Proposed Study Plan for Collection of Data for Overall Risk Assessment For BNSF Rail Sites in California

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Introduction

BNSF Railway Company (BNSF) entered into an Agreement with the California Air Resources Board (ARB) entitled "Particulate Emissions Reduction Program at California Rail Yards". As required under section C.5.b of the agreement, BNSF has prepared this study plan to address the following requirement:

> *"At a minimum, for each designated Yard, this information shall include rail yard specific activity data, an emission inventory of any resident or transient major diesel equipment (including locomotives, on and off-road vehicles, and non-road engines) operating in the rail yard, dispersion modeling results (concentrations) of diesel particulate matter (DPM) emissions, collection of appropriate meteorological and demographic data, and other information deemed reasonable and appropriate by the Participating Railroads and ARB."*

This proposed study plan is outlined in three sections: activity and emissions estimates, air dispersion modeling, and demographic data for the sites listed in Table 1. Each of the sites will have freight movements and some degree of car classification, however only a few sites will be engaged in engine service or intermodal activity.

Table 1. Activity at the BNSF Designated Railyards.

Site/Operation	Study Due	Service	Classification	Intermodal
Barstow	30 months	Engine/ Fueling	*Yes*	Negligible
San Bernardino	30 months	Fueling	*Yes*	Yes
Watson Yard Wilmington	18 months	Fueling	*Yes*	None
Richmond	18 months	Engine/ Fueling	*Yes*	Yes
Hobart Yard Los Angeles	18 months	None	*Yes*	Yes
San Diego	30 months	None	*Yes*	Small
Commerce	18 months	Engine/ Fueling	*Yes*	None
Stockton	18 months	Fueling/minor maintenance	*Yes*	Yes

BNSF will continue to work with ARB as this proposed study plan is implemented in practice. BNSF expects that ARB and the railroads will continue communication with local districts that are also interested in the study analysis and in this proposed study plan for each site.

I. ACTIVITY AND EMISSION INVENTORY ESTIMATES

Each source category is described in more detail below with the actions that must be taken to determine the equipment activity and estimate emissions. This review expects that the universe of emission sources comprises locomotives, cargo-handling equipment, on-road trucks visiting the site, on-road vehicles owned/operated by BNSF, other off-road equipment including track maintenance equipment, and stationary sources.

Locomotives

Locomotive activity will be divided into three (3) main categories: line-haul engines, switch engines, and service and maintenance load testing. Using the Roseville study (ARB, 2004) as a basis, the line-haul engine activity will include through-train, engines receiving basic service (such as refueling, sand, and other normal maintenance), point of origin or departure activity (such as idling and train building), and movements between these activities within the site. Switching activity includes hump yard activity, classification and train building, movements within the site, and movements to basic or engine testing and maintenance locations. Refueling idling, short pre-departure load tests, and maintenance load and opacity testing occurs at well-defined areas but only at a few BNSF yards. The fleets will be described by make, model, and model year so emission rates per operating mode (notch setting and idle) as developed by ARB or provided by the original equipment manufacturer may be used to estimate emissions.

Line-haul Engine Activity

Line-haul engines engage in four typical activity types; (1) through-train, (2) point of arrival or departure activity (such as idling and train building), (3) engines receiving basic service (such as refueling, sand loading, and other normal maintenance), and (4) movements between these activities.

To gather line-haul locomotive activity for all such engines, there are many potential methods. One method may be the best long-term solution but would entail installing radio receivers on all engines and downloading and compiling activity data transmitted from those receivers. A second method would be to physically download data from each single engine and consist (as each engine in a consist operates in concert). These two methods would be time consuming and impose additional costs beyond those incurred in preparing the Roseville study. So, at a minimum, using the ARB Roseville study as the example process, the number of through trains, typical consist configuration (typically three engines), and typical notch setting through each yard will be used for this study. The activity estimates generated in this manner will be compared to the activity estimates using gross ton-mile freight transfers and average fuel consumption rates to ensure consistency. The data will be limited to activity distributions by milepost at the finest detail but would be considered as a line source for dispersion modeling.

