MODELING PROTOCOL FOR $PM_{2.5}$ HOT SPOT ANALYSIS

I-580 WESTBOUND EXPRESS LANE PROJECT, ALAMEDA COUNTY

EA 04-2G4900
04-ALA-580 PM 21.5-7.8

Prepared for

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Introduction

This is a modeling protocol (Protocol) that will be used for the Interstate 580 (I-580) Westbound Express Lane Project (Project) in the event that the Bay Area Air Quality Conformity Task Force concludes that the project is a Project of Air Quality Concern (POAQC).

The California Department of Transportation (Department), in cooperation with the Alameda County Transportation Commission (Alameda CTC), proposes to convert the proposed single High Occupancy Vehicle (HOV) lane on westbound I-580 to a single express lane. The express lane would be restricted to HOVs (which include automobiles with two or more persons, buses, and motorcycles) and vehicles that pay a toll. The project limits are from west of the Greenville Road undercrossing to just east of the San Ramon Road/Foothill Road overcrossing in eastern Alameda County (Post Miles 7.8 to 21.5). The total length of the project is approximately 13.7 miles.

The proposed express lane would not require any roadway expansion, placement of additional pavement, or acquisition of right-of-way. The express lane would use the same striping and alignment as the HOV lane. Tolling equipment and signage would be installed, and trenching along the outside edge of pavement would occur for installation of conduits.

It is projected that construction of the westbound HOV lane and the conversion to an express lane will be simultaneous, to allow the facility to open to traffic as an express lane. Consultation with the Bay Area Air Quality Conformity Task Force was completed in February 2012 for the westbound HOV lane project (TIP ID ALA070018; FMS ID 185.00).

This modeling protocol outlines the major modeling decisions and inputs that will be utilized to model the $PM_{2.5}$ impacts from the project in relation to the National Ambient Air Quality Standards (NAAQS). This analysis is being conducted as part of the transportation conformity analysis Particulate Matter (PM) Hot Spot Program. The United States Environmental Protection Agency (USEPA) has issued guidance on how to conduct this type of analysis.[1] This document outlines nine major steps to completing a PM Quantitative Hot Spot Analysis.

Step 1: Determine Need for Analysis
Step 2: Determine Approach, Models, and Data
Step 3: Estimate On-Road Motor Vehicle Emissions
Step 4: Estimate Emissions from Road Dust, Construction, and Additional Sources
Step 5: Select Air Quality Model, Data Inputs, and Receptors
Step 6: Determine Background Concentrations
Step 7: Calculate Design Values and Determine Conformity
Step 8: Consider Mitigation or Control Measures
Step 9: Document Analysis

This Protocol will outline the key decisions and data inputs that will be used in Steps 2 through 6. Step 1 is to be determined by the Bay Area Air Quality Conformity Task Force, and this

[1] USEPA. 2010. Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas. EPA-420-B-10-040. December.

Protocol will only be used if it is determined that a quantitative $PM_{2.5}$ Hot Spot Analysis is required. Steps 7 through 9 will be completed after the modeling protocol is approved and the analyses are completed. After completion of the analyses, the $PM_{2.5}$ Hot Spot Analysis will be provided to the Bay Area Air Quality Conformity Task Force for concurrence that the project meets the $PM_{2.5}$ conformity hot spot requirements in 40 Code of Federal Regulations (CFR) 93.116 and 93.126.

Step 1: Determine Need for Analysis

The Transportation Conformity regulations specify five main types of projects that would require a quantitative PM hot spot analysis. These are outlined below along with a summary of why this project does not qualify under the criteria.

(i) New or expanded highway projects with significant number/increase in diesel vehicles?

The single express lane would not allow for a significant increase in diesel vehicles. The majority of diesel trucks are restricted from using HOV lanes, even for passing, by California Vehicle Code Section 21655(b).

The estimated increase in diesel trucks compared with the No Build condition is 4.3% in 2015 and 6.9% in 2035. This does not constitute a significant increase under 40 CFR 93.123(b)(1).

(ii) Affects intersections at LOS D, E, or F with a significant number of diesel vehicles?—Not Applicable

(iii) New bus and rail terminals and transfer points?—Not Applicable

(iv) Expanded bus and rail terminals and transfer points?—Not Applicable

(v) Affects areas identified in PM_{10} or $PM_{2.5}$ implementation plan as site of violation?

There is no state implementation plan for PM2.5, and the project area is therefore not identified in an implementation plan as an area of potential violation (40 CFR Section 93.123(b)(1)(v)).

