Appendix C
Air Emissions Data

Appendix C-1

Modeling Protocol

The following Modeling Protocol was submitted for review to the California Energy Commission (CEC), the U.S. Environmental Protection Agency (U.S. EPA) and the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) on April 22, 2008. Since development of the Protocol, the Project has undergone certain refinements. Please refer to Section 2.0, Project Description, of the Application for Certification for the comprehensive description of the Project and its operations. None of the refinements made to the Project subsequent to development of the Modeling Protocol affect the appropriateness of the Modeling Protocol for use in analyzing Project impacts. Comments on the Modeling Protocol were received from the CEC and U.S. EPA. Those comments, and Applicant's responses thereto, are also included in this Appendix under C-2.

AIR QUALITY MODELING PROTOCOL FOR THE HECA POWER PROJECT KERN COUNTY, CALIFORNIA

Prepared For:

- San Joaquin Valley Air Pollution Control District

- California Energy Commission

- U.S. Environmental Protection Agency Region IX

- U.S. Forest Service

- National Park Service

Prepared on behalf of

Hydrogen Energy International LLC

April 22, 2008

URS

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$\mu g/m^3$	Micrograms per cubic meter
AAQS	Ambient Air Quality Standards
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AFC	Application for certification
APN	Assessor Parcel Number
AQRV	Air quality related values
ARB	Air Resources Board
ARM	Ambient Ratio Method
ATC	Authority to construct
BACT	Best available control technology
BART	Best available retrofit technology
BPAE	BP Alternative Energy
BPIP	Building profile input program
BPIP-Prime	Building Parameter Input Program – Prime
CAAQS	California Ambient Air Quality Standards
CARB	California Air Resources Board
CEC	California Energy Commission
CO	Carbon monoxide
CO_2	Carbon dioxide
CTG	Combustion turbine generator
°C	degrees Celsius
DAT	Deposition analysis threshold
DCS	Distributed Control System
DEGADIS	Dense gas dispersion model
DEM	Digital elevation model
DOC	Determination of compliance
EC	Element carbon
ERC	Emission reduction credit
FLAG	Federal land manager air quality related values group
FLM	Federal Land Manager
°F	Degree Fahrenheit
GEP	Good engineering practice
g/s	Gram per second
H_2S	Hydrogen Sulfide
HARP	Hotspots analysis and reporting program
HECA	Hydrogen Energy California
HEI	Hydrogen Energy Inc
HHV	Higher heating value
HI	Hazard Indices
HNO_3	Nitric acid
HRA	Health risk assessment
HRSG	Heat recovery steam generator
IGCC	Integrated gasification combined cycle
ISCST3	Industrial Source Complex Short Term 3rd version

ISO	International Organization for Standardization
IWAQM	Interagency Workgroup on Air Quality Modeling
km	Kilometers
LAC	Level of acceptable change
LCC	Lambert Conformal Conic
LORS	Laws, ordinances, regulations, and standards
LULC	Land use land cover
MEI	Maximally exposed individual
m	Meters
mm	Millimeters
MICR	Minimum individual cancer risk
MM5	Mesoscale meteorological
MMBtu/hr	Million British thermal unit per hour
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NH_4NO_3	Ammonium nitrate
$(NH_4)_2SO_4$	Ammonium sulfate
NNSR	Non-attainment New Source Review
NO_2	Nitrogen dioxide
NO_3	Nitrate
NO_x	Nitrogen oxides
NPS	National Park Service
NSR	New source review
NWS	National Weather Service
O_3	Ozone
OEHHA	Office of Environmental Health Hazard Assessment
OLM	Ozone limiting method
Pb	Lead
$PM_{2.5}$	Particulate matter less than 2.5 μm in diameter
PM_{10}	Particulate matter less than 10 μm in diameter
ppb	Parts per billion
ppm	Parts per million
PMS	Particulate Matter Speciation
PSD	Prevention of significant deterioration
PTE	Potential to emit
RH	Relative humidity
ROC	Reactive organic compound
SCR	Selective catalytic reduction
SIL	Significant impact level
SJVAPCD	San Joaquin Valley Air Pollution Control District
SO_2	Sulfur dioxide
SO_x	Sulfur oxides
SOA	Secondary organic aerosol
STG	Steam turbine generator
TAC	Toxic air contaminants

T-BACT	Best available control technology for toxics
TGT	Tail gas treatment
tpy	Tons per year
TSP	Total suspended particles
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
WRAP	Western regional air partnership
ZOI	Zone of impact

SECTION 1 INTRODUCTION

1.1 BACKGROUND

Hydrogen Energy California (HECA) will be a nominal net 250-megawatt (MW) integrated gasification combined cycle (IGCC) power plant to be constructed on an approximately 315-acre parcel near an oil producing area in Kern County, Southern California. The Project will be owned and operated by Hydrogen Energy International LLC, a joint venture of BP Alternative Energy (BPAE) and Rio Tinto. HECA will integrate a gasification block consisting of two active gasification trains (and one spare in hot standby mode) and associated equipment and a power block consisting of one hydrogen-fired or natural gas-fired, or a combination of hydrogen and natural gas, combustion turbine-electrical generator (CTG), duct-fired heat recovery steam generator (HRSG), one condensing steam turbine generator (STG) and associated equipment. HECA will be permitted as a base loaded facility. A blend of petroleum coke and coal or 100 percent petroleum coke will be the primary feedstock to the gasifier. The Carbon Dioxide (CO_2) gas exiting the gasifier will be separated from the hydrogen stream and injected into the nearby oil fields to reduce greenhouse gas emissions from the project and for enhanced recovery of oil. Natural gas will be used in the CTG during startups and at other times in the CTG and the HRSG to supplement the hydrogen fuel. The project will also include an auxiliary CTG for electrical power production for on-site and off-site use. This will be a natural gas-fired simple cycle gas turbine GE model number LMS-100 with an output of approximately 100 MW.