Point of arrival and departure information will be available at each yard in terms of the number of trains. The consists comprised of typical 3 engines arrive or depart at locations dictated by the operation of the yard with the time at idle and notch settings during movements identified. The idle time and all movements of arriving and departing trains will be identified.

The typical movements between engine service and arriving and departing trains will be identified to include in the overall emission estimates. The notch settings for these movements will be determined from typical operations between points in the yard.

Switch engine Activity

Switch engine activity will consist of several activities at each yard, including classification, train building, culling empty cars, and other activities. In addition, switch engines must be serviced and refueled and therefore move between all locations within the yard.

Switch engine activity would be best estimated from event recorder data downloaded from engines at each site. Using a set of engines as a survey of typical activity, an estimate of the various notch setting could be determined. This method is time consuming and represents an analysis beyond that for the Roseville study. At a minimum however, the Roseville approach could be used as a backstop method where operating time, idling time, and pushing and pulling time and notch level were identified.

Engine Service and Maintenance

Engine service will be considered as separate modes of operation to address basic service (refueling and sand replenishment), and various engine maintenance modes (interim service, full maintenance, opacity testing, etc.) for line-haul and switch engines. Each mode will be detailed in terms of the time in notch setting or at idle, and placing those activities at the spatial location of the activity.

The Barstow, Commerce, and Richmond sites are the primary sites that perform engine maintenance where load and opacity testing is performed. The number of engines serviced and opacity tested will be gathered for each site and associated with typical load testing procedures to determine time in mode per engine. Other sites perform some refueling primarily by truck delivery. Activity prior to or during refueling may be characterized by extended idle as the primary mode of consideration.

Passenger Rail and Other Freight Rail

For the BNSF yards that have passenger rail activity, the number of trains and typical engine type and notch setting for these engines will be used to generate emissions similar to line-haul emissions of through trains. These estimates will be compared with those using generic fuel consumption rates per train-mile.

In addition, other freight railroads with track rights past a BNSF facility will be accounted for using the number of trains and typical operating parameters of those passing trains.

Cargo Handling Equipment

Hobart, San Bernardino, and Stockton are BNSF's designated railyards with major intermodal sites in California with Richmond and San Diego as the only other railyards engaged in any degree of intermodal activity. These sites contract cargo handling equipment service firms that operate the equipment for cargo movements within the yard. Equipment populations are regularly maintained, but age distribution, rated power, actual activity, and especially load for the equipment are not routinely collected currently. However, for this risk assessment, BNSF expects to generate information for the activity of general equipment types at each of the intermodal sites to provide input data to the emission estimates.

BNSF will work with ARB to determine appropriate emission rates and modeling approaches. BNSF expects that ARB will be providing publicly available OFFROAD or other emissions modeling approaches that incorporate ARB best practices for emissions estimates for off-road equipment. The equipment types used for cargo handling include rubber-tire gantry (RTG) cranes, various container handlers, and yard tractors. OFFROAD does not have exact matches for these equipment types, so there are no default estimates for the use of this equipment. Table 2 describes the cargo equipment found at BNSF intermodal sites. BNSF expects ARB to provide default data for activity variables that may be supplemented with BNSF provided site-specific activity data. ARB has indicated that it will publish results of their Cargo Handling Equipment Survey (http://www.arb.ca.gov/msprog/offroad/cargo/documents/survey.htm) along with a methodology for estimating emissions from these equipment types.

Table 2. Cargo handling equipment types and activity examples.

Equipment	OFFROAD Analog	OFFROAD Activity (hours/year)	OFFROAD Load Factor
Crane (RTG)	Crane	1434	43%
Empty Handling	Forklift	1800	30%
Chassis Stacker	Forklift	1800	30%
Side Loader	Forklift	1800	30%
Yard Tractors	Industrial Tractors? Specialty Vehicles?	None available	None available

On-Road Trucks

This category was assumed to include trucks serving an intermodal facility. The basic activity data will be gate counts and typical activity on-site for a typical truck. The idling periods and average speed of the trucks will need to be determined by tracking individual vehicles within the yard to determine typical activity from a sample set of trucks.