In addition, the project area is not included in the Bay Area Air Quality Management District's Community Air Risk Evaluation program, which identifies Bay Area communities that are disproportionately impacted by emissions from transportation and stationary sources.

Additional support for a determination that the project is not a Project of Air Quality Concern is provided below.

1. According to the Federal Highway Administration $PM_{2.5}$ FAQs, which were coordinated with the USEPA:

Would any nonexempt project on a facility with 125,000 AADT and 8% diesel trucks be a "project of air quality concern," or would only a project that significantly increased the number of diesel vehicles on such a facility be a "project of air quality concern?"

As discussed in the examples in the preamble to the March 10, 2006 rule (71 FR 12491), 40 CFR 93.123(b)(1)(i) should be interpreted as applying only to projects that would involve a significant increase in the number of diesel transit busses and diesel trucks on an existing highway facility [Emphasis added]. The example of 125,000 AADT and 8% diesel trucks is intended for new facilities, not as an example of a "significant increase." This is consistent with 93.123(b)(1)(iv) which defines projects of air quality concern based on a significant increase the number of diesel vehicles due to terminal or transfer project expansion. A "significant increase" in the number of diesel transit busses and diesel trucks under either 40 CFR 93.123(b)(1)(ii) or (iv) would need to be determined through interagency consultation.
(http://www.fhwa.dot.gov/environment/air_quality/conformity/reference/faqs/pm25faqs.cfm)

Westbound I-580 in the project limits is an existing roadway that contains segments with existing AADT and truck percentages that are over 125,000 AADT and 8% or more diesel truck traffic. The proposed single express lane project would allow for only a nominal increase in diesel truck traffic, as some non-diesel vehicles move from the general purpose lanes to the express lane. Neither the HOV lane nor the express lane can be used by diesel trucks, even for passing (California Vehicle Code Section 21655(b)).

AADT data for the 2015 and 2035 Build conditions show an average truck percentage increase of 4.3% and 6.9%, respectively, compared with No Build conditions.

2. In February 2012, Alameda CTC provided the Air Quality Conformity Task Force with a qualitative Hot Spot Analysis for the I-580 Westbound HOV Lane in the generally same project limits on I-580. The Hot Spot Analysis demonstrated that the HOV lane would reduce $PM_{2.5}$ emissions in both 2015 and 2035 because of travel time savings, decreased delay times, and improvements in average network speed when compared to the No Build Alternative.

   The proposed express lane would allow for only a nominal increase in diesel truck traffic compared with the HOV lane, as some non-diesel vehicles move from the general purpose lanes to the express lane. As demonstrated in the LOS data for 2015 and 2035 Build conditions, the express lane would improve the overall level of service compared with the HOV lane (No Build condition). Therefore, the proposed project is expected to further reduce $PM_{2.5}$ emissions compared with No Build.

3. State Implementation Plan (SIP) requirements that pertain to developing a plan will be suspended, as described further below. As there is no plan for $PM_{2.5}$, there are no areas formally identified as areas of concern. However, the Bay Area Air Quality Management District (BAAQMD) has developed the Community Air Risk Evaluation (CARE) program to identify Bay Area communities that are disproportionately impacted by emissions from transportation and stationary sources. The CARE program has identified six disproportionately impacted communities: Concord; Richmond/San Pablo; western Alameda County; San Jose; Redwood

City/East Palo Alto; and eastern San Francisco. The location of this project is not in one of these identified CARE communities. Therefore, this area is not an area identified by the BAAQMD as an area of potential air quality concern.

Step 2: Determine Approach, Models and Data

The project area is shown in Figure 1. The project is located on westbound I-580 from Greenville Road to San Ramon Road/Foothill Road. This section of I-580 passes through the cities of Dublin, Pleasanton, and Livermore. The project is located in the eastern portion of Alameda County, which is part of the San Francisco Bay Area Air Basin. The local air district is the BAAQMD.

The area is designated as nonattainment for the 24-hour $PM_{2.5}$ NAAQS. A quantitative hot spot analysis is required for transportation projects in federal nonattainment or maintenance areas for PM that are funded or approved by the Federal Highway Administration or Federal Transit Administration. No other pollutants or averaging times are required to be analyzed since the area is in attainment.