The HECA site area is approximately 315 fenced acres located near an oil producing area in Kern County, Southern California. It is 11 miles southwest of Bakersfield near Buttonwillow. The parcel is just west of Tupman Road and south of the town of Buttonwillow. The legal description is as follows: North ½ of Section 22 within Township 30 South, Range 24 East on Kern County Assessor's Parcel Number is APN 159-180-12 (See Figure 1).

The project is subject to the site licensing requirements of the California Energy Commission (CEC). The CEC will coordinate its independent air quality evaluations with the San Joaquin Valley Air Pollution Control District (SJVAPCD) through the Determination of Compliance (DOC) process. The HECA will be a Major Source as this term is defined in the United States Environmental Protection Agency's (USEPA) Prevention of Significant Deterioration (PSD) regulations, because it is a categorical source (fossil-fuel fired steam electric plant of more than 250 MMBtu/hr heat input), and will have a potential to emit more than 100 tons per year (tpy) of nitrogen oxides (NO_x), particulate matter of diameter less than or equal to 10 microns (PM_{10}) and carbon monoxide (CO). Volatile Organic Compounds (VOC) and sulfur oxides (SO_x) will be emitted in lesser amounts. Because the project will emit more than 100 tpy of at least one attainment pollutant, PSD analyses are also required for any other criteria pollutants for which the proposed facility's Potential to Emit exceeds PSD significant emission levels.

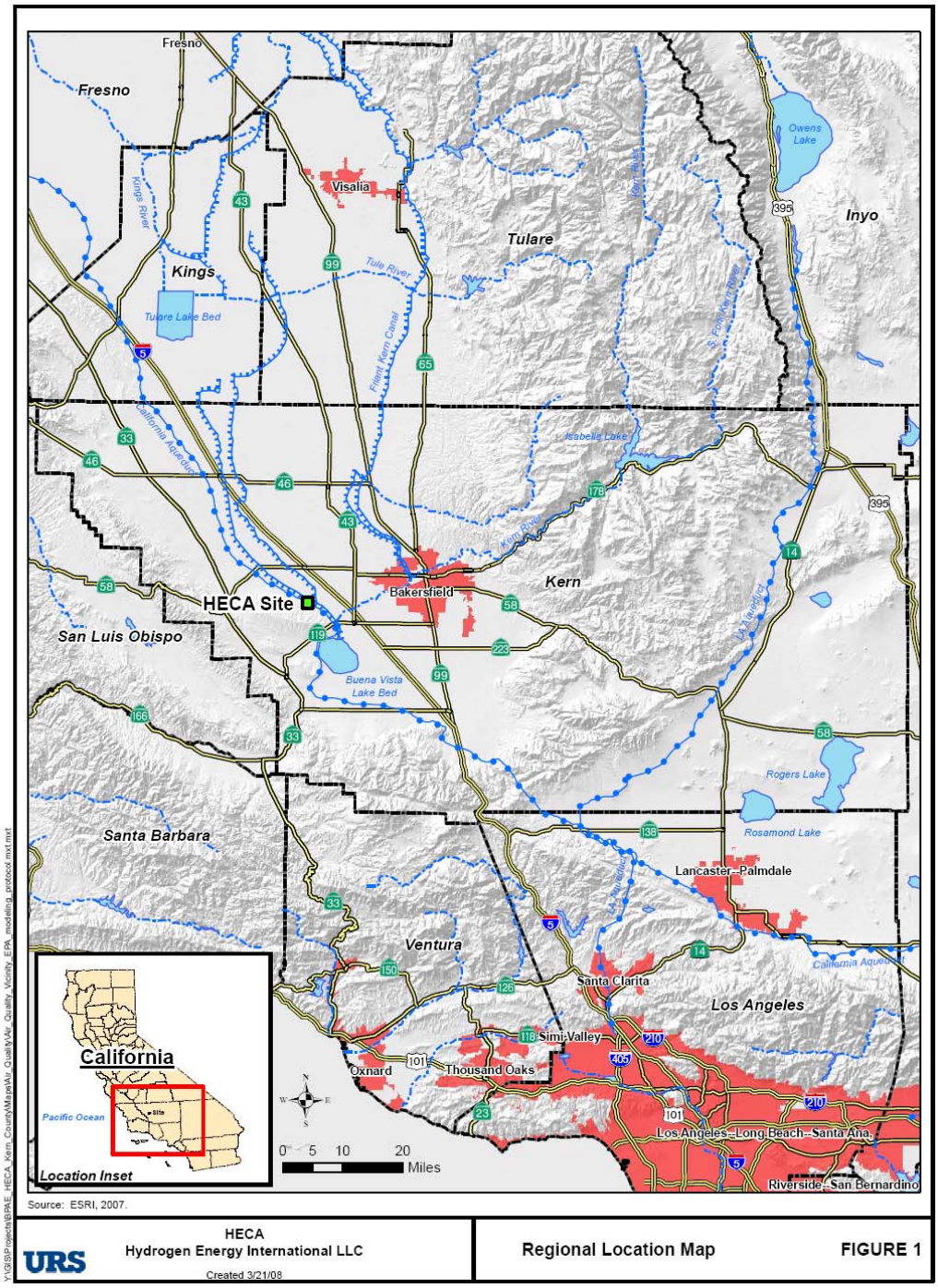
The annual emissions estimates described above are based on the following annual operating parameters:

- Up to 4 gasification block startups and shutdowns each year;
- Up to 3 cold power block starts, 2 warm power block starts and 5 shutdowns per year of the CTG;
- Up to 7,500 hours/year at steady state operation of the power block;
- Up to 8,520 hours/year operation of the cooling towers;

- Up to 4,000 hours per year operation of the Auxiliary CTG
- Up to 25 percent annual capacity of the auxiliary boiler; and
- Intermittent testing of the emergency diesel generator and the emergency diesel fire pump.