The trucks used to perform short hauls to and from intermodal facilities often are older than the typical heavy-duty truck found in the region. Without specific studies of these age distributions, using the region average may misrepresent the emission levels for these trucks. Therefore, we will replace available data or methods that might better be used for this purpose.

Areas will be designated as typical sites for extended idling. The sites will be identified with current operations and traffic flows to estimate areas where trucks are forced to wait significant periods. Routes for truck movements will be identified within each yard to distribute the emissions for trucks operating within the yard. The EMFAC model does not directly provide gram per mile emission rates at different speeds and at idle by model year, so BNSF will work with ARB to determine appropriate emission factors for these driving modes within the facility.

Other On-Road Vehicles

Fleet vehicles will be identified using the same approach used for cargo handling equipment. The service vehicles could be gasoline or diesel pickup trucks or light-duty vehicles. Other vehicles could include fueling trucks or other deliveries to each site unrelated to intermodal deliveries or collections. Activity data will need to be hours at idle or mileage for service vehicles, and gate counts for deliveries. The emissions from this source are not expected to be a significant fraction of the yards' emissions. If a significant fraction of these vehicles are gasoline fueled then the TAC components will be estimated. BNSF will work with ARB to determine appropriate emission factors for these vehicle types and driving modes within the facility.

Other Off-Road Equipment

There are a number of other emission sources including transportation refrigeration units (TRU) in railcars and trucks, track maintenance equipment or other activities yet to be identified. Activities that are routine and predictable will be included under this miscellaneous emission source category.

Ad hoc methods of activity collection will need to be developed to estimate this category. For TRU's, both refrigeration truck and rail cars could contribute to emissions from this equipment type. Gate counts of truck intermodal activity may need to include a sample of those with TRU and estimates of the time on site. Refrigerated railcar counts will also need to be estimated from annual or special surveys to determine the TRU activity.

With miscellaneous source categories, it may be more difficult to obtain detailed activity data because of the potentially large number of different activities contained within this general category. BNSF will work with ARB to determine appropriate emission sources and model approach for smaller emission sources and miscellaneous source categories.

Stationary Sources

BNSF already reports stationary source activity and emissions through its Title V reporting requirements. This information will be used to provide an emissions estimate for this emission source category. Emergency or general purpose diesel generators, industrial boilers, degreasing and other area source emissions sources will be included to estimate DPM and TAC emissions.

Geographic and Temporal Allocation

The geographic distribution of emissions will be assessed for each site. An example of how this will be accomplished is demonstrated using the Commerce Engine Service Site. At Commerce, the following activities outlined below for locomotive activity will be geographically distributed as shown in the schematic representation.

A. Basic Service (refueling and sanding)
B. Basic Engine Inspection
C. Full Engine Service/Inspection
D. Movements of Cars to Car Repair Yard
E. Movements in Adjacent Classification Yard
F. Freight Movements on Adjacent Mainline
G. Commuter Rail Operations on Adjacent Mainline

The representation of emission sources in these geographical areas is discussed in Section II (Air Dispersion Modeling).

In addition, any predictable and recurring temporal activity and emissions profiles will be incorporated in the activity and emissions estimates used as input data to the dispersion modeling. The temporal activity profiles will be used to investigate short as well as long-term average emission concentrations.

