Modeled Stationary Locomotive Sources - Switching and Idling at DTL Refueling Sites
BNSF Barstow Rail Yard
Barstow, California

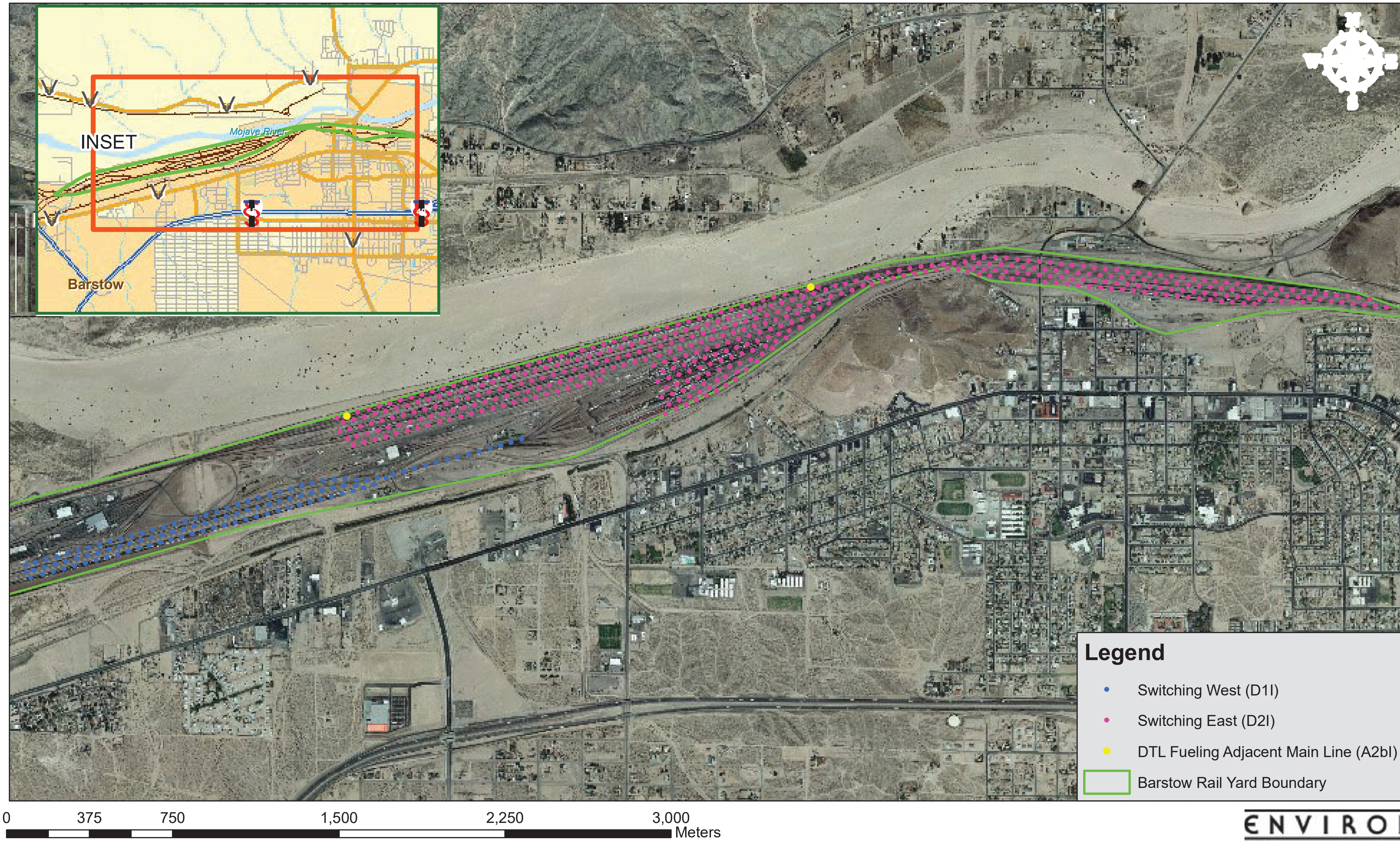

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Figure 4-1c: Locations of Modeled Stationary Locomotive Sources - BNSF Arriving-Departing Line Haul
BNSF Barstow Rail Yard
Barstow, California

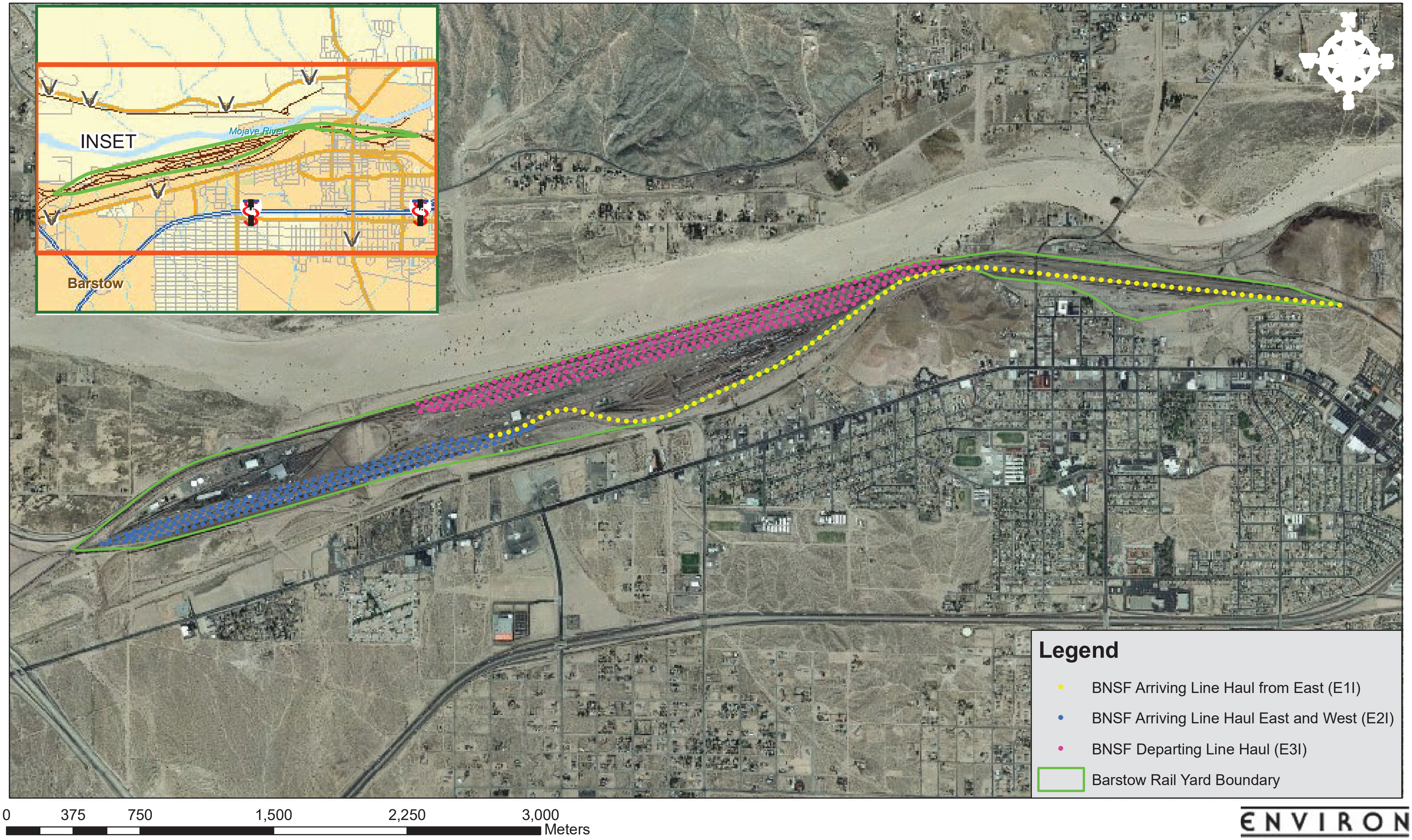

Figure 4-1d: Locations of Modeled Stationary Locomotive Sources - Passing Line Haul (BNSF and Non-BNSF)
BNSF Barstow Rail Yard
Barstow, California

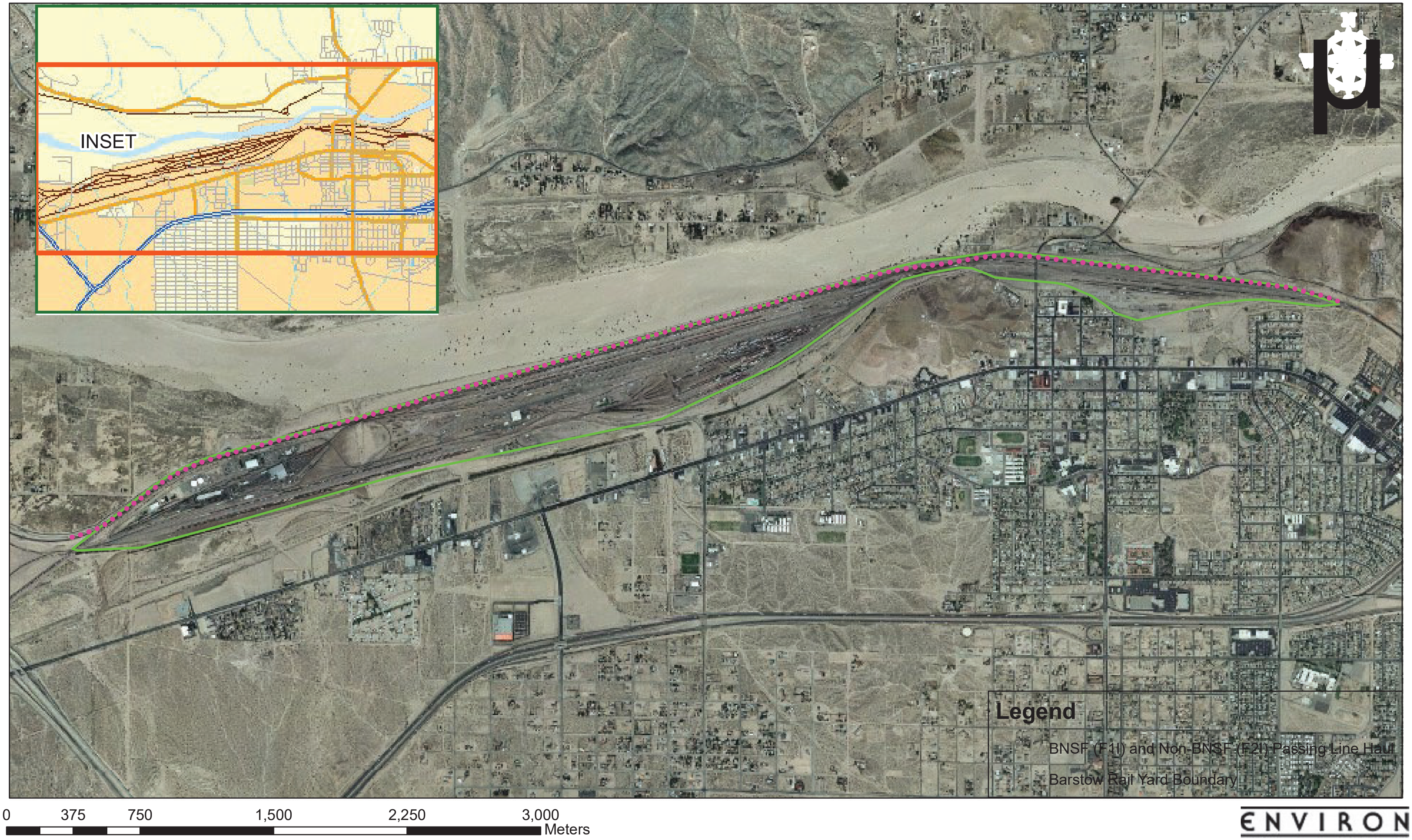

Figure 4-1e: Locations of Modeled Stationary Locomotive Sources - Passenger Locomotives
BNSF Barstow Rail Yard
Barstow, California