Because the project triggers PSD review, the air dispersion modeling for this project will be conducted in conformance with PSD requirements. For example, worst-case predicted impacts will be compared with the applicable monitoring exemption limits to demonstrate that the project will be exempt from the requirements relating to pre-construction ambient air quality monitoring. The PSD regulations apply only to those pollutants for which the project area is in attainment of the National Ambient Air Quality Standards (NAAQS). State and local new source review (NSR) and non-attainment NSR (NNSR) regulations potentially apply to all criteria pollutants, depending on the quantity of pollutants emitted.

Figure 1
General Vicinity – Hydrogen Energy California



The area around HECA is classified as attainment with respect to the NAAQS for nitrogen dioxide (NO_2), particulate matter with diameter less than 10 micrometers (PM_{10}), CO, and SO_2, and non-attainment for ozone (O_3) and particulate matter with diameter less than 2.5 micrometers ($PM_{2.5}$). With respect to the California Ambient Air Quality Standards (CAAQS), the area around HECA is classified as attainment for NO_2, CO, sulfates, lead (Pb), hydrogen sulfide, and SO_2, and non-attainment for O_3, PM_{10}, and $PM_{2.5}$. NO_2 and SO_2 are regulated as PM_{10} precursors, and NO_2 and volatile organic compounds (VOC) as O_3 precursors. Project emissions of non-attainment pollutants and their precursors will be offset to satisfy federal and local NNSR regulations.

1.2 PURPOSE

The CEC, SJVAPCD and USEPA all require the use of atmospheric dispersion modeling to demonstrate that a new power generation facility or modification to an existing facility will comply with applicable air quality standards. These agencies also require an assessment of the potential impacts on human health from the toxic air contaminants that may be emitted by such projects. In addition, CEC power plant siting regulations require modeling to evaluate the cumulative impacts of the proposed project with other new and reasonably foreseeable projects within 10 km (6 miles) of the project site.

This document summarizes the procedures that are proposed for the air dispersion modeling for project certification and permitting. Modeling of both operation and construction emissions due to the proposed power plant will be performed in accordance with CEC and SJVAPCD guidance. This Protocol is being submitted to the CEC and SJVAPCD for their review and comment prior to completion of the applicable permit applications. The Protocol is also being provided to USEPA Region IX, U.S. Forest Service and National Park Service, because of the need to obtain a separate PSD permit for the proposed project. The proposed model selection and modeling approach is based on review of applicable regulations and agency guidance documents, and recent discussions with staffs of the responsible agencies.

SECTION 2 PROJECT DESCRIPTION

2.1 PROJECT LOCATION

The location of the proposed project is shown on Figure 1, which also illustrates the project site, and nearby roads and other features. The HECA site is approximately 315 acres in size. The site is accessible from Bakersfield via State Highway 119 westbound and west of Tupman Road.

2.2 DESCRIPTION OF THE PROPOSED SOURCES

Figure 2 shows the preliminary layout of the proposed power plant, including property lines and the locations of all major equipment. The process diagram of the project is shown in Figure 3. Emission points are identified on Figure 2 by number and shown in the legend. These numbers are used in the discussions below.

The proposed power generation facility (power block) will consist of one GE Model 7FB or equivalent Siemens CTG with an ISO base load gross output of approximately 230 MW. The CTG will be designed and constructed to burn multiple fuels (i.e., a combination of fuels ranging from hydrogen to pipeline-quality natural gas and mixtures of the two) with an evaporative cooling system installed on the inlet air for use when the ambient temperatures exceed 59°F. The CTG will be followed by a Heat Recovery Steam Generator (HRSG). The HRGS will also be designed to burn the same multiple fuels as the CTG. The maximum fuel flow rate for the CTG and HRSG will be approximately 1,850 MMBtu/hr and 500 MMBtu/hr (higher heating value, HHV), respectively. Exhaust from the CTG/HRSG will exit through a stack with a height of 160 feet (Emission Point No. 4).

An air/nitrogen mixture is supplied to the CTG through an inlet air filter, inlet air evaporative cooling system, compressor section of the combustion turbine and then exits through the compressor discharge casing to the combustion chambers. Fuel is also supplied to the combustion chambers where it is ignited with the compressed air/nitrogen mixture, expanding through the turbine blades, driving the turbine, electricity generator, and the CTG compressor. Exhaust gas from the CTG is directed through internally insulated ductwork to the HRSG. Steam generated in the HRSG is admitted to a steam turbine generator (STG) for electric power generation. The STG system, rated at approximately 150 MW consists of a steam turbine, gland steam system, lube oil system, hydraulic control system, and a hydrogen cooled generator with all required accessories.

A diffusion combustor system using nitrogen as a diluent when firing hydrogen and using steam as a diluent when firing natural gas will be used to control the NO_X emissions from the CTG. A selective catalytic reduction (SCR) system will be provided in the HRSG to further reduce the NO_X emissions to the atmosphere. The SCR system for the HRSG will inject aqueous ammonia into the exhaust gas stream upstream of a catalyst bed to reduce NO_X to inert nitrogen and water. An oxidation catalyst system will also be incorporated into the air quality control system to control emissions of CO and ROGs.

The auxiliary CTG will be fired exclusively on natural gas and will be equipped with water injection and selective catalytic reduction (SCR) for the control of NO_x emissions and an oxidation catalyst for control emissions of CO and ROGs. The auxiliary CTG will operate in simple cycle mode and will have an

exhaust stack with a height of 90 feet. (Emission Point No. X). The auxiliary CTG will be added to the plot plan and the process diagram in their next revision.