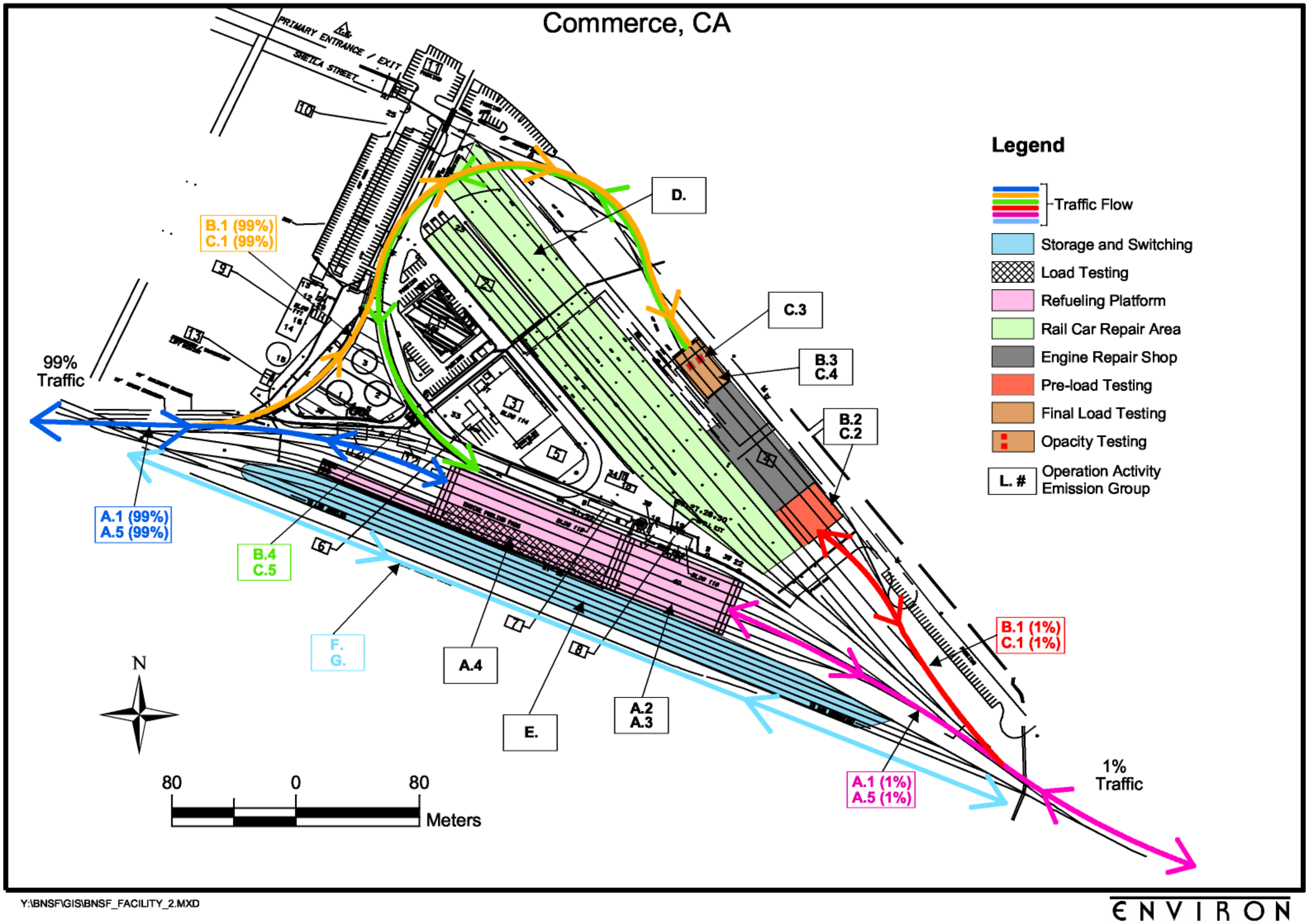

Figure 1. Annotated locomotive operations noted by location within the Commerce engine service site.

II. AIR DISPERSION MODELING

Air dispersion modeling will be performed to estimate the dispersion of DPM and significant TAC emissions from sources at the facilities identified in Table 1. 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. The type of air dispersion model and modeling inputs (i.e., source characterization and parameters, meteorological data, building downwash, terrain, land use, receptor locations, and averaging times) that will be used in the air dispersion modeling for the facilities in Table 1 are discussed below.

Model Selection and Model Control Options

BNSF will use the Industrial Source Complex Short Term (ISCST3) model (Version 02035), a steady-state Gaussian plume dispersion model, to estimate ambient air concentrations at the receptor locations described below. The ISCST3 model uses site-representative hourly surface and twice-daily upper air meteorological data for estimating the dispersion of emissions through the atmosphere. ISCST3 is a USEPA-recommended air dispersion model (see 40 CFR Part 51, Appendix W: *Guideline on Air Quality Models*) and preferred by ARB and California Air Districts such as South Coast Air Quality Management District (SCAQMD) and Bay Area Air Quality Management District (BAAQMD). BNSF will use the regulatory default model options for ISCST3, including:

- Stack-tip downwash (except for Schulman-Scire downwash);
- Buoyancy-induced dispersion (except for Schulman-Scire downwash);
- Final plume rise (except for building downwash);
- Calms processing;[1]
- Upper-bound concentration estimates for sources influenced by building downwash from "super-squat" buildings;
- Default wind profile exponents; and
- Default vertical potential temperature gradients.