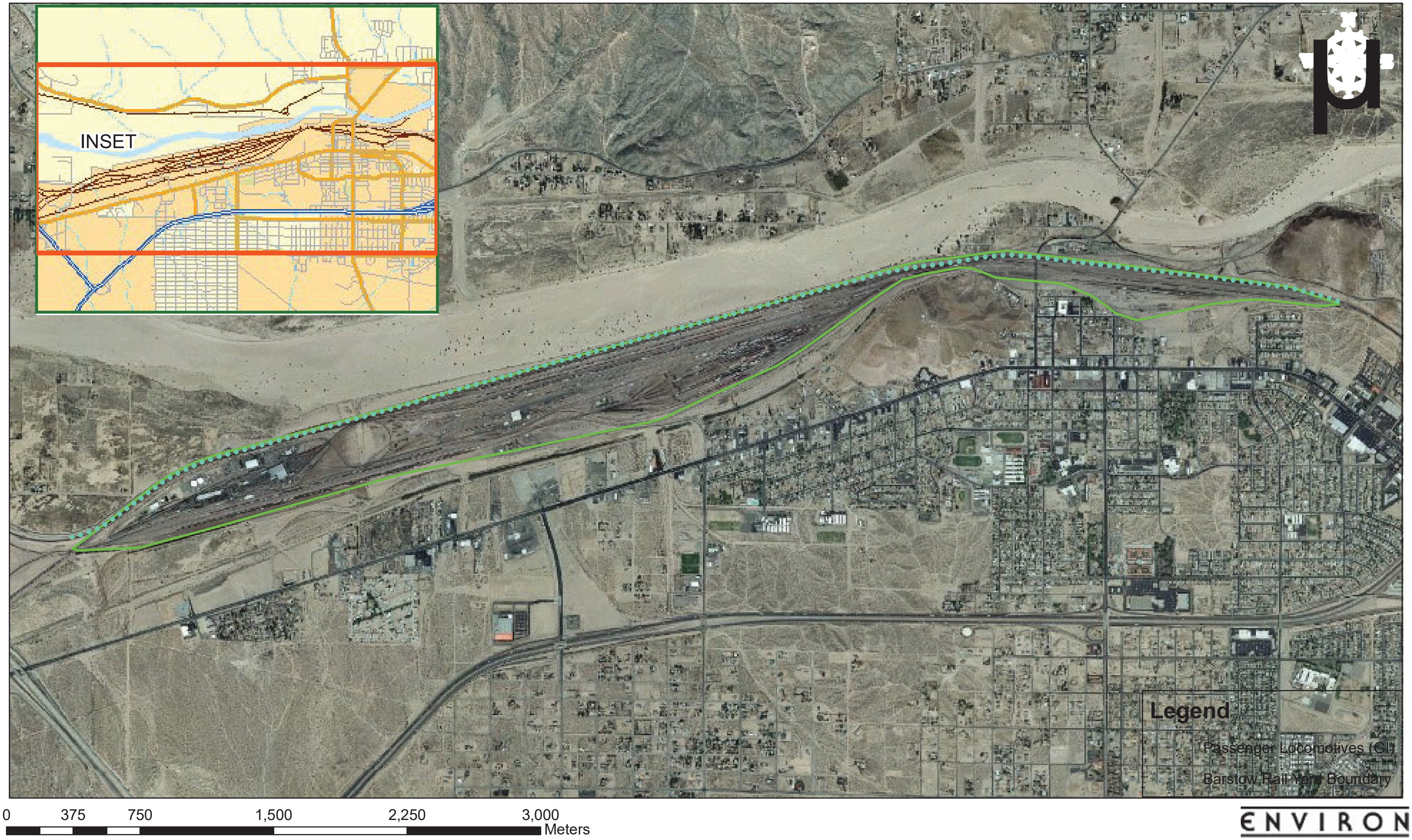

Figure 4-2a: Locations of Modeled Movement Locomotive Services - Basic Services in Maintenance Area
BNSF Barstow Rail Yard
Barstow, California

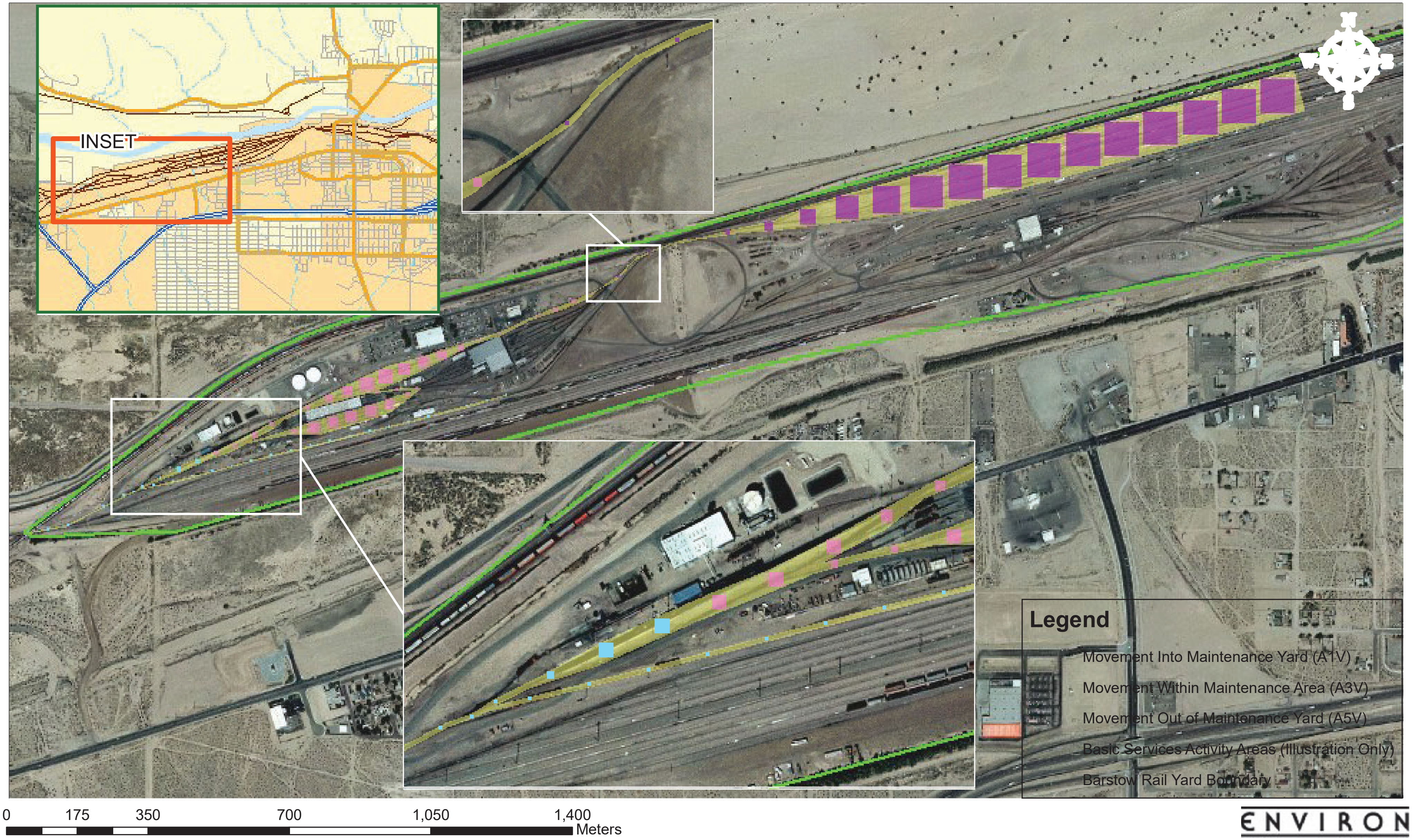

Figure 4-2b: Locations of Modeled Movement Locomotive Sources - Engine Test in Maintenance Area
BNSF Barstow Rail Yard
Barstow, California

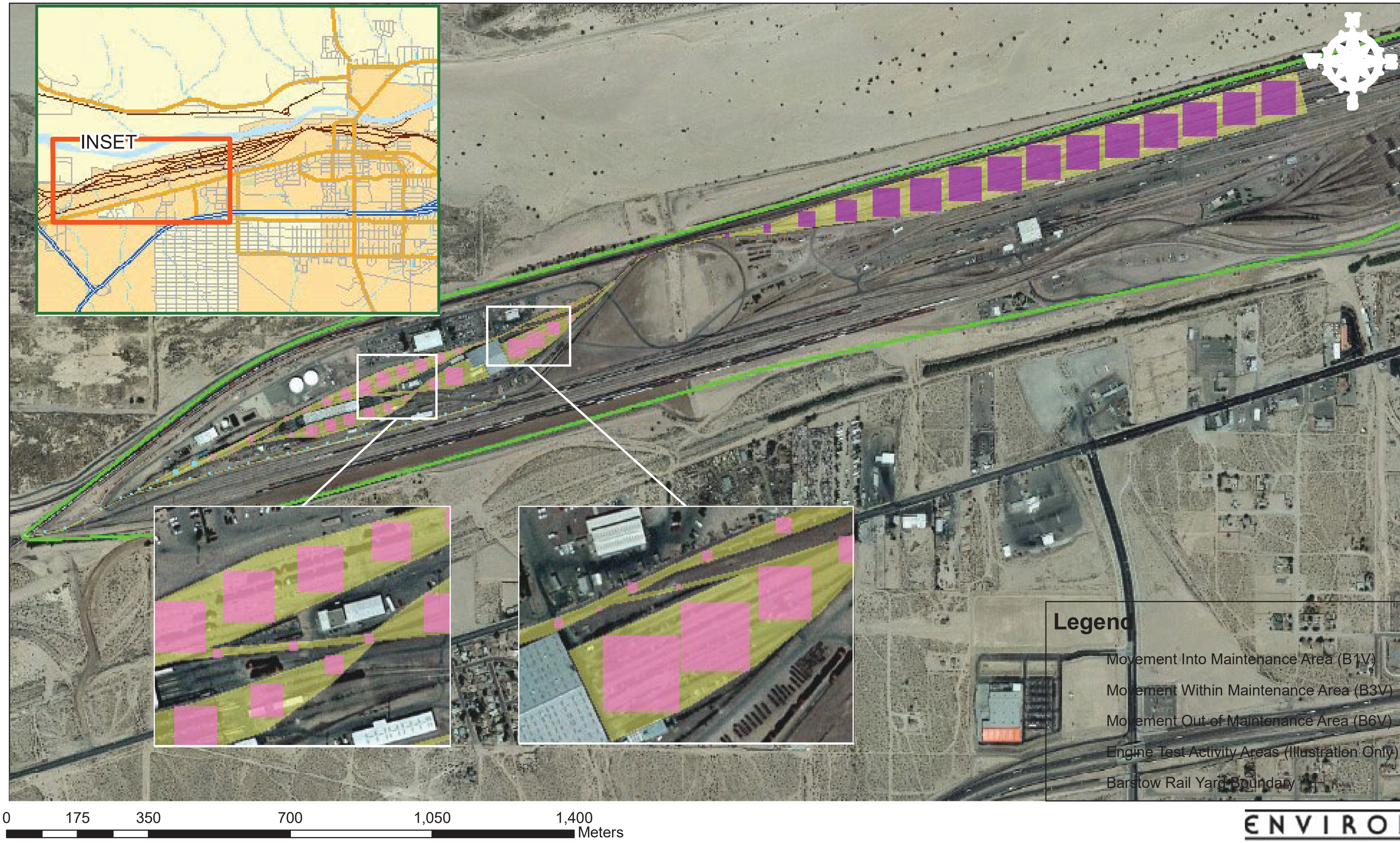

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Figure 4-2c: Locations of Modeled Movement Locomotive Sources - Full Inspection in Maintenance Area
BNSF Barstow Rail Yard
Barstow, California