An auxiliary boiler (Emission Point No. 6) will provide steam to facilitate CTG startup and for other purposes. The auxiliary boiler will be designed to burn a single fuel (i.e., pipeline-quality natural gas) at the design maximum fuel flow rate of 100 MMBtu/hr HHV. The auxiliary boiler will be equipped with ultra-low NO_X combustors and will have an estimated annual capacity of 25 percent.

HECA will also incorporate a thermal oxidizer (Emission Point No. 7) on the tail gas treatment (TGT) unit to control emissions during startup of the TGT unit. After the TGT unit is started, emissions from the TGT thermal oxidizer will cease being emitted and will be returned to the process. An enclosed ground flare (Emission Point No. 10) will be used during gasifier startup and an elevated flare (Emission Point No. 9) will be used to oxidize releases of system overpressure. Each of the three gasification trains will have one natural-gas fired burner used to keep the gasification train in hot standby mode (Emission Point Nos. 11a -11c). These burners will not operate when the gasification train is operating.

A 16-celled mechanical draft cooling tower (Emission Point No. 2) will be installed to perform the required cooling for the CTGs, STG, and associated equipment. Other sources of emissions will include a 4-celled mechanical draft cooling tower for the air separation unit (Emission Point No. 1), diesel-fired internal combustion engine drivers for an emergency fire pump rated at about 550 horsepower (Emission Point No. 5), and two 1 MW each emergency generators (Emission Point No. 3).

A CO_2 vent stack (Emission Point No. 8) will provide an alternative operating scenario for releasing the produced CO_2 when the CO_2 injection system is unavailable. The CO_2 vent will enable HECA to operate for brief periods rather than be disabled by a gasifier shutdown and subsequent gasifier restart. The CO_2 vent exhaust stream will be nearly all CO_2, with small amounts of CO and Hydrogen Sulfide (H_2S).

In addition to the sources above, there will be emissions of PM_{10} from feedstock and gasifier solids materials handling operations. These operations include bulk material unloading, loading, belt conveying, belt transfer points, silo loading and reclaim.