The Bay Area levels of $PM_{2.5}$ were just over the national 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$ based on data for the three-year cycle 2006-2008. This triggered the requirement for the Bay Area to prepare a SIP submittal to demonstrate how the region would attain the standard. However, data for both the 2008-2010 and the 2009-2011 cycles showed that Bay Area PM levels currently meet the standard. On October 29, 2012, EPA issued a proposed clean data determination rule-making to determine that the Bay Area now attains the 24-hour $PM_{2.5}$ national standard. Once this determination is finalized, the SIP requirements that pertain to developing a plan will be suspended.

The details of the approach, models and inputs are described under Steps 3 through 6.

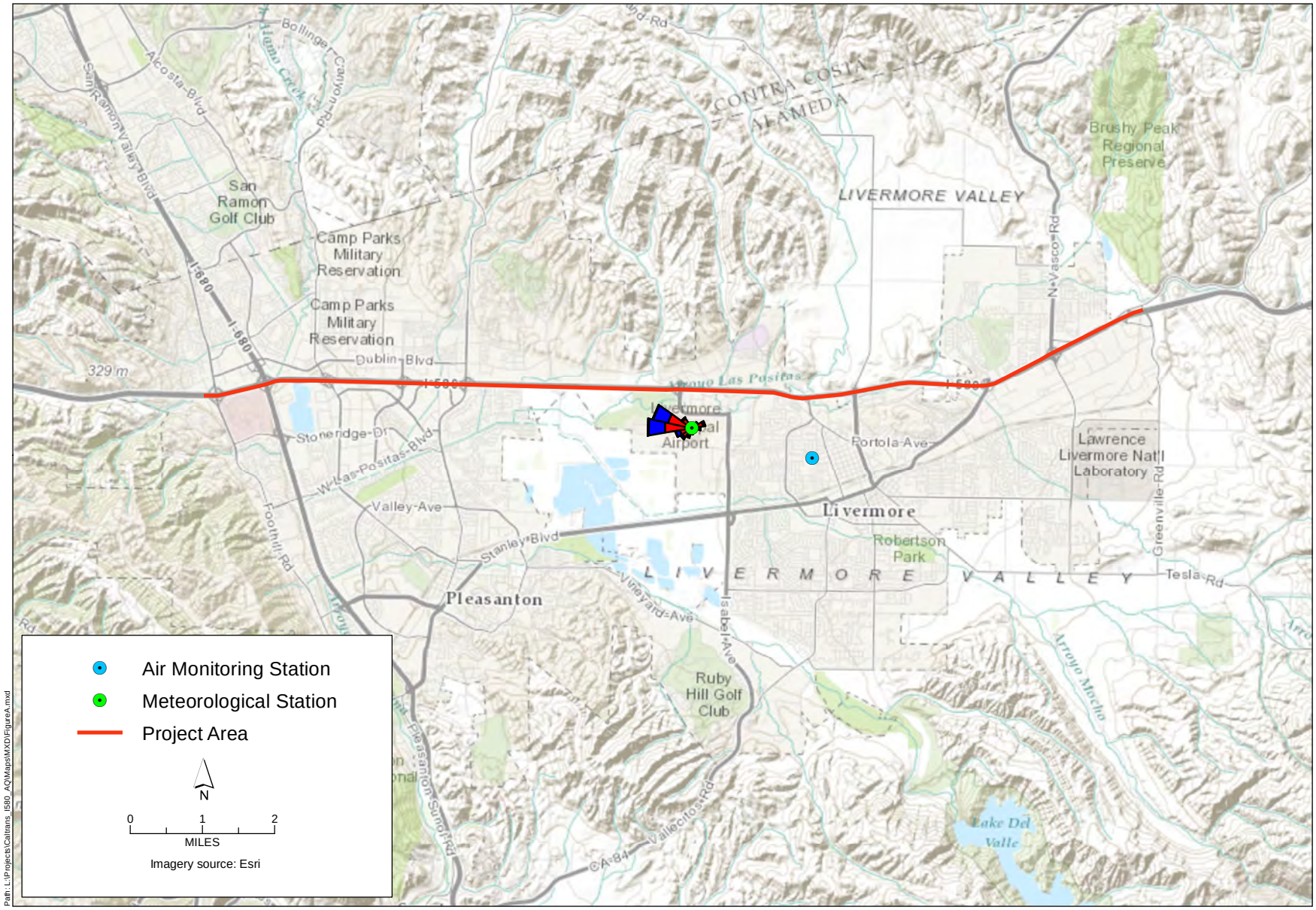

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Figure 1
Monitoring stations

Step 3: Estimate On-Road Motor Vehicle Emissions

Since the project is located in California, the USEPA requires use of the EMFAC2007 program. The USEPA has yet not approved the newer EMFAC2011 for use in transportation conformity analyses. The EMFAC 2007 model does not include some of the more recent regulations enacted that will decrease particulate matter emissions. For this reason, the use of EMFAC2007 is conservative.