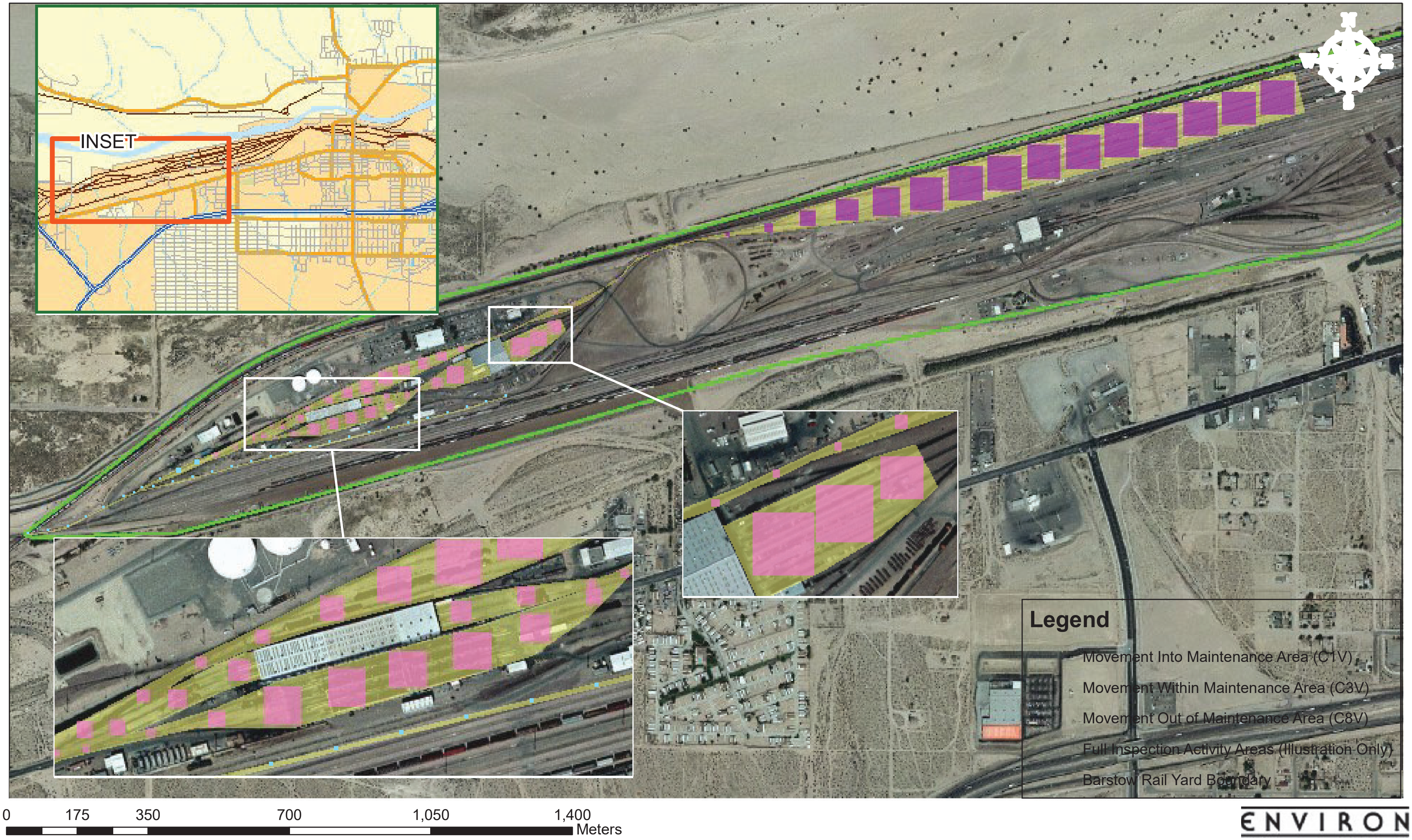

Figure 4-2d: Locations of Modeled Movement Locomotive Sources - Switching
BNSF Barstow Rail Yard
Barstow, California

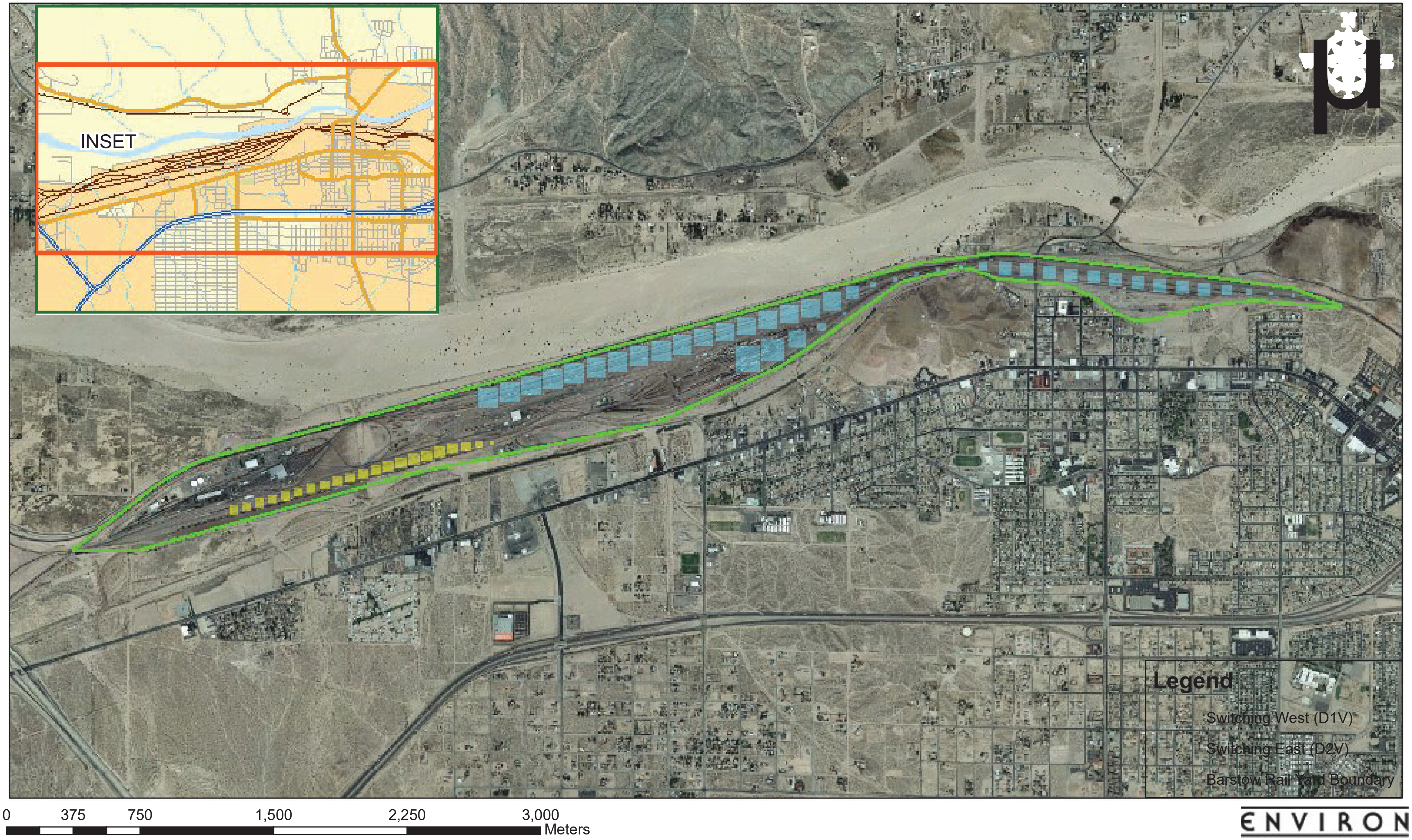

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Figure 4-2e: Locations of Modeled Movement Locomotive Sources - BNSF Arriving-Departing Line Haul
BNSF Barstow Rail Yard
Barstow, California

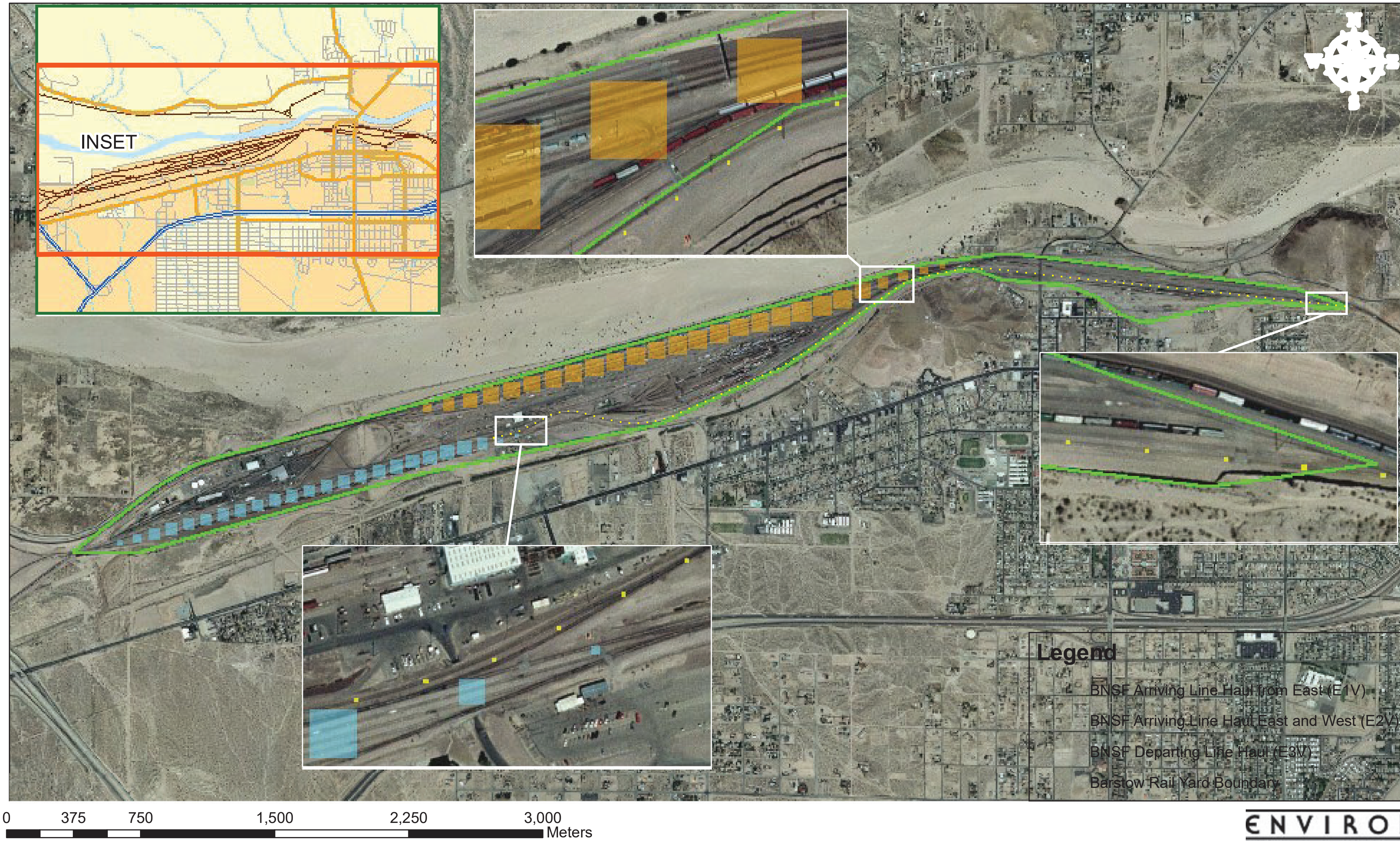

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Figure 4-2f: Locations of Modeled Movement Locomotive Sources - Passing Line Haul (BNSF and Non-BNSF)
BNSF Barstow Rail Yard
Barstow, California