Figure 2
HECA Facility Plot Plan and Fenceline

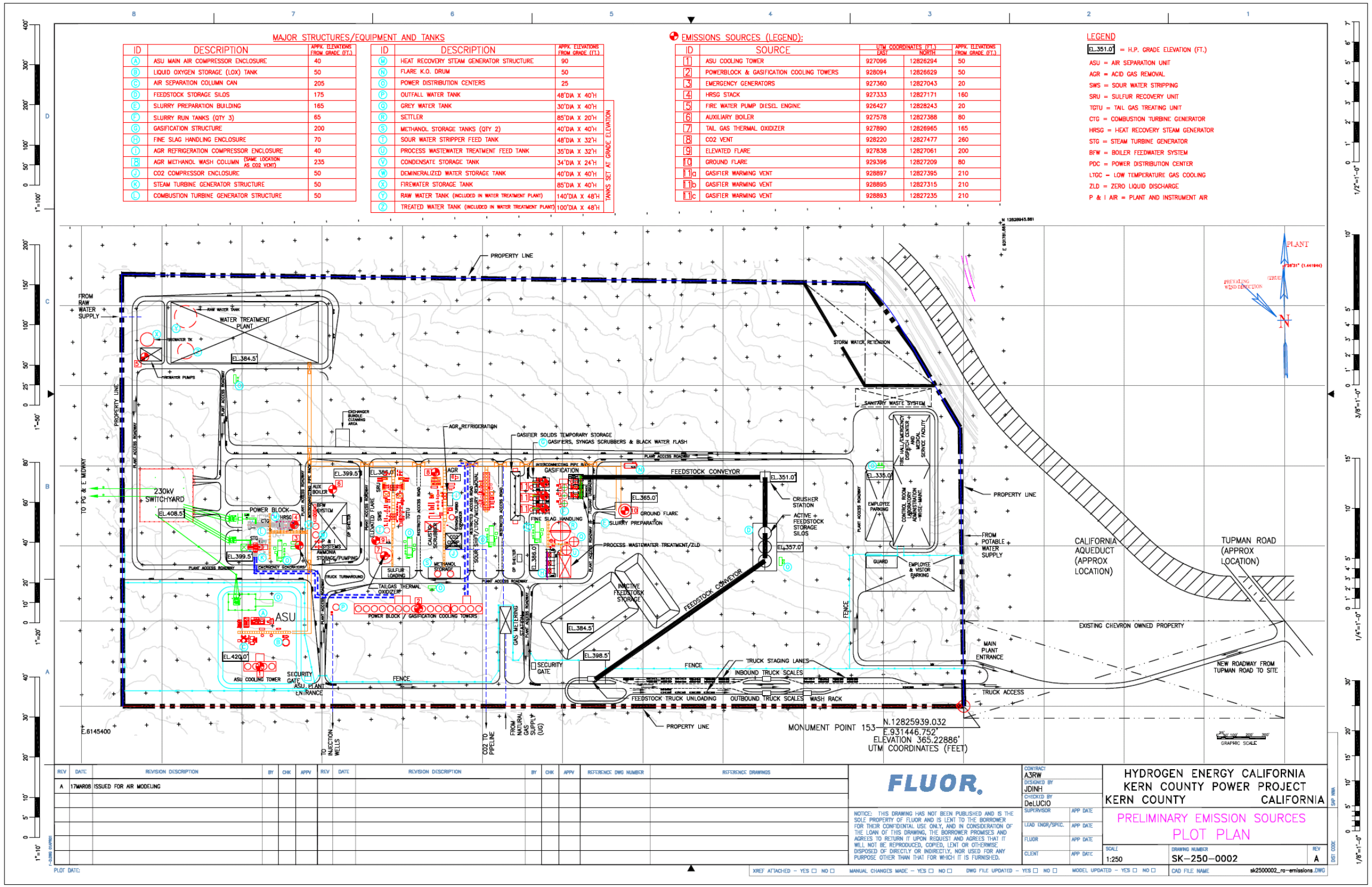
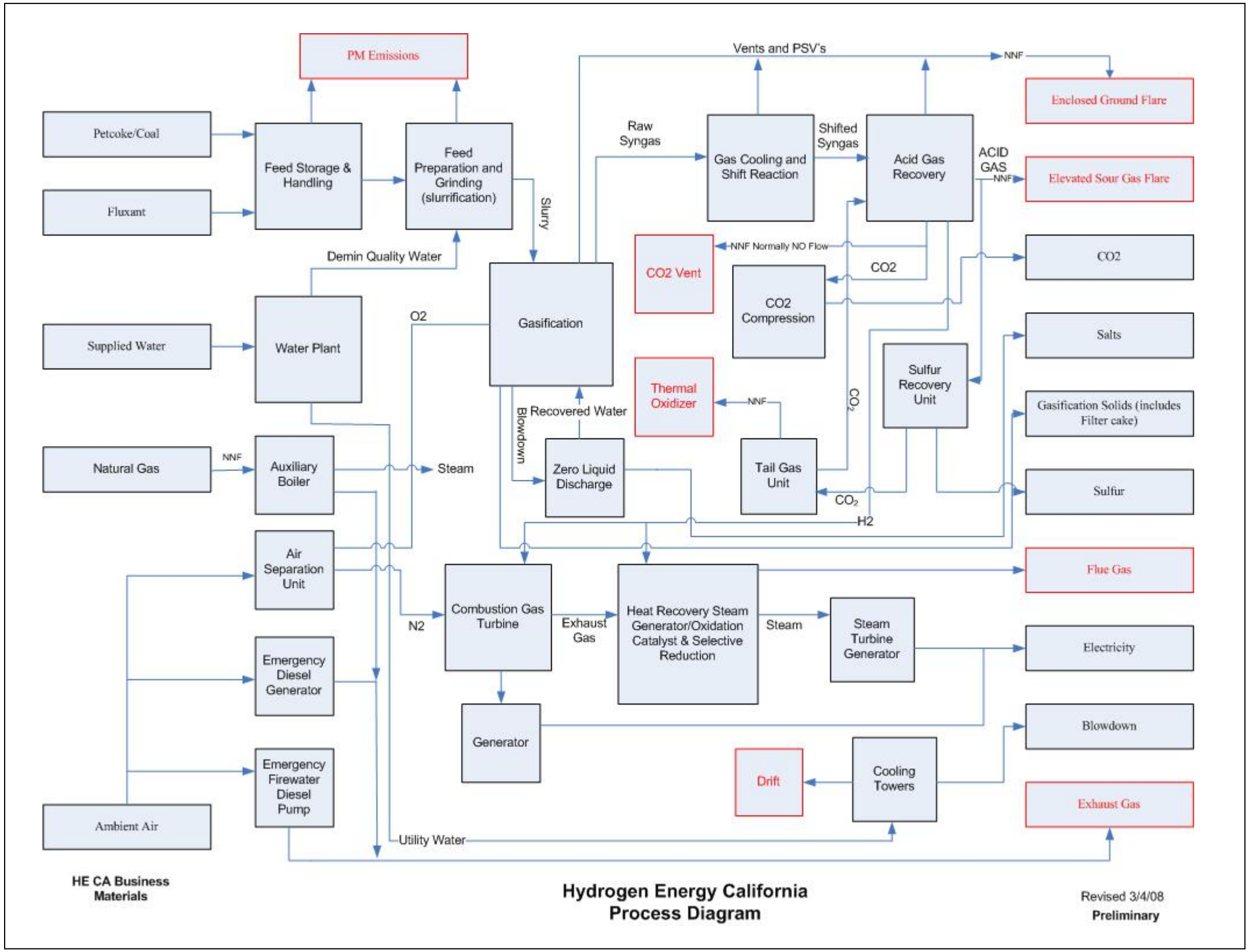


Figure 3
HECA Process Diagram



SECTION 3 REGULATORY SETTING

3.1 CALIFORNIA ENERGY COMMISSION REQUIREMENTS

For projects with electrical power generation capacity greater than 50 MW, CEC requires that applicants prepare a comprehensive Application for Certification (AFC) document addressing the proposed project's environmental and engineering features. An AFC must include the following air quality information (CEC, 1997):

- A description of the project, including project emissions of air pollutants and greenhouse gases, fuel type(s), control technologies and stack characteristics;
- The basis for all emission estimates and/or calculations;
- An analysis of Best Available Control Technology (BACT) according to San Joaquin Valley Air Pollution Control District (SJVAPCD) Rules;
- Existing baseline air quality data for all regulated pollutants;
- Existing meteorological data, including temperature, wind speed and direction, and mixing height;
- A listing of applicable laws, ordinances, regulations, standards (LORS), and a determination of compliance with all applicable LORS;
- An emissions offset strategy;
- An air quality impact assessment (i.e., national and state ambient air quality standards [AAQS] and PSD review) and protocol for the assessment of cumulative impacts of the proposed project along with permitted and under construction projects within a 10 km radius; and
- An analysis of human exposure to air toxics (i.e., health risk assessment [HRA]).

For HECA, the air quality impact assessment, the cumulative impacts assessment, and the HRA will be performed using dispersion models.