EMFAC requires several inputs in order to generate the appropriate emission factors for the various vehicle classes. The inputs are summarized in Table 1.

Table 1: EMFAC Input Parameters

Parameter	Value
Geographic Area	Alameda County
Calendar Years	2015 and 2035
Season	Annual
Model Years	All
Vehicle classes	All
I/M Schedules	Default
Temperature	74%
Relative Humidity	57°F
Speed	To be determined by traffic analysis
EMFAC Program Constants	To be adjusted based on Truck and non-truck percentage for VMT, population, and trips

The emission factors generated in EMFAC2007 are combined with the traffic volumes and vehicle speeds for each of the links analyzed by the traffic model. This creates an emissions density for the link that is combined with the air dispersion model to obtain ambient air concentrations associated with the project.

Step 4: Estimate Emissions from Road Dust, Construction, and Additional Sources

The project will not include any additional emissions from road dust, construction or additional sources.

The transportation conformity rule requires a hot spot analysis in a $PM_{2.5}$ nonattainment and maintenance area to include emissions from re-entrained road dust only if emissions from re-entrained road dust are determined to be a significant contributor to the $PM_{2.5}$ nonattainment problem. Road dust has not been determined to be a significant contributor to the $PM_{2.5}$ nonattainment problem.

Emissions from construction-related activities are not required to be included in PM hot spot analyses if such emissions are considered temporary, as defined in 40 CFR 93.123(c)(5) (i.e., emissions that occur only during the construction phase and last five years or less at any individual site). Since project construction will take less than five years, there is no need to analyze construction emissions.

There are no nearby or other emissions sources that would not be found in the background concentration estimate, since the monitoring station is near the project and downwind of sources in the area.

Step 5: Select Air Quality Model, Data Inputs, and Receptors

For PM hot-spot analyses, there are two models that USEPA recommends under Appendix W to 40 CFR Part 51. These models are the American Meteorological Society/EPA Regulatory Model (AERMOD) and CAL3QHCR, which is an extension of the CAL3QHC model. For Highway and Intersection Projects, either of these models can be utilized.

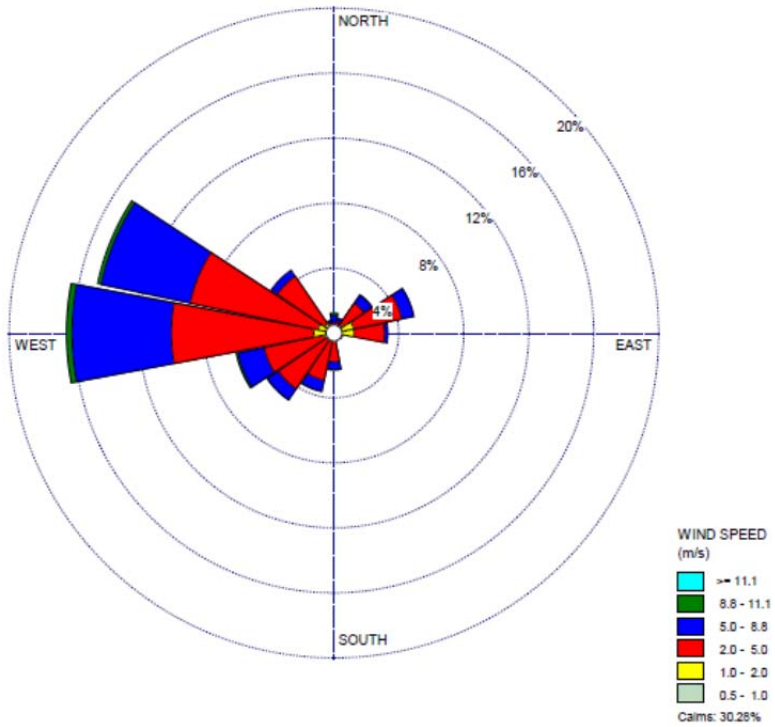
For this project, AERMOD will be utilized based on the following three reasons. First, AERMOD is flexible in how different sources are represented, while CAL3QHCR represents all sources as “line sources.” Second, AERMOD allows for a much greater number of receptors and sources to be modeled simultaneously. Third, AERMOD’s treatment of dispersion in the lower atmosphere is based on more current atmospheric science than CAL3QHCR.