Figure 4-2g: Locations of Modeled Movement Locomotive Sources - Passenger Rail
BNSF Barstow Rail Yard
Barstow, California

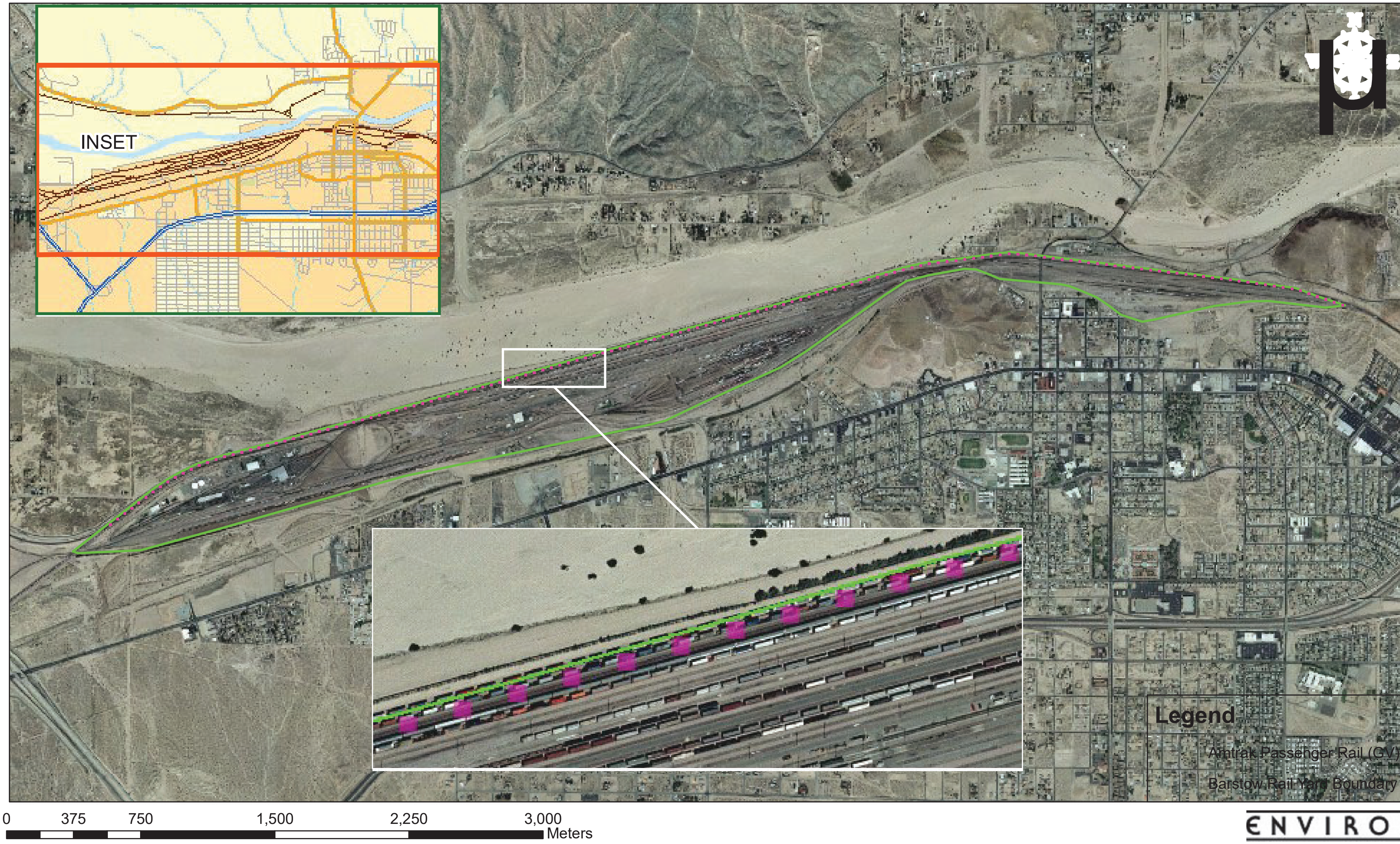

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Figure 4-3: Location of Modeled Material Handling Equipment
BNSF Barstow Rail Yard
Barstow, California

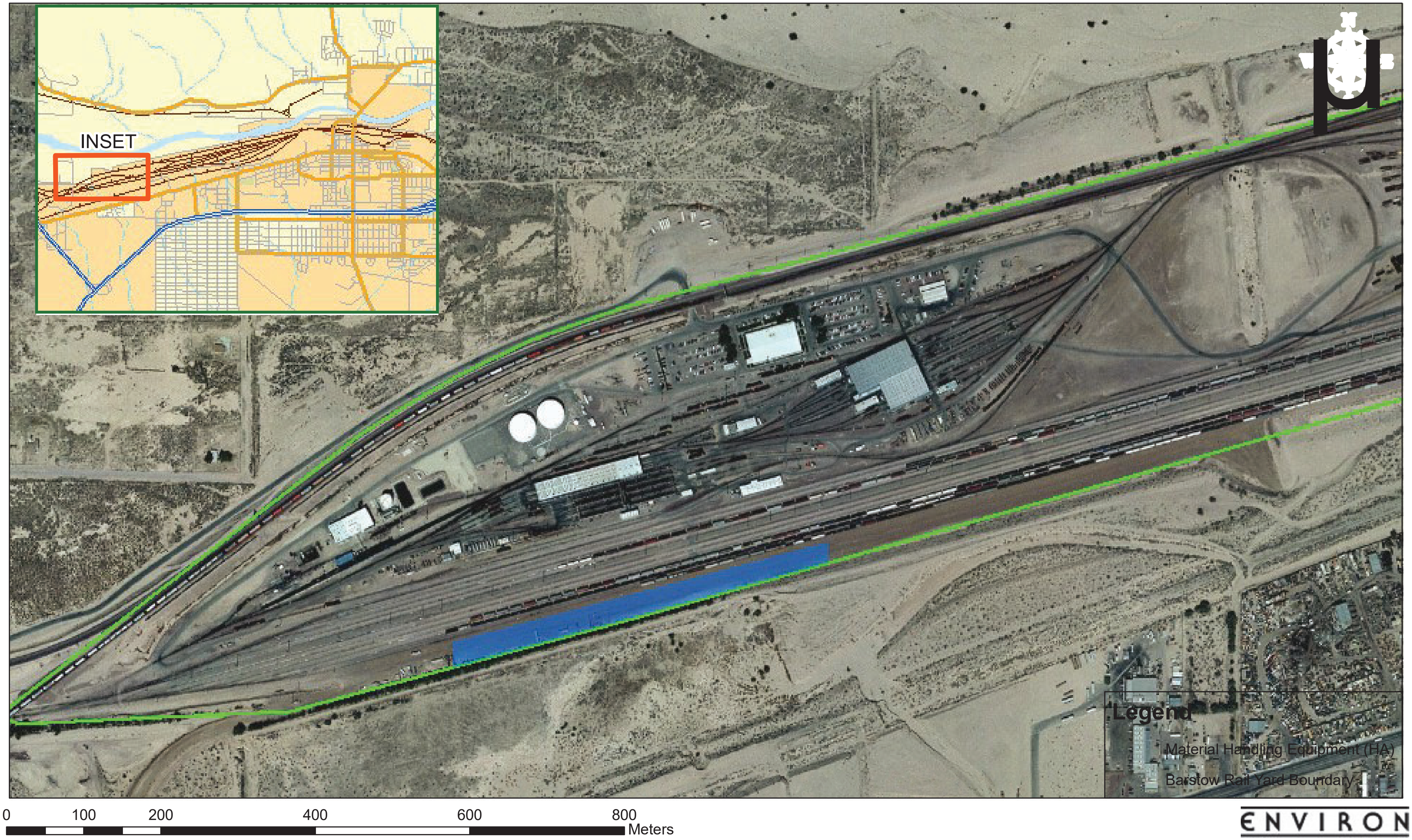

Figure 4-4: Locations of Modeled On-Site Refueling Truck
BNSF Barstow Rail Yard
Barstow, California