3.2 SAN JOAQUIN VALLEY AIR POLLUTION CONTROL DISTRICT REQUIREMENTS

The SJVAPCD has promulgated NSR requirements under Rule 2201. In general, all equipment with the potential to emit air pollutants is subject to the requirements of this rule, which has the following major requirements that potentially apply to new sources such as HECA:

- Installation of BACT,
- Ambient air quality impact modeling to demonstrate compliance with NAAQS and CAAQS and to evaluate impacts to plume visibility in Class I areas near the proposed source(s),
- Emission offsets,
- Statewide compliance for all applicant-owned or operated facilities in California,

Assembly Bill 2588, California Air Toxics Hot Spots Program and SJVAPCD Rule 3110 establish allowable incremental health risks for new or modified sources of toxic air contaminant (TAC) emissions This rule specifies limits for maximum individual cancer risk (MICR), cancer burden, and non-carcinogenic acute and chronic hazard indices (HI) for new or modified sources of TAC emissions. The health risks resulting from project emissions, as demonstrated by means of an approved health risk assessment, must not exceed established threshold values.

3.3 U.S. ENVIRONMENTAL PROTECTION AGENCY REQUIREMENTS

USEPA has promulgated PSD regulations applicable to new Major Sources and Major Modifications to existing Major Sources. HECA will be a Major Source because it is a fossil-fuel fired steam electric plant of more than 250 MMBtu/hr heat input and will have the potential to emit more than 100 tpy of NO_x, and CO. Many of the PSD requirements are the same as the AFC and SJVAPCD Rule 2201 requirements described above (e.g., project description, BACT, ambient air quality standards analysis). However, PSD requires the following additional analyses:

- An analysis of the potential impacts from the new emissions from HECA relative to PSD Significant Impact Levels (SILs) and PSD Increments;
- An analysis of air quality related values (AQRV) to ensure the protection of visibility in federal Class I National Parks and National Wilderness Areas within 100 km of the proposed project;
- An evaluation of potential impacts on soils and vegetation of commercial and recreational value; and
- An evaluation of potential growth-inducing impacts.

SECTION 4 AIR QUALITY IMPACT ANALYSIS FOR CLASS II AREAS

This section describes the dispersion models and modeling techniques that will be used in performing the near-field criteria pollutant impact analysis for HECA. The objectives of the modeling are to demonstrate that air emissions from HECA will not cause incremental impacts that exceed the Class II PSD Significant Impact Levels (SILs), nor contribute to exceedances of state and federal ambient air quality standards.

In November 2005, the USEPA officially recognized the American Meteorological Society/ Environmental Protection Agency Regulatory Model (AERMOD) as the preferred dispersion model for regulatory applications, replacing the Industrial Source Complex Short Term 3 (ISCST3) model. Also, both CEC staff recommendations and the SJVAPCD guidance for air dispersion modeling (SJVAPCD, 2006) support the use of AERMOD for power plant licensing/permitting analyses. Accordingly, AERMOD (Version 07026) will be used for the dispersion modeling associated with HECA.

4.1 TURBINE SCREENING MODELING

An initial screening modeling analysis will be conducted to determine the turbine stack parameters for the most important project source, i.e., the CTG/HRSG that correspond to maximum ground-level pollutant concentrations. This information will be obtained by running a series of AERMOD simulations with the full meteorological input data set (see Section 4.6) with source inputs representing a range of different load conditions and ambient temperatures. The stack parameters that align with the highest offsite impact from these sources for each pollutant and averaging time period will be used in the subsequent refined modeling simulations.

4.2 REFINED MODELING

The purpose of the refined modeling analysis is to demonstrate that air emissions from HECA will not cause or contribute to an ambient air quality violation. The AERMOD model (version 07026) will be used for the refined modeling of criteria pollutants. Specific modeling procedures that will be used for evaluating project impacts versus the state and federal ambient air quality standards, PSD significance thresholds and applicable health risk criteria are discussed below. Table 4-1 shows the regulatory criteria that will be used to evaluate the significance of predicted pollutant concentrations.

Analysis of land uses adjacent to HECA was conducted in accordance with Section 8.2.8 of the Guideline on Air Quality Models (EPA-450/2-78-027R and Auer [1978]), EPA AERMOD implementation guide (2004), and its addendum (2006).

Based on the Auer land use procedure, more than 50 percent of the area within a 3-km radius of HECA power plant is classified as rural. Since the Auer classification scheme requires more than 50 percent of the area within the 3-km radius around a proposed new source to be non-rural for an urban classification, the rural mode will be used in the AERMOD modeling analyses. All regulatory default options will be used, including building and stack tip downwash, default wind speed profiles, exclusion of deposition and gravitational settling, consideration of buoyant plume rise, and complex terrain.

Table 4-1
Relevant Ambient Air Quality Standards and Significance Levels

Pollutant	Averaging Time	CAAQS (a, b)	NAAQS (b, c)	PSD Class II Significance Impact Levels ($\mu g/m^3$)	PSD Significant Emission Rates (tpy)	PSD Increments ($\mu g/m^3$)	
						Class I	Class II
CO	8-hour	9.0 ppm (10,000 $\mu g/m^3$)	9.0 ppm (10,000 $\mu g/m^3$)	500	100		
	1-hour	20 ppm (23,000 $\mu g/m^3$)	35 ppm (40,000 $\mu g/m^3$)	2,000			
NO_2[d]	Annual	0.030 ppm (57 $\mu g/m^3$)	0.053 ppm (100 $\mu g/m^3$)	1	40	2.5	25
	1-hour	0.18 ppm (339 $\mu g/m^3$)					
SO_2	Annual		0.03 ppm (80 $\mu g/m^3$)	1	40	2	20
	24-hour	0.04 ppm[e] (105 $\mu g/m^3$)	0.14 ppm (365 $\mu g/m^3$)	5		5	91
	3-hour		0.5 ppm (1,300 $\mu g/m^3$)	25		25	512
	1-hour	0.25 ppm (655 $\mu g/m^3$)					
PM_{10}	Annual	20 $\mu g/m^3$	See footnote[e]	1	15	4	17
	24-hour	50 $\mu g/m^3$	150 $\mu g/m^3$	5		8	30
$PM_{2.5}$	Annual	12 $\mu g/m^3$	15 $\mu g/m^3$				
	24-hour		35 $\mu g/m^3$				
O_3	8-hour	0.07 ppm (137 $\mu g/m^3$)	0.075 ppm (147 $\mu g/m^3$)	See footnote[f]			
	1-hour	0.09 ppm (180 $\mu g/m^3$)	See footnote[g]				
H_2S	1-hour	0.03 ppm[h]					