The latest AERMOD version is 12345. AERMOD requires several data inputs, which are described in further detail below.

Meteorological Data

AERMET is a meteorological data pre-processor for AERMOD. This program formats both surface and upper air meteorological data into the format utilized by AERMOD. The latest AERMET version, 12345, will be used along with five years of the most recent meteorological data from the nearest National Weather Service station. For this project, the Livermore Airport station for the years 2008 through 2012 will be used for the surface station. See Figure 1 for the location of this meteorological station relative to the project. The figure also shows the wind rose for the five years of meteorological data, which is also shown in larger detail in Figure 2. The upper air data is from Oakland International Airport since it is the closest upper air station.

Figure 2: Wind rose of Livermore Airport Meteorological Data 2008-2012



The USEPA requires that meteorological data be 90% complete by quarter in order for it to be used in air dispersion modeling. Table 2 shows the completeness statistics for the Livermore Airport station. All quarters meet the completeness requirement.

Table 2: Data Completeness for Livermore Airport Station

Year	Q1	Q2	Q3	Q4
2008	98%	94%	95%	98%
2009	98%	90.5%	96%	98%
2010	98%	95%	95%	98%
2011	98%	96%	95%	98%
2012	97%	96%	94%	97%

AERMET requires the use of three surface parameters: surface roughness, albedo, and Bowen Ratio. The USEPA has developed the program AERSURFACE (version 13016 is the most recent) to assist in estimating these parameters. This program uses the 1992 National Land Cover Dataset (NLCD). This Protocol recommends the use of AERSURFACE with the 1992 NLCD even though a more recent 2001 NLCD is available. The USEPA just released a new version of AERSURFACE without incorporating the 2001 NLCD as an option. This is likely due to some differences in land use classifications that make it difficult to assign appropriate surface parameters to the classifications. In an analysis of the differences between the 2001 and 1992

NLCDs shown in Figures 3 and 4 and Table 3, no major differences are noted in the 1-kilometer buffer region used for the surface roughness. There is a slight difference in the 10-kilometer buffer region. This is mainly attributed to a change from pasture to developed land. There is no significant difference between the albedo assigned to these classifications. There is a slight difference in Bowen Ratios between these classifications. However, given the small overall impact of the Bowen Ratio on the final air dispersion results, it is not anticipated that this would be a significant concern given the uncertainty in assigning appropriate values to the 2001 NLCD for the new land use classifications.

Table 3: Comparison of Land Use Area

1992 NLCD				2001 NLCD			
NLCD Code	**Description**	**Percent Area 10 km**	**Percent Area 1 km**	**NLCD Code**	**Description**	**Percent Area 10 km**	**Percent Area 1 km**
11	Water	3%		11	water	4%	1%
21	Low Intensity Residential	18%	2%	21	Developed open space	17%	24%
22	High Intensity Residential	0%	0%	22	Developed low intensity	10%	11%
23	Commercial Industrial	13%	38%	23	Developed Medium Intensity	27%	30%
31	Bare Rock	3%	3%	24	Developed High Intensity	4%	10%
32	Quarries	0%	0%	31	Barren Land	1%	0%
41	Deciduous Forest	0%	0%	42	Evergreen Forest	0%	0%
42	Evergreen Forest	0%	0%	43	Mixed Forest	0%	
43	Mixed Forest	1%	0%	52	Shrub/Scrub	1%	0%
51	Shrub land	2%	4%	71	Grassland	31%	23%
61	Orchards	1%	6%	81	Pasture	2%	0%
71	Grassland	33%	8%	82	Cultivated Crops	3%	0%
81	Pasture	17%	20%	90	Woody Wetlands	0%	0%
82	Row Crops	3%	11%				
83	Small Grains	4%	2%				
85	Urban/Recreational Grasses	3%	7%				
91	Woody Wetlands	0%					
92	Emergent Herbaceous Wetlands	0%					

Terrain Data

Complex terrain will utilize the best available resolution of elevation data from the National Elevation Data (NED).