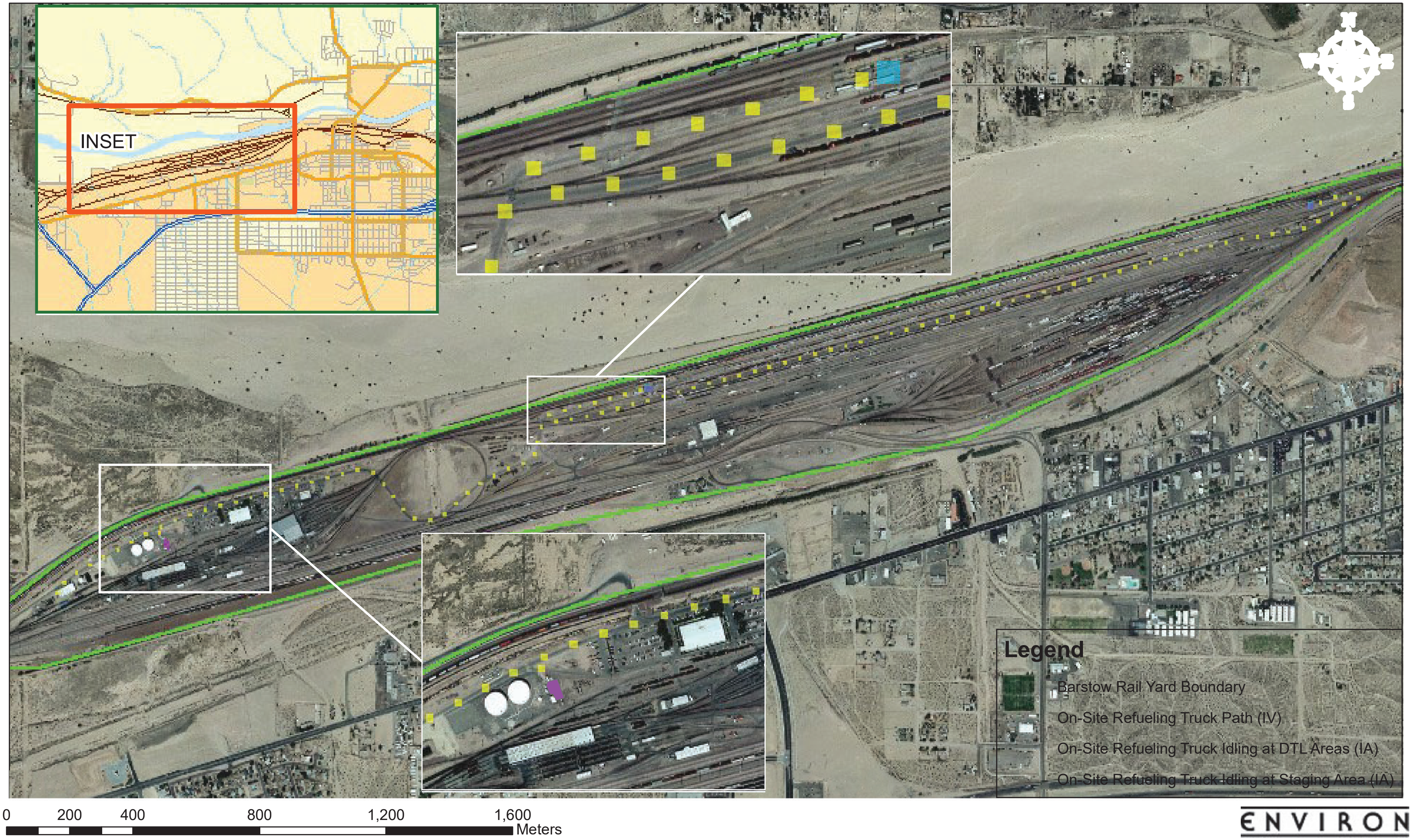

Figure 4-5: Locations of Modeled On-Road Fleet Sources - BNSF On-Road Fleet
BNSF Barstow Rail Yard
Barstow, California

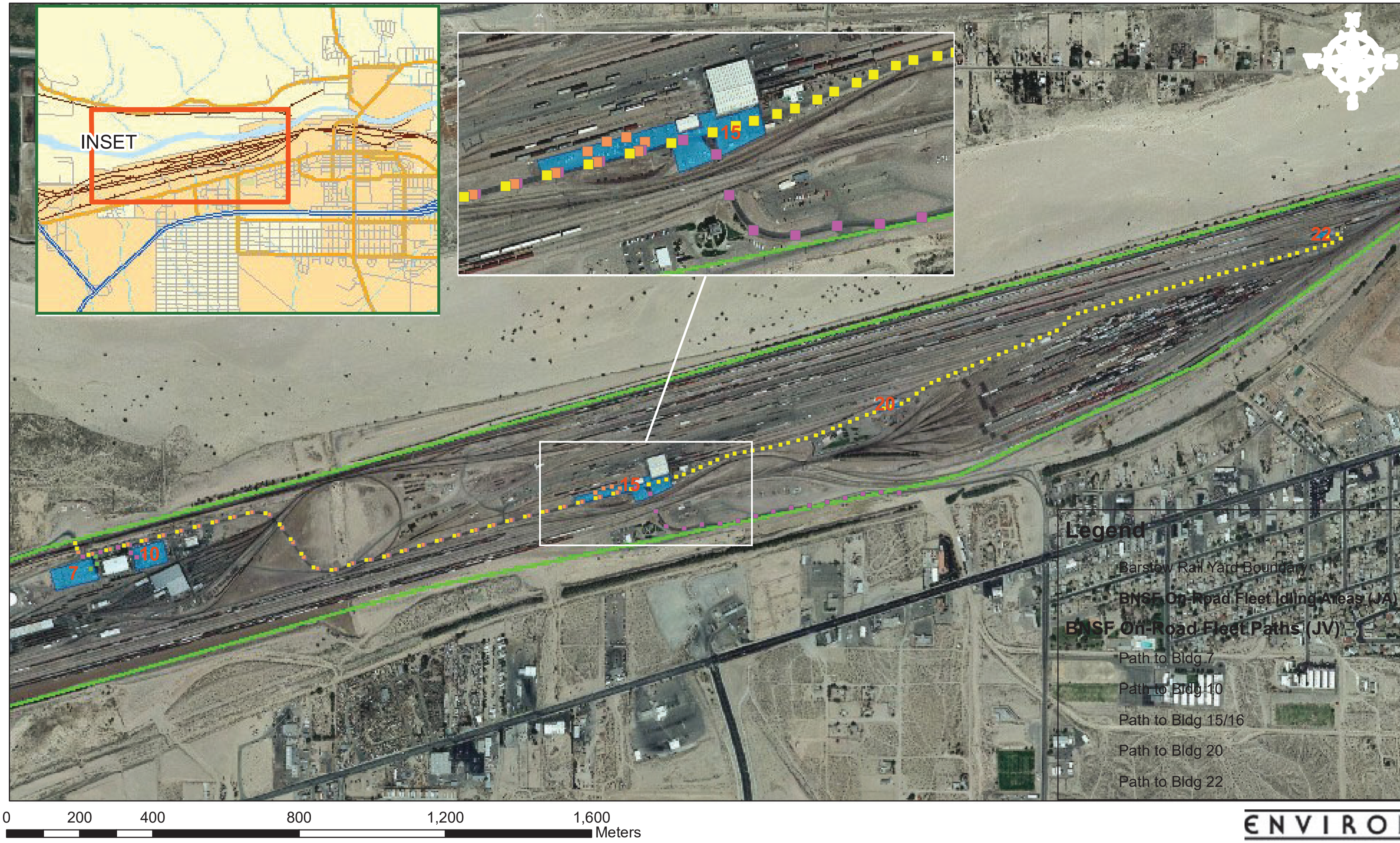

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Figure 4-6a: Locations of Modeled Off-Road Sources - Track Maintenance Equipment
BNSF Barstow Rail Yard
Barstow, California

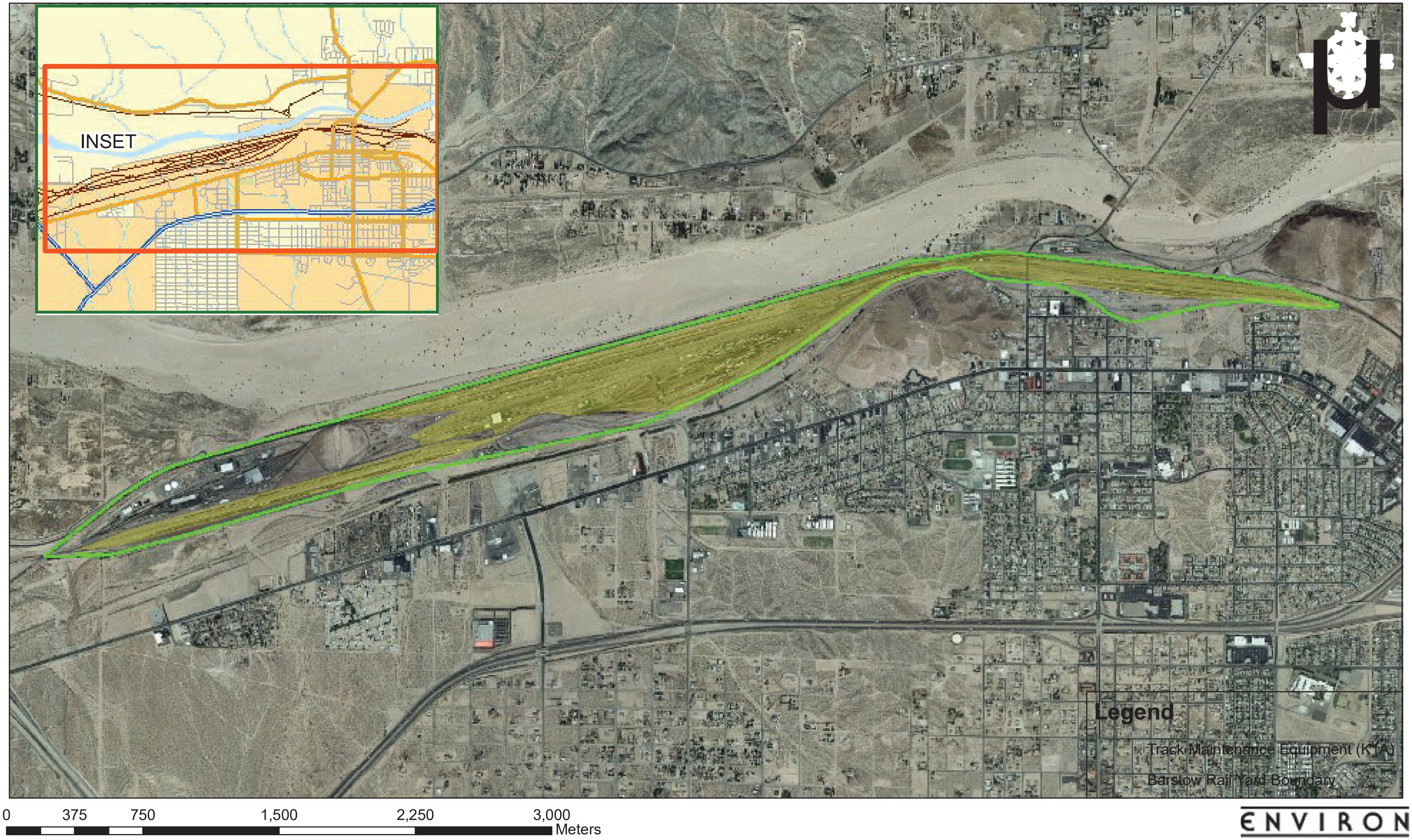

Figure 4-6b: Locations of Modeled Off-Road Sources - Transportation Refrigeration Units
BNSF Barstow Rail Yard
Barstow, California