Source Characterization and Parameters

Source characterization, location, and parameter information is necessary to model the dispersion of air emissions. All sources within the facility boundaries that have quantifiable emissions of DPM or TACs, as determined in the evaluation of source activities and emissions discussed above, will be modeled using ISCST3. In general, source locations will be determined from the activity information discussed above, facility plot plans, information provided by facility personnel, and/or recent aerial photographs of the facilities. BNSF will account for potentially significant temporal (i.e., hourly, daily, and/or seasonal) variations in activities and emissions from each source by using variable emission factors. Additional details regarding the

[1] Depending on the source of meteorological data, calms processing may not be used. For example, many SCAQMD-approved data sets contain high frequencies of calms data. Therefore, SCAQMD does not recommend calms processing be used for SCAQMD data sets.

characterization of sources, source locations, and modeling parameters for each source category discussed in Section I are described below.

Locomotives

In ARB's Roseville study, stationary locomotive activities were represented by series of point sources and movement sources were represented by individual volume sources. Locomotive sources were placed at individual points along the center rail line in areas where activities occurred on several parallel rail lines over long distances. Adjacent point sources and adjacent volume sources were spaced approximately 50 to 150 meters apart along these rail lines. Because each locomotive type had a different set of emissions release parameters at each notch setting, a series of point sources was used to represent each combination of locomotive type and notch setting (a maximum of 11 locomotive types and 9 notch settings per locomotive type) at each stationary source location. ARB used US EPA's SCREEN3 model to calculate plume rise adjustments to the initial plume release height and initial vertical dispersion for locomotive movement (volume) sources. Plume rise adjustments were calculated based on the average speeds for three different notch settings and two different atmospheric stability conditions (stability D representative of daytime conditions and stability F representative of night-time conditions). It is BNSF's understanding that ARB is currently developing guidance for emissions estimation, source placement, source representation, and source parameter estimation for activities associated with ports and railyards (e.g., locomotive, cargo handling equipment, and on-road truck acitivities) based on ARB studies at Roseville and the Port of Long Beach.

BNSF will work with ARB to determine appropriate methodologies for locomotive source representation, source placement, modeling parameters, and plume rise adjustments for line and volume sources. BNSF also proposes to perform sensitivity analyses to evaluate the effect of release parameters for each locomotive type and notch setting on downwind concentrations to determine if a smaller subset of release parameters may be used for each stationary source location in the dispersion modeling. After these sensitivity analyses have been completed, BNSF will work with ARB to determine whether the configuration of stationary sources (i.e., the number of sets of different release parameters) can be simplified/reduced. BNSF will also perform sensitivity analyses similar to those conducted in ARB's Roseville study to determine appropriate plume rise adjustments to the initial release height and initial vertical dimension for movement sources assuming a range of average locomotive similar to plume rise adjustments calculated by ARB for the Roseville study.

Cargo Handling Equipment

Cargo handling equipment such as cranes, chassis stackers, and side loaders will be represented as individual point, area, or volume sources depending on the emissions release characteristics (e.g., orientation of the emissions release, dimensions of the potential release area/volume) and the level of information available regarding specific operating locations for each source type. Modeling source parameters will be based on information from ARB studies, equipment manufacturer information, information from facility personnel, field measurements for specific equipment types, and/or consultation with ARB.

On-Road Trucks and Fleet Vehicles

BNSF will represent stationary on-road truck and fleet vehicle emissions (e.g., idling at gates, scales, and loading/unloading areas) as volume sources and movement emissions as line sources (series of volume sources). Volume and line source modeling parameters will be based on modeling parameters used for similar types of on-road trucks and fleet vehicles in previous ARB studies, vehicle manufacturer information, information from facility personnel, and/or consultation with ARB, and will account for plume rise adjustments.