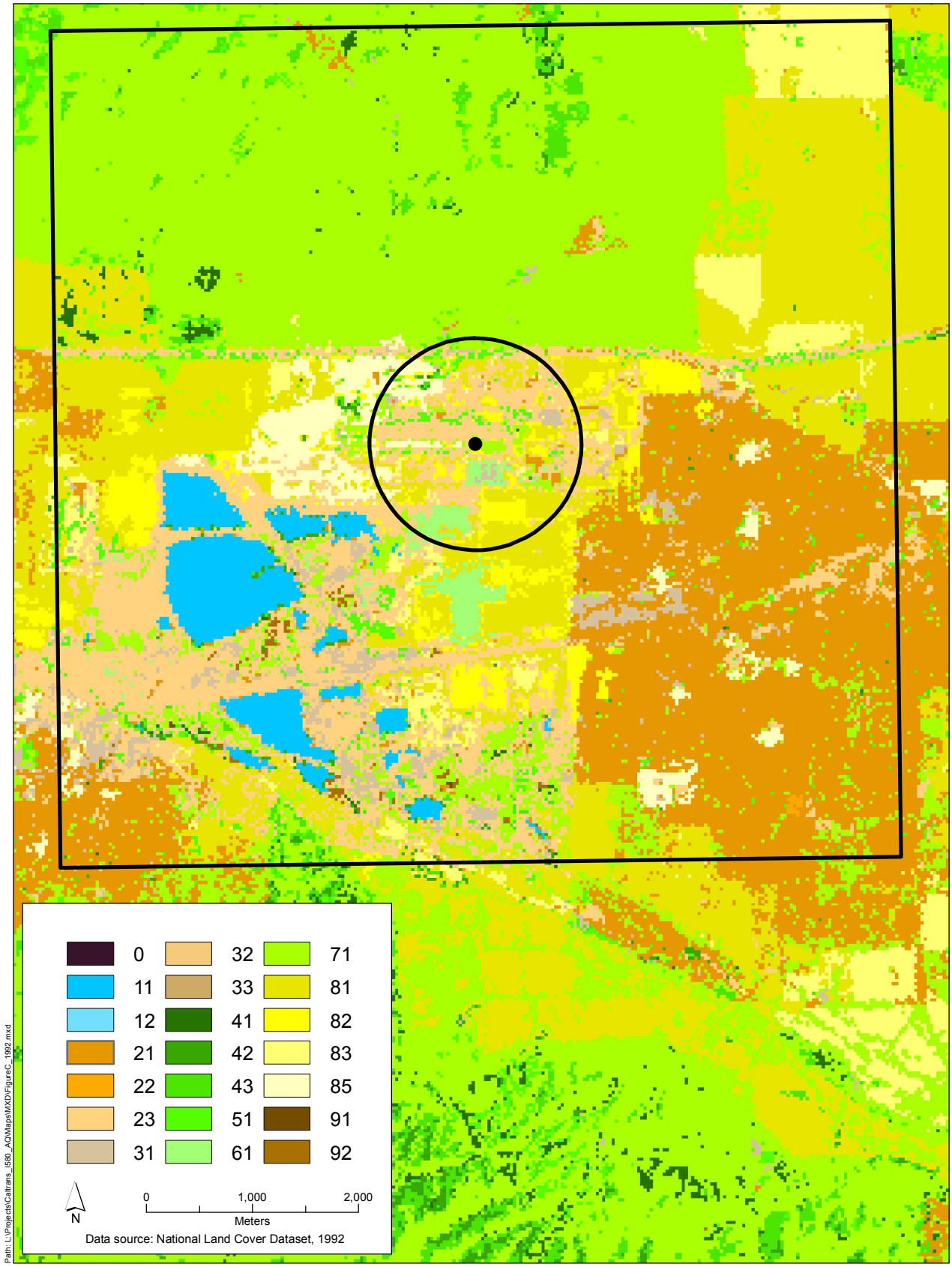


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Figure 3
1992 Land use

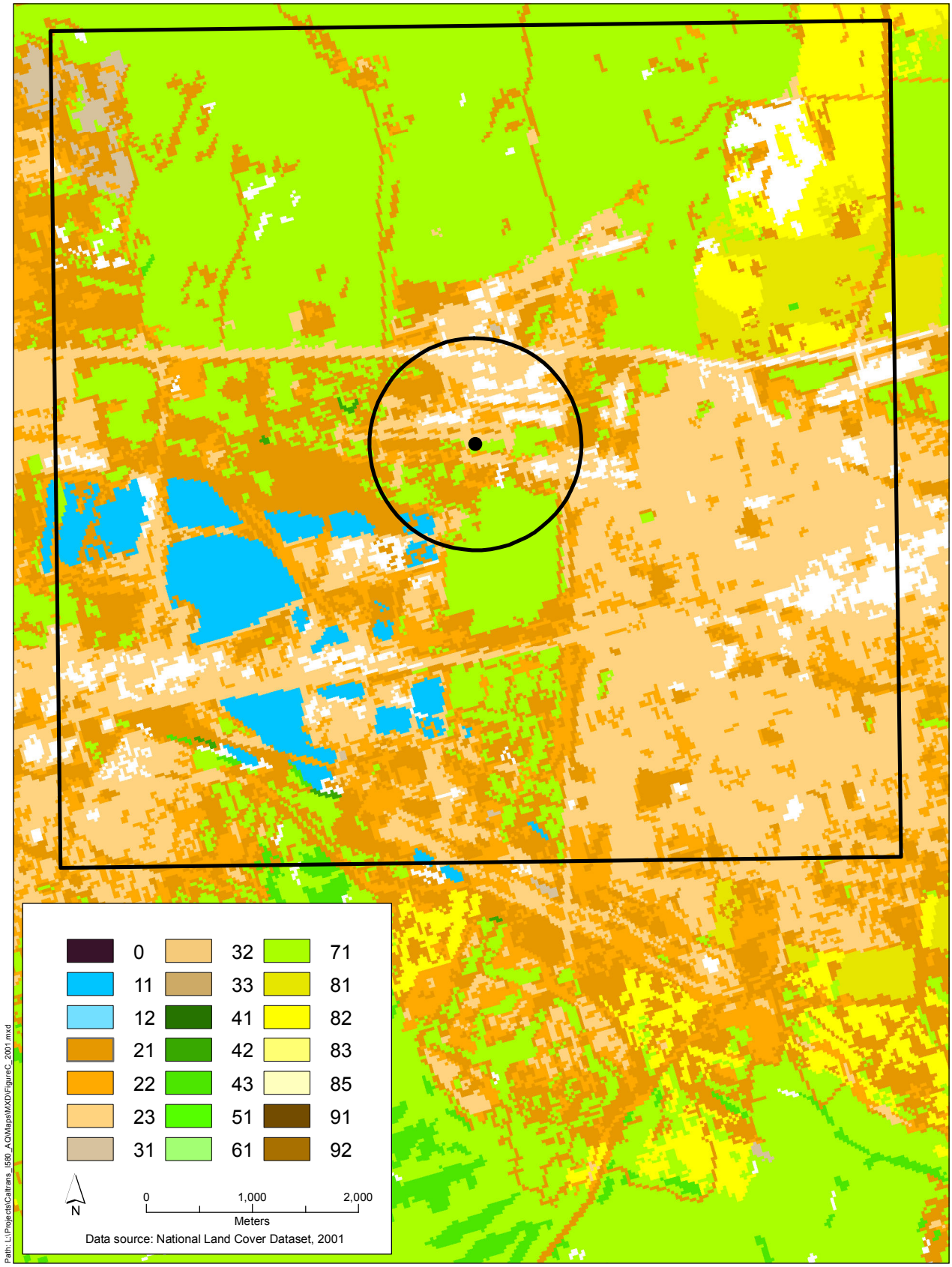

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Figure 4
2001 Land use

Source Characterization

The HOV/express lane and the regular lanes will be modeled as separate links and separate volume sources. Adjacent volume sources will be utilized with the following formulas to determine the source parameters[1]:

Source Parameter	Value
Release Height	Height cars = 1. 3 meters Height trucks = 3.4 meters (this will be weighted for volume of cars versus trucks)
Initial Lateral Dimension	Lane width + 6 meters
Initial Vertical Dimension	1.7 * vehicle height /2.15 Vehicle height cars = 1.53 meters Vehicle height trucks = 4 meters (this will be weighted for volume of cars versus trucks)

All sources will be classified as urban sources with a population of 197,289, which represents the combined populations of Dublin, Livermore, and Pleasanton based on 2010 U.S. Census data.

The surface roughness will be the default of 1 recommended by USEPA.

Time of day variation will be taken into account based on the changes in traffic volume for the a.m. peak, p.m. peak, and all other times.

Receptor Grid

Figure 5 shows the proposed receptor grid for modeling. This is based on a 25-meter-by-25-meter grid from 0 to 0.1 kilometers from the project right-of-way, a 50-meter-by-50-meter grid for 0.1 to 0.5 kilometers, a 100-meter-by-100-meter grid for 0.5 to 1 kilometers, and a 200-meter-by-200-meter grid for 1 to 2 kilometers.