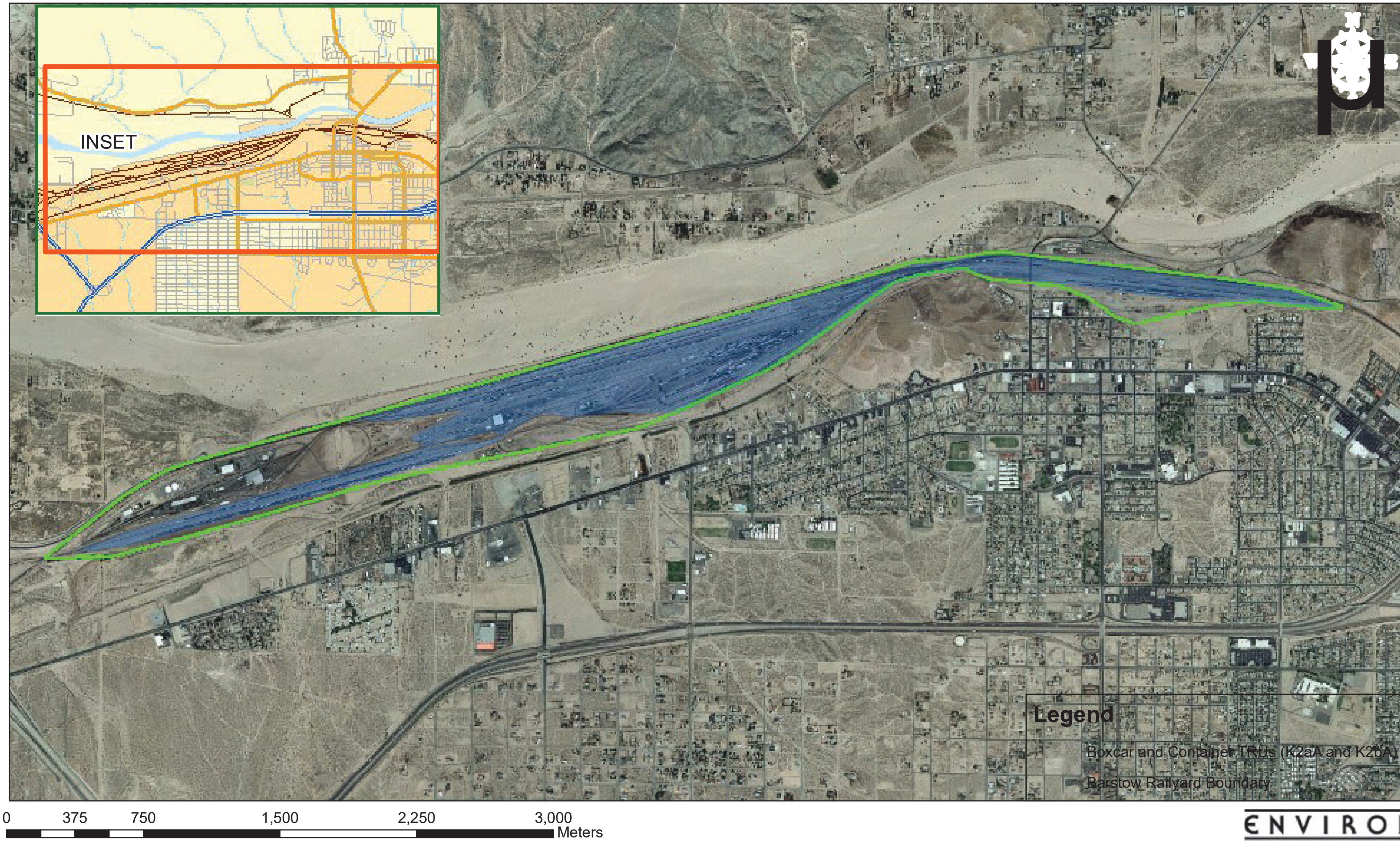

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Figure 4-7: Locations of Modeled Permitted Stationary Sources
BNSF Barstow Rail Yard
Barstow, California

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Figure 4-8: Sector Selection for Surface Parameter Analysis
BNSF Barstow Rail Yard
Barstow, CA

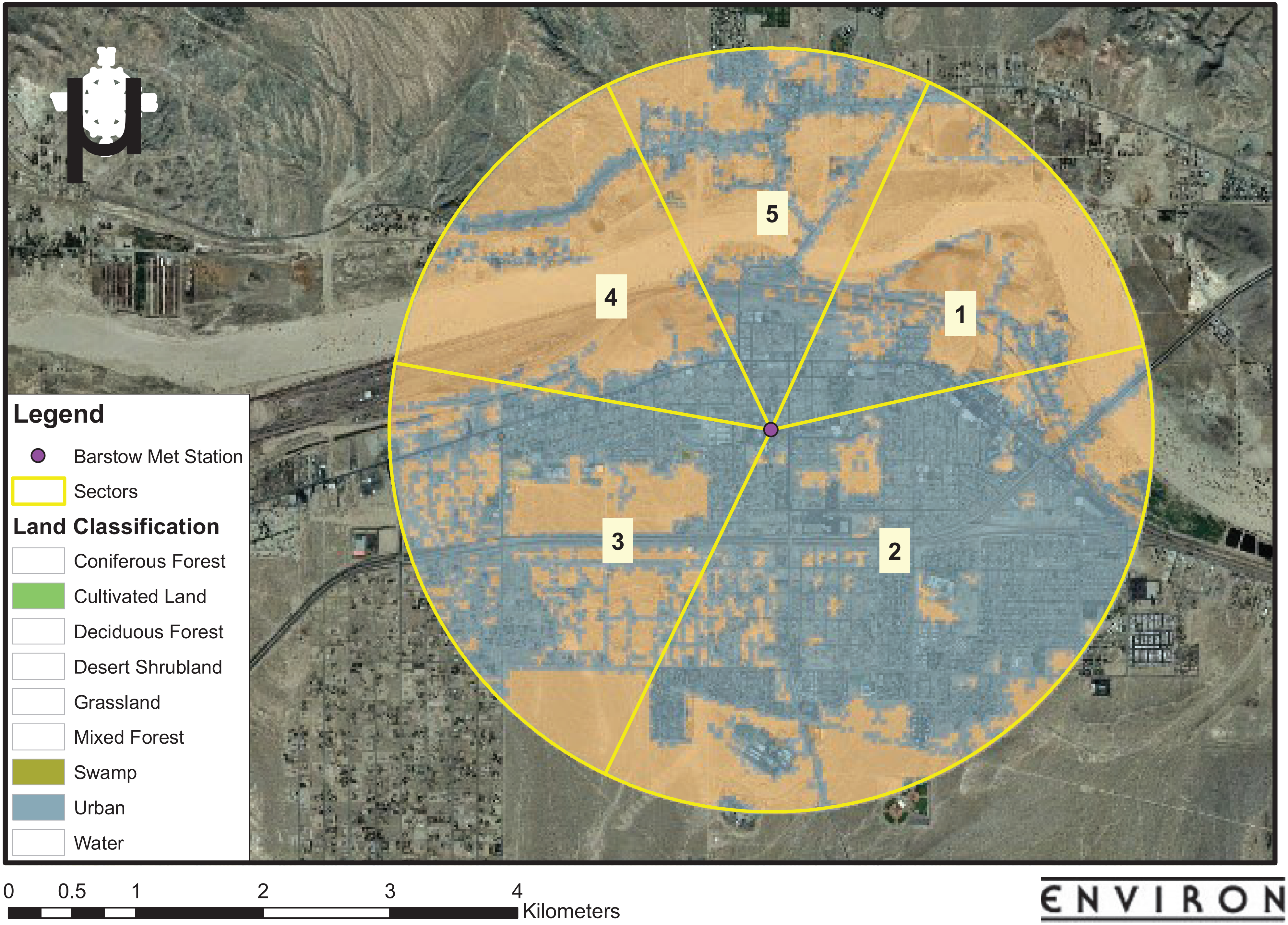

Figure 4-9: Locations of Buildings at the Facility
BNSF Barstow Rail Yard
Barstow, California

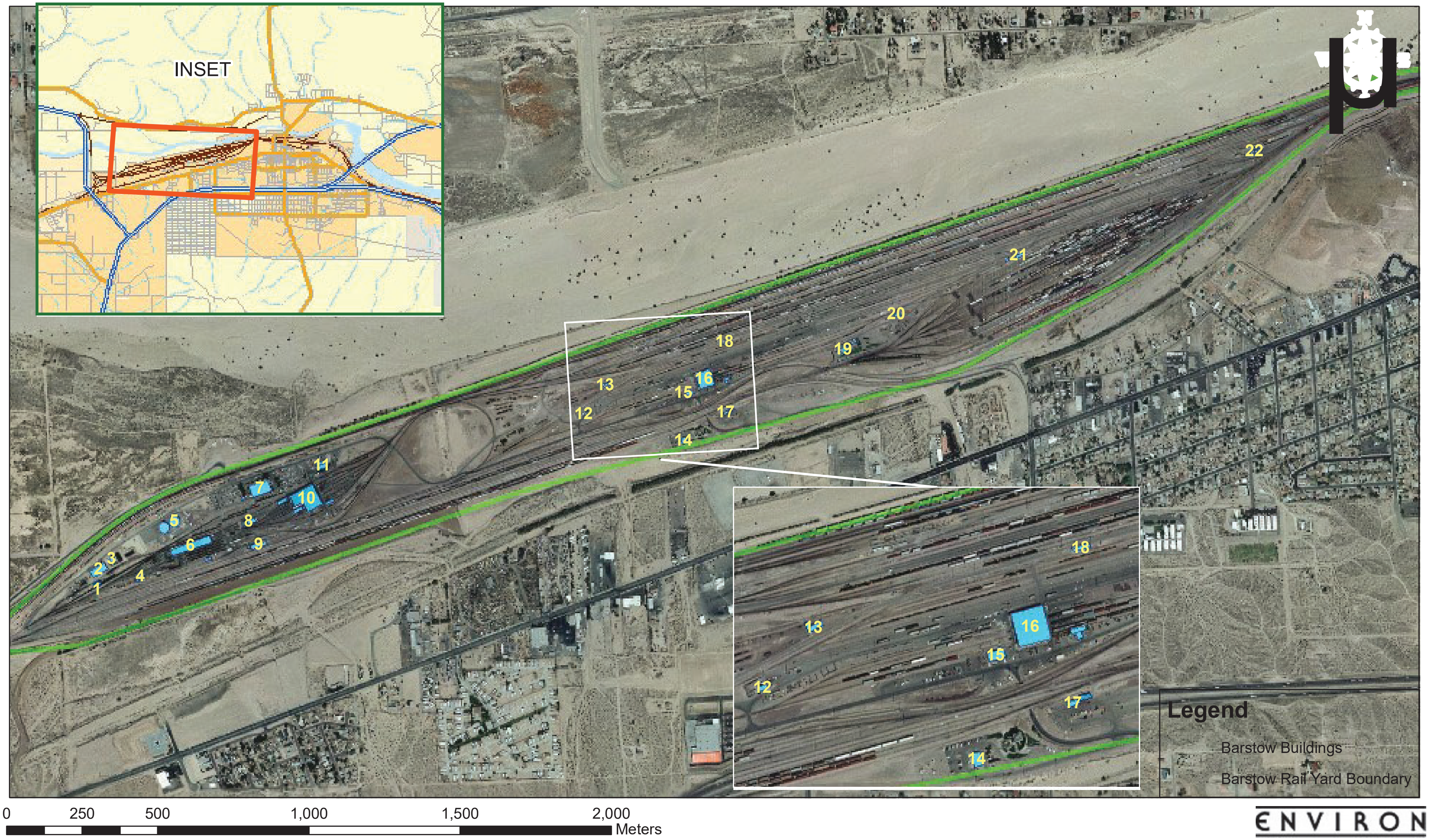

Figure 4-10a: Land Use Within Three Kilometers of the Facility
BNSF Barstow Rail Yard
Barstow, California