Notes:

a. California standards for ozone (as volatile organic compound), carbon monoxide, sulfur dioxide (1-hour), nitrogen dioxide, and PM_{10}, are values that are not to be exceeded. The visibility standard is not to be equaled or exceeded.

b. Concentrations are expressed first in units in which they were promulgated. Equivalent units are given in parentheses and based on a reference temperature of 25°C and a reference pressure of 760 mm of mercury. All measurements of air quality area to be corrected to a reference temperature of 25°C and a reference pressure of 760 mm of mercury (1,013.2 millibars).

c. National standards, other than those for ozone and based on annual averages, are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is ≤ 1.

d. NO_2 is the compound regulated as a criteria pollutant; however, emissions are usually based on the sum of all NO_x.

e. The federal annual PM_{10} standard was revoked by USEPA on October 17, 2006.

f. Modeling is required for any net increase of 100 tons per year or more of ROC subject to PSD.

g. New federal 8-hour ozone and fine particulate matter ($PM_{2.5}$) standards were promulgated by USEPA on July 18, 1997. The federal 1-hour ozone standard was revoked by USEPA on June 15, 2005.

h. The Hydrogen Sulfide ambient air quality standard is an odor based threshold instead of health based.

4.2.1 PSD Modeling Analyses

As the proposed project will trigger PSD as a Major Source, modeling will be required to determine whether its incremental impacts on ambient levels of attainment pollutants (NO_2, SO_2 and CO) will exceed Class II significant impact levels, or SILs. If these SILs were predicted to be exceeded, then an analysis of increment consumption due to all new sources that commenced operation since the local PSD baseline date would be required. However, it is anticipated that the increased emissions of these pollutants due to HECA will not cause incremental effects above the federal SILs.

4.2.2 Ambient Air Quality Standards Analysis

Compliance with the SJVAPCD Rule 2201 modeling requirements for attainment pollutants will be demonstrated by modeling the maximum ground-level concentrations of the proposed Project at any receptor and adding conservative background concentrations, based on recent data from the most representative SJVAPCD air quality monitoring station. HECA will not be considered to cause or contribute to a near-field ambient air quality violation unless impacts from these sources combined with the background concentration exceed the most stringent ambient air quality standard.

NO_2 impact estimates for both the 1-hour and annual averaging times will be modeled by executing AERMOD with the USEPA ozone limiting method (OLM) option for both hourly and annual impacts.

Note that emissions reduction credits will be obtained by the applicant to offset Project emissions increases of all non-attainment pollutants and their precursors, i.e. NO_x, ROG, PM_{10} and SO_2 that are above the SJVAPCD offset triggering levels specified in the Districts Rule 2201.4.5.3.

4.2.3 Health Risk Assessment Analysis

Both CEC and SJVAPCD require a health risk assessment (HRA) to evaluate potential health effects of TAC emissions from the operation of the project. Contaminants emitted by the project with potential carcinogenic effects or chronic and/or acute non-carcinogenic effects will be considered. This health risk assessment will be performed following the Office of Environmental Health Hazard Assessment (OEHHA), *Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA, 2003)*. As recommended by the *Guidelines*, the California Air Resources Board (CARB) Hotspots Analysis and Reporting Program (HARP) (CARB, 2005) will be used to perform an OEHHA Tier 1 health risk assessment for the project. HARP includes two modules: a dispersion module and a risk module. The HARP dispersion module incorporates the USEPA ISCST3 air dispersion model, and the HARP risk module implements the latest Risk Assessment Guidelines developed by OEHHA. For consistency with the criteria pollutant modeling, the dispersion modeling will be conducted with AERMOD. ARB has created a beta version software package, HARP File Converter, to convert AERMOD dispersion results into a format that can be read into the HARP risk module. Thus HARP with AERMOD will be used for this HRA.

First, ground-level concentrations from HECA emissions will be estimated using the AERMOD dispersion model. The dispersion modeling analysis will be consistent with, and use input parameters that are similar to those discussed above for the criteria pollutant analyses using AERMOD. The same five-year Bakersfield meteorological data set that will be used for the criteria pollutant air quality impact assessment will also be used in the HRA. The maximum 1-hour and annual impacts determined by AERMOD will be used in the HARP model to estimate the corresponding health risks. Receptor spacing will be the same as for the criteria pollutant modeling described later in this Protocol. The HARP simulations will also include the census receptors out to 10 km, and additional receptors will be placed at all sensitive locations (e.g., schools, hospitals, etc.) out to a distance of 5 km (3 miles). Receptors will also be placed at all nearby residents.

Incremental cancer risk will be estimated using the "Derived (Adjusted)" calculation method in HARP. For the calculation of cancer risk, the duration of exposure to project emissions will be assumed to be 24 hours per day, 365 days per year, for 70 years, at all receptors. Chronic non-cancer risks will be calculated by means of the "Derived (OEHHA)" method. No bodies of water are near HECA , thus fish ingestion and drinking water consumption pathways will not be included in this analysis.

The HRA performed by means of the HARP model will follow the following steps:

- Define the location of the maximally exposed individual (MEI) (i.e., the location where the highest carcinogenic risk may occur);
- Define the locations of the maximum chronic non-carcinogenic health effects and the maximum acute health effects;
- Calculate concentrations and health effects at locations of maximum impact for each pollutant; and
- Calculate cancer burden if the maximum cancer risk is predicted to be greater than one in a million.