Discrete sensitive receptors will be added, designating any schools and care facilities in the area. The Geographic Names Information System (GNIS) database will be used along with supplemental information from California databases. The following state databases will be used to identify these receptors:

Hospitals: http://www.alirts.oshpd.ca.gov/AdvSearch.aspx
Licensed child care facilities:
https://secure.dss.cahwnet.gov/ccld/securenet/ccld_search/ccld_search.aspx
Schools: http://www.cde.ca.gov/re/sd/index.asp

[1] These values are consistent with recommendation in Appendix J of USEPA's Transportation Conformity Guidance (USEPA. 2010 Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas. EPA-420-B-10-040. December.)

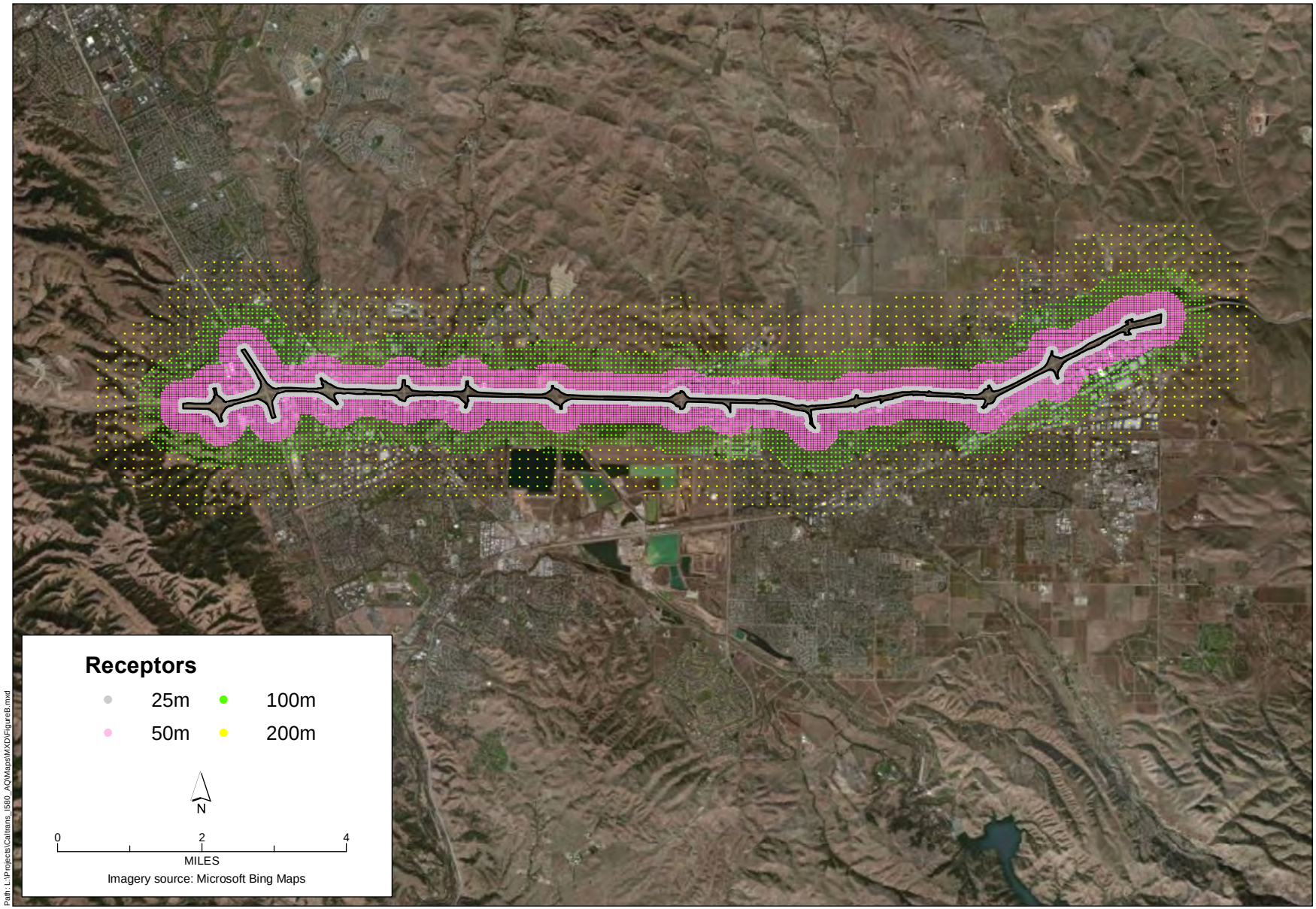

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Figure 5
Receptor grid

Step 6: Determine Background Concentrations

Livermore Rincon station is the closest ambient monitoring station in the area. See Figure 1 for its location relative to the project area. Since this is the only station nearby, it will be used to determine background concentrations.