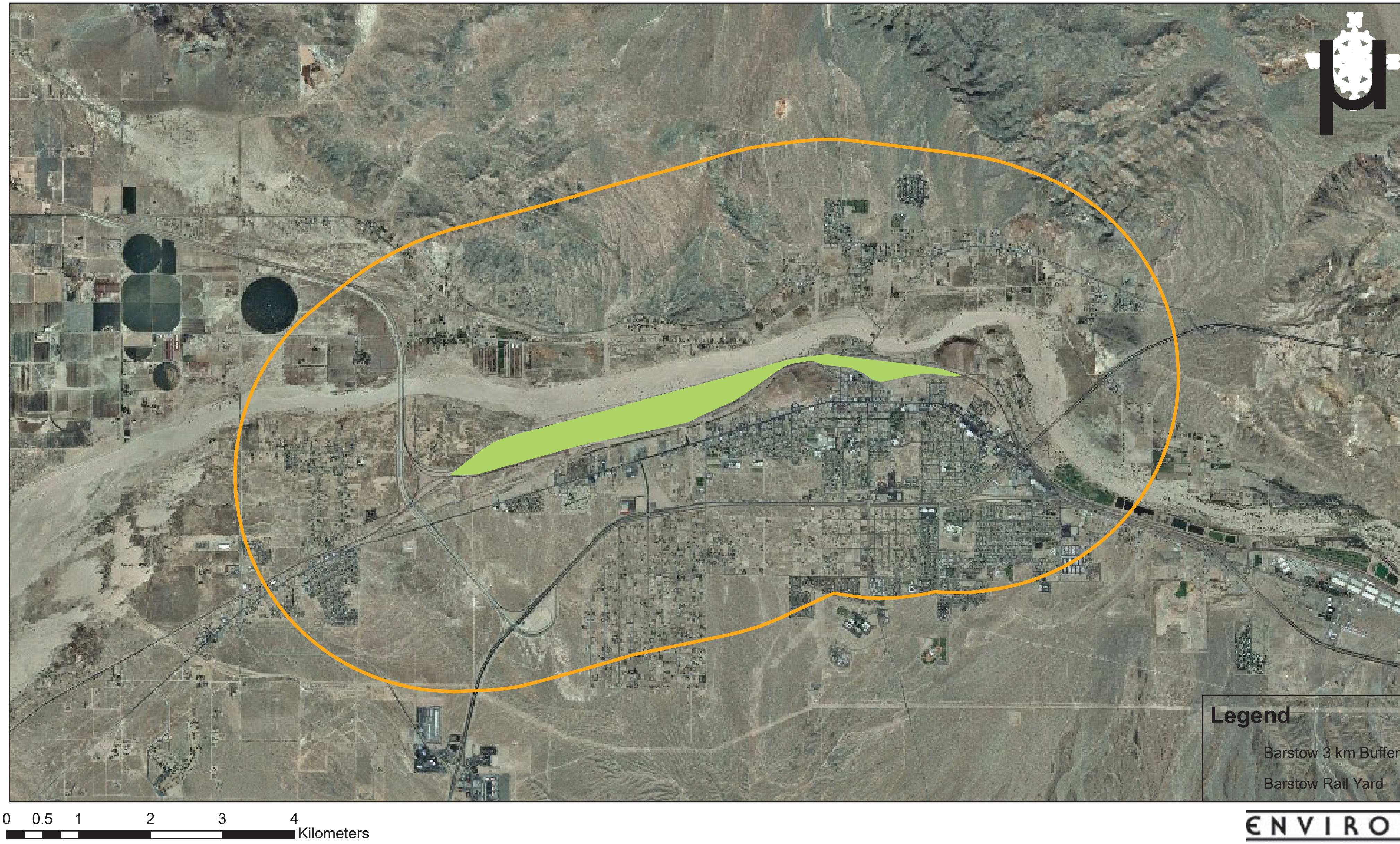

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Figure 4-10b: Population Density Within Three Kilometers of the Facility
BNSF Barstow Rail Yard
Barstow, California

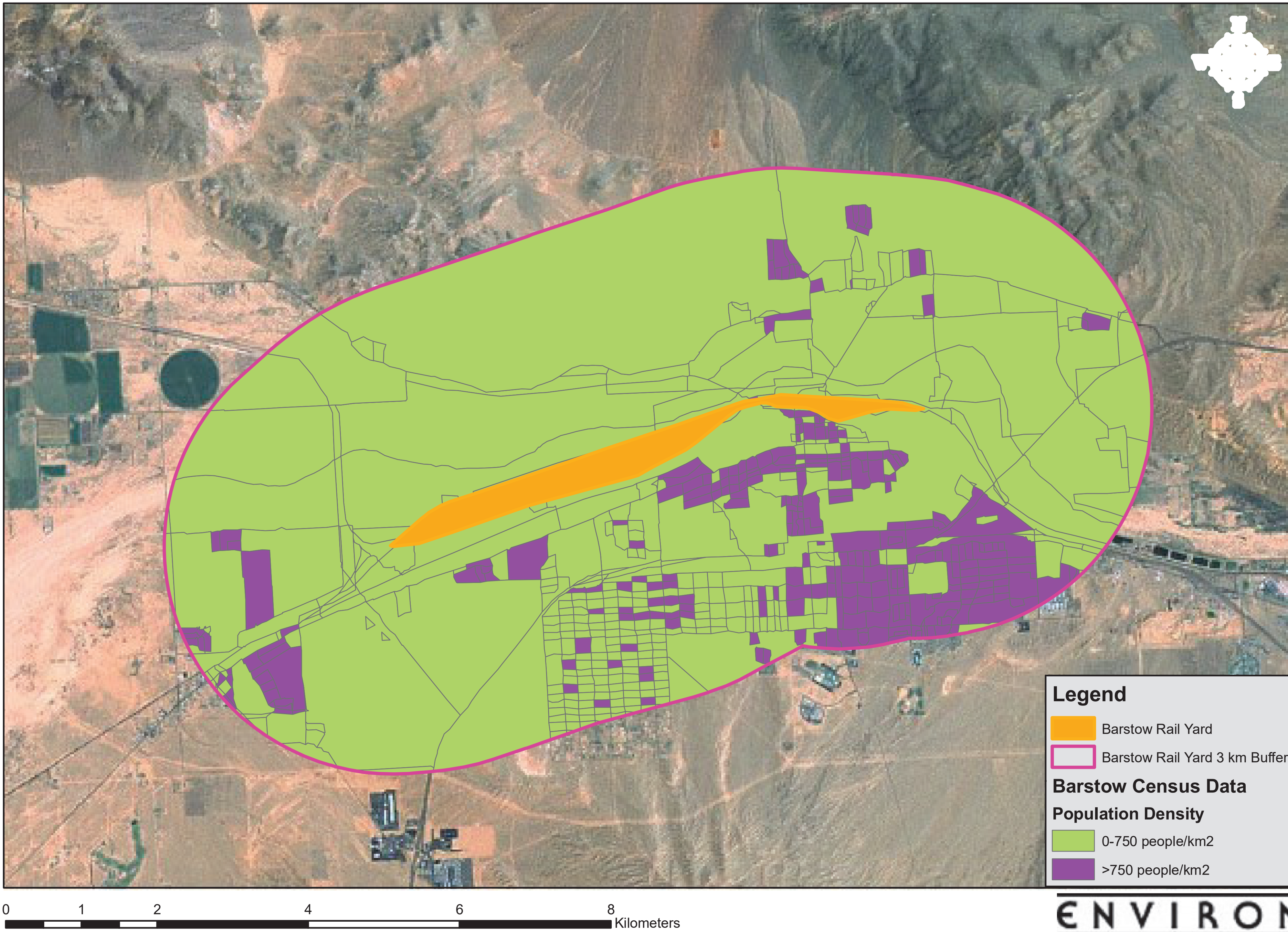

Figure 4-11a: Locations of Discrete Receptors in Coarse Grid
BNSF Barstow Rail Yard
Barstow, California

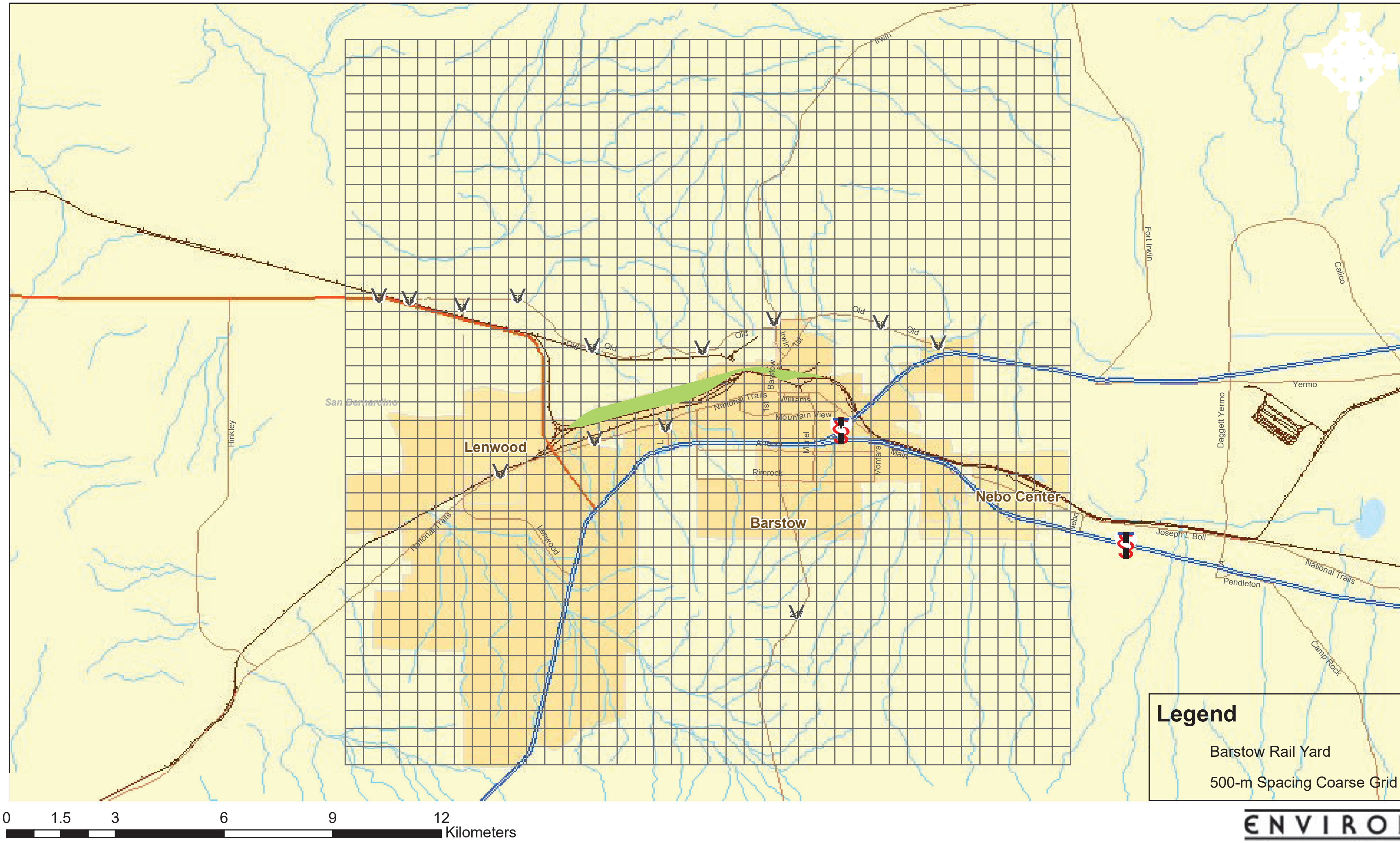

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Figure 4-11b: Locations of Discrete Receptors in Medium Grid
BNSF Barstow Rail Yard
Barstow, California