4.3 MODELING EMISSIONS INVENTORY

4.3.1 Operational Project Sources

Operational emissions from the project will be dominated by the CTG with HRSG. Conceptual plant design includes SCR for NO_x and oxidation catalysts for CO that will comply with recent BACT determinations for similar IGCC projects recently permitted in United States. Emissions of SO_2 and PM_{10} will be maintained at low levels, owing to HECA commitment to have SO_2 and PM_{10} emissions comparable to a similarly sized integrated gasification combined cycle power plant having exclusive use of hydrogen as fuel for the gas turbine. Table 4-2 summarizes the estimated annual emissions from the main project sources for each criteria pollutant. The CTG and HRSG emissions estimates reflect the assumed operating hours and numbers of turbine startups described in Section 1.1. Table 4-2 does not include the small contributions to project emissions that will come from the one emergency diesel generator and the one emergency firewater pump engine, or the startup emissions from the thermal oxidizer and the two flares. The engines will normally be operated only a few hours per year in order to test their operability in the event of an emergency situation. The thermal oxidizer and the two flares will

have only pilot flame emissions during normal operation. However, emissions from these engines, the thermal oxidizer and the two flares will be included in the dispersion modeling conducted for HECA.

Table 4-2
Approximate Annual Pollutant Emissions for HECA Turbine/HRSG, Auxiliary CTG, Auxiliary Boiler, and the Cooling Towers at Steady State Operation

Pollutant	Annual Emissions (tpy)				
	Turbine/HRSG	Auxiliary CTG	Auxiliary Boiler	Cooling Towers	Total HECA Emission Approximation *
NO_x	215	17	2	0	~ 250
CO	140	28	6	0	> 250
SO_2	30	5	<1	0	<50
PM_{10}	160	21	<1	25	< 250
VOC	35	5	<1	0	<50

Note: * Total HECA emission approximations include bulk materials handling dust emissions and fixed duration events such as startups and shutdown

4.3.2 Project Construction Sources

Temporary construction emissions will result from heavy equipment exhaust (primarily NO_x and diesel particulate emissions) and fugitive dust (PM_{10}) from earthmoving activities and vehicle traffic on paved and unpaved surfaces. A detailed Excel Workbook will be created to estimate criteria pollutant emissions for non-overlapping phases of Project construction, based on information from the Project design engineers on the equipment use by month throughout the construction schedule and the area extent of ground disturbance that will occur during different construction phases. Depending on the magnitude of emissions for different pollutants and the proximity of construction activities to the property boundary for each phase, one or more emission scenarios representing reasonable worst-case equipment activity and ground disturbance for each averaging time will be selected for subsequent dispersion modeling to ensure that maximum off-site air quality impacts due to these temporary activities will be assessed. The selected emissions scenarios will be modeled using AERMOD with the same near-field receptor grids and the same meteorological input data used for the modeling of the Project's operational emissions. Fugitive dust emissions from the construction site, including the corridors for new transmission lines, gas lines or water pipelines, parking areas and lay-down areas will be modeled as area or volume sources. Equipment exhaust emissions of gaseous pollutants and particulates will be modeled as a series of point sources distributed over the site and linears corridors, as appropriate. Ultra-low sulfur diesel fuel (15 ppm by weight or less) will be utilized on any emission calculations for construction equipment used at HECA site.

4.3.3 Toxic Air Contaminant Sources

TACs will also be emitted from the operational HECA project due to combustion of natural gas, hydrogen gas and diesel fuels. Only small quantities of TACs will be emitted from these sources - primarily benzene, formaldehyde, and polycyclic aromatic hydrocarbons, when natural gas will be used as fuel for the CTG/HRSG train and the auxiliary boiler. Two new diesel-fired engines are proposed as part of the project. These include one fire pump engine and two standby emergency generator engine drivers. Emission estimates for TACs from these sources will be based on diesel particulate mater (DPM)

emission factors obtained from standard SJVAPCD, CARB and EPA factors and/or vendor data, if available. The cooling towers' TAC emissions will be estimated using cooling tower feedwater quality data and drift calculations. Emissions of TACs from the CTG/HRSG train when hydrogen is being used and from the flares and the tailgas incinerator during periods of startup and shutdown will be estimated using a combination of emission factors, inventories from other IGCC facilities and vendor data, if available.

4.3.4 Cumulative Impact Analysis Including Off-Property Sources

A cumulative modeling analyses will be performed using AERMOD to evaluate the combined impacts of HECA Project emissions increases with those of any other new sources within 10 km (6 miles) from HECA that are currently either under construction, undergoing permitting or expected to be permitted in the near future. Requests will be made to the SJVAPCD, Kern County Planning Department, the City of Bakersfield, and adjacent cities to request information that will be used to develop lists of all such new or planned emission sources. When received, these lists will be forwarded to CEC for review. Based on this information, and the CEC response, additional sources may be included in the cumulative source modeling analysis. However, because of the relative remoteness and rural nature of the project site area, few recent new sources are expected to be identified.

4.4 BUILDING WAKE EFFECTS

The effect of building wakes (i.e., downwash) upon the stack plumes of emission sources at the facility will be evaluated in accordance with USEPA guidance (USEPA, 1985). Direction-specific building data will be generated for stacks below good engineering practice (GEP) stack height using the most recent version of USEPA Building Parameter Input Program – Prime (BPIP-Prime). Appropriate information will be provided in the AFC and other permit applications that describe the input assumptions and output results from the BPIP-Prime model.

4.5 RECEPTOR GRID

The receptor grids that will be used in the AERMOD modeling analyses described in this Protocol for operational sources will be as follows:

- 25-m spacing along the fenceline and extending from the fenceline out to 100 m beyond the property line;
- 50-