Other Off-Road Equipment

Off-road equipment such as TRUs in railcars and trucks and track maintenance equipment will be represented as individual point, area, or volume sources depending on the emissions release characteristics (e.g., orientation of the emissions release, dimensions of the potential release area/volume) for each source type. BNSF will work with ARB to determine the appropriate type of modeling source to represent each type of equipment. Modeling parameters will be obtained from equipment manufacturer information, information from facility personnel, field measurements for specific source types, and/or consultation with ARB.

Stationary Sources

Stationary sources, such as diesel generators and degreasing equipment, will be represented as individual point, area, or volume sources depending on the emissions release characteristics (e.g., orientation of the emissions release, dimensions of the potential release area/volume) for each source type. BNSF will work with ARB to determine the appropriate type of modeling source to represent each type of stationary source. Modeling parameters will be obtained from Title V and/or local Air District permits, equipment manufacturer information, information from facility personnel, and/or field measurements for specific source types.

Meteorological Data

BNSF will work with ARB and the appropriate Air District(s) to determine the appropriate meteorological data set(s) to use in air dispersion modeling for each facility. In general, meteorological data will be selected based upon the following criteria: proximity of the meteorological monitoring station to the facility, the extent to which meteorology and terrain at the meteorological monitoring station is representative of meteorology and terrain at the facility, data completeness, and data availability (i.e., number of years of complete data).

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). Complex terrain can affect the results of an air dispersion analysis involving point and volume sources, but does not affect the predicted results for area sources. BNSF will evaluate terrain elevations in the vicinity of each facility using the appropriate United States Geological Survey (USGS) 7.5 Minute Quadrangle map(s). If the proposed modeling area in the vicinity of the facility contains both simple and complex terrain, the appropriate USGS digital elevation maps (DEMs) will be included in air dispersion modeling.

Building Downwash

Building downwash is the effect of buildings and structures on the dispersion of emissions from nearby point (stack) sources. BNSF will account for building-induced aerodynamic downwash effects by determining building dimensions (i.e., location of building corners and heights of buildings) in the vicinity of all stack sources. This information will be used as input into US EPA's Building Profile Input Program (BPIP) to generate building downwash parameters for the ISCST3 model. BNSF will perform sensitivity analyses to evaluate the impact of locomotive structures on off-site DPM concentrations from stationary locomotive (point) sources. Based on the results of these sensitivity analyses, BNSF will work with ARB determine if it is necessary to include locomotive structures in the dispersion modeling analysis.

Land Use

When using the ISCST3 air dispersion model, the user may select one of two types of dispersion coefficients based on the type of surrounding land use: rural or urban. Urban land use results in a larger surface roughness than rural land use. Larger surface roughness values result in increased mixing due to turbulence generated as the wind blows over surface obstacles, which typically results in lower predicted exposure point concentrations.

BNSF will work with ARB and the appropriate Air District(s) to determine whether urban or rural dispersion coefficients will be used in the air dispersion model. To assist in this evaluation, BNSF will use Auer's (Auer 1978) method of classifying land-use as either rural or urban to analyze the surrounding region in which the Site is located. This method calls for analysis of the land within a three-kilometer radius from the Site to determine if the majority of the land can be classified as either rural (i.e. undeveloped) or urban. If more than fifty percent of the area circumscribed by this three-kilometer radius circle consists of Auer land-use industrial, commercial or residential land types, then urban dispersion coefficients are used in modeling; otherwise, rural dispersion coefficients are used.

To determine the land-use surrounding the each facility, BNSF will review the following sources of information, if available: 1) the most recent USGS aerial photograph of the area surrounding each facility; 2) the most recent USGS topographic map of the area; and 3) the most recent zoning map from the city/municipality of jurisdiction, if available.