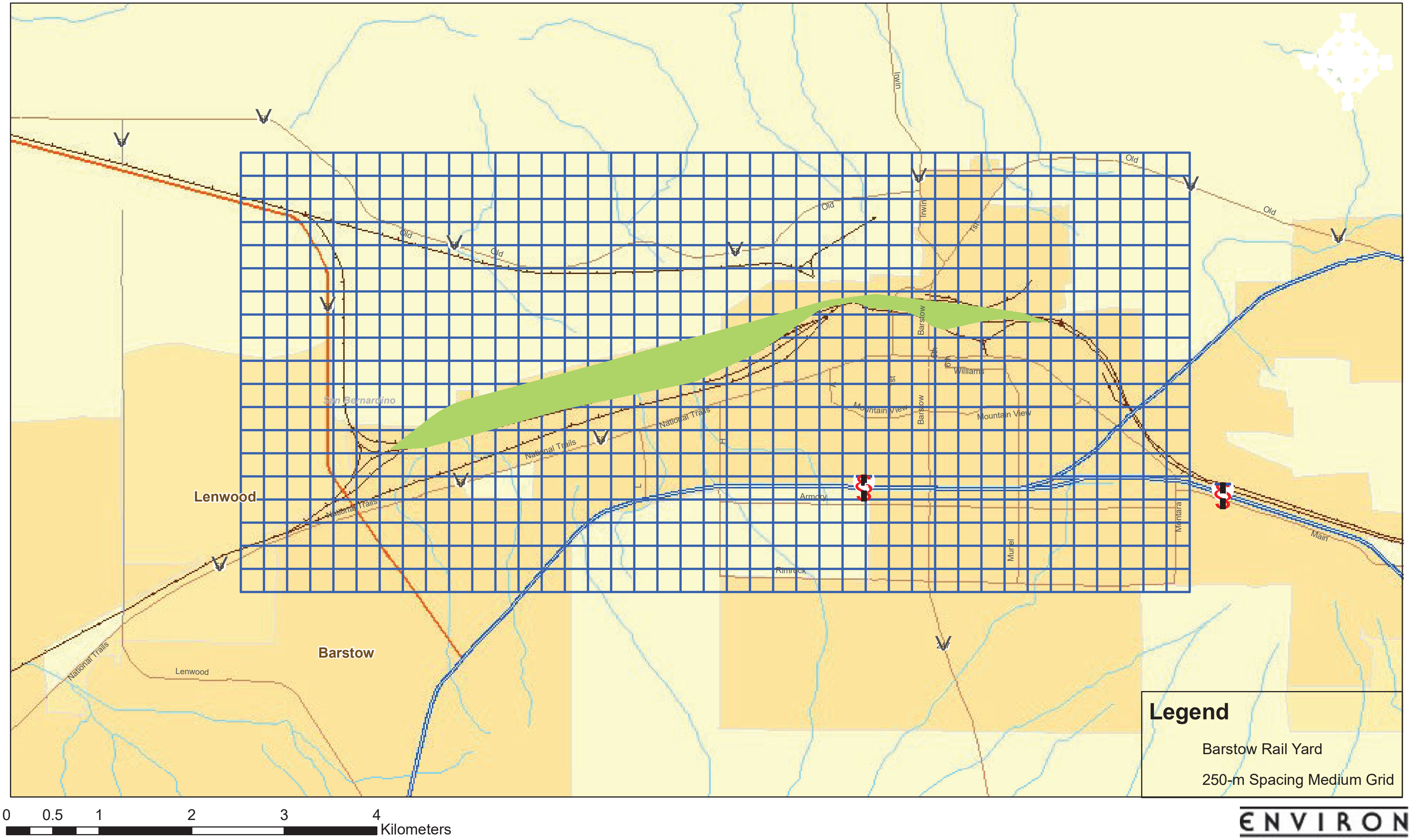

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Figure 4-11c: Locations of Discrete Receptors in Intermediate Grid
BNSF Barstow Rail Yard
Barstow, California

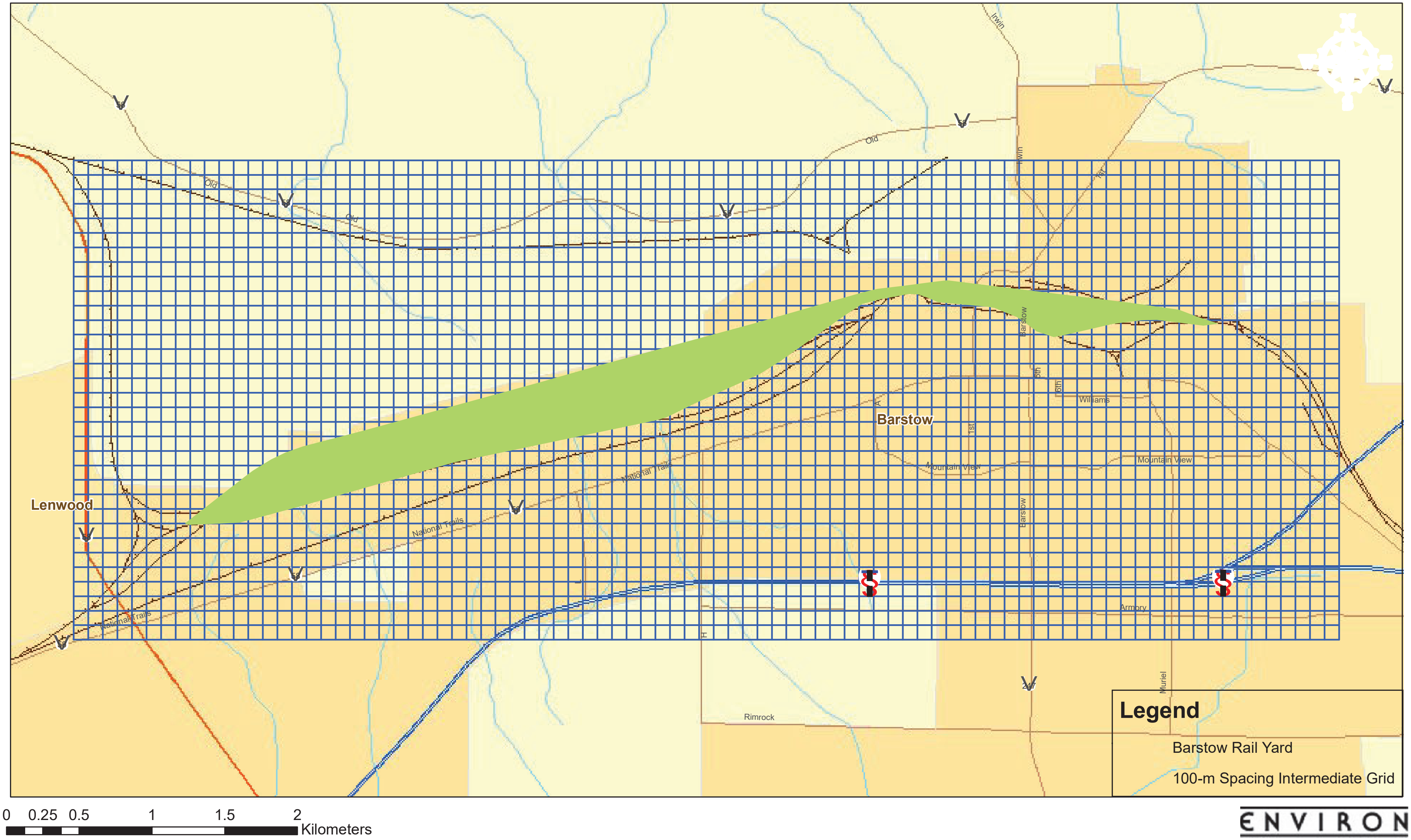

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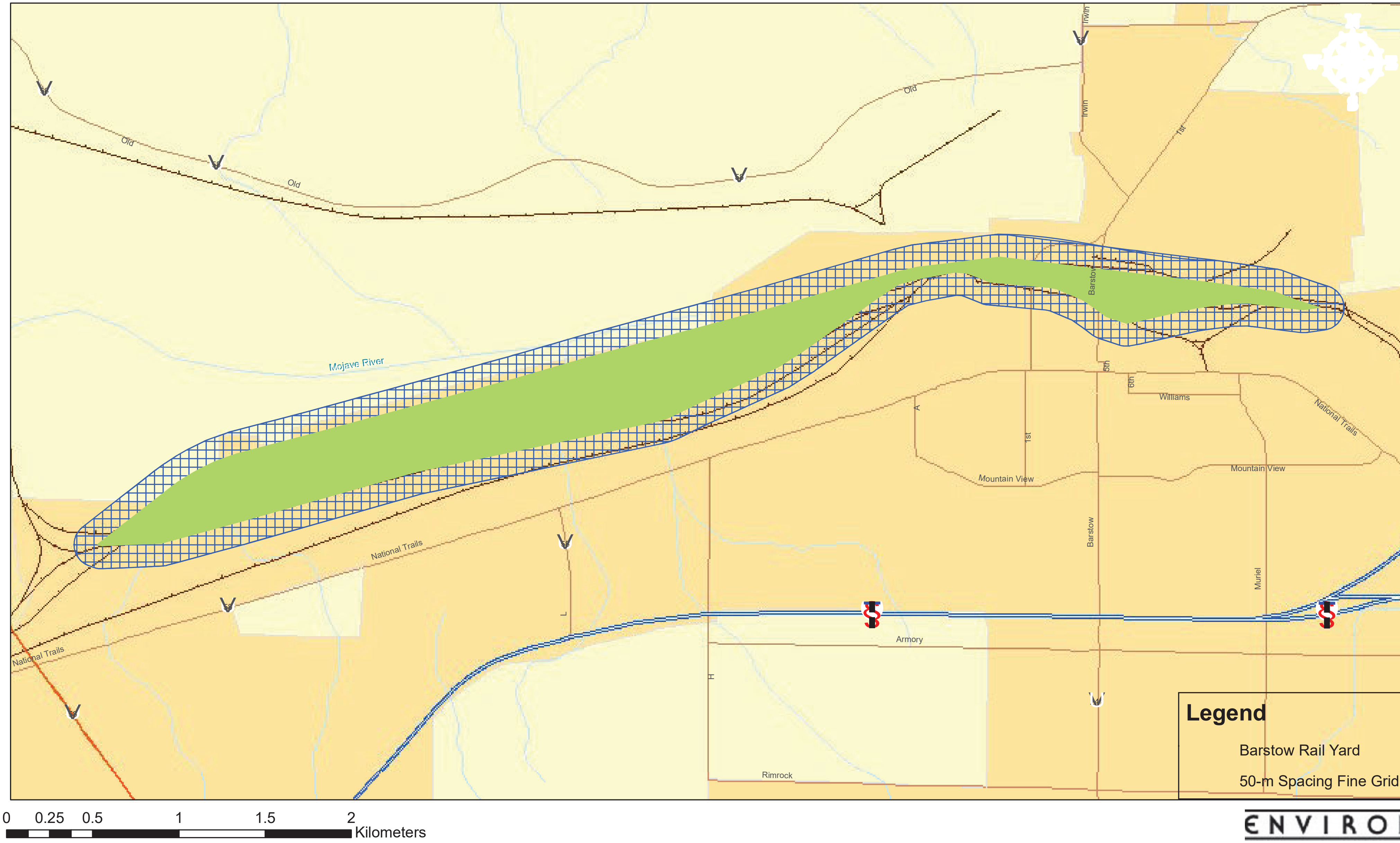
Figure 4-11d: Locations of Discrete Receptors in Fine Grid
BNSF Barstow Rail Yard
Barstow, California



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