Receptor Locations

Locations of the receptor points at which air concentrations will be estimated must also be specified in an air dispersion analysis. ARB's Roseville study included a fine grid of receptors (20-meter spacing) extending one kilometer by one kilometer around the Maintenance Shop, a medium grid of receptors (50-meter spacing) extending six kilometers by eight kilometers covering the entire Roseville Yard and surrounding residential areas, and a coarse grid of receptors (200-meter spacing) extending 18 kilometers by 16 kilometers, covering the entire City of Roseville and part of Sacramento County. ARB's Roseville study did not include individual receptor points at potential sensitive receptors.

BNSF will also include a Cartesian grid of off-site receptors points around each facility. BNSF proposes to follow Guidance from the California EPA Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA 2003) which states, "The modeling analysis should contain a network of receptor points with sufficient detail (in number and density) to permit the estimation of the maximum concentrations." BNSF proposes to include for each facility a fine grid receptor network (100-meter spacing), a medium grid receptor network (250-meter spacing), and a coarse grid receptor network (500-meter spacing). The extent of each receptor grid network will depend on the magnitude of emissions from each site and the size of the site. After the point of maximum impact (PMI), maximum exposed individual resident (MEIR), and maximum exposed individual worker (MEIW) receptor points are identified, a fine receptor grid networks (with 20 to 50 meter spacing) will be modeled around the PMI, MEIR, and MEIW.

BNSF will not include individual receptor points at off-site locations corresponding to potential sensitive receptors. As indicated above, ARB's Roseville study did not include potential sensitive receptors. Furthermore, the results of ARB's Roseville study indicated that cancer risks of 10 in one million extended beyond the modeling domain (18 kilometers by 20 kilometers, covering a large portion of both Sacramento and Placer Counties). It is unlikely that government or online databases will contain sufficient information to locate all sensitive receptors within such large modeling domains. Based on the results of the ARB study, it is not feasible or practical to identify all potential sensitive receptors.

Averaging Times

Calculation of chemical concentrations for use in an exposure analysis requires the selection of appropriate concentration averaging times. BNSF will calculate chemical concentrations for multiple averaging times in this analysis. Annual average DPM and TACs concentrations will be calculated for use by ARB in estimating cancer and chronic non-cancer risk. If sources of TACs with acute toxicity criteria available from OEHHA are considered in the emission inventory, maximum short-term non-diesel TAC concentrations (one-hour averages) will also be calculated for use by ARB in estimating acute non-cancer risk for these TACs (DPM does not have acute toxicity criteria).

III. DEMOGRAPHIC DATA COLLECTION

BNSF will work with ARB to determine appropriate demographic data for each site. At a minimum, BNSF will collect Census block data to determine the affected residential population within proximity of each site. It may be necessary to ground truth these population estimates to ensure that the Census results are reasonable representations of surrounding neighborhoods. BNSF with assistance of municipal planners may determine that the Census data could be improved with data specific to the neighborhoods under consideration.

IV. SUMMARY

BNSF commits to working with ARB to refine the study approach, and provide all the necessary data in response to the MOU. BNSF will strive to meet or exceed ARB's expectation and forthcoming guidance for the Health Risk Assessment.

A proposed timeline for completing the work is suggested here. One of the sites due within 18 months will be completed within 12 months to allow ARB to review the method prior to the submittal of the results for the other sites.

Table 3. Proposed timeline.

Month	Start	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Sample Sites																														
Activity Data Collection	■	■	■	■																										
Emission Estimates					■	■	■	■																						
Site Evaluation	■	■	■	■	■	■																								
Dispersion Analysis							■	■	■	■	■	■																		
18 Month Sites																														
Activity Data Collection	■	■	■	■	■	■																								
Emission Estimates							■	■	■	■	■	■																		
Site Evaluation	■	■	■	■	■	■	■	■	■																					
Dispersion Analysis										■	■	■	■	■	■	■	■	■												
30 Month Sites																														
Activity Data Collection							■	■	■	■	■	■																		
Emission Estimates													■	■	■	■	■	■												
Site Evaluation										■	■	■	■	■	■	■	■	■	■	■	■									
Dispersion Analysis																			■	■	■	■	■	■	■	■	■	■	■	■

V. REFERENCES

ARB/Railroad Statewide Agreement. 2005. "Particulate Emissions Reduction Program at California Rail Yards," June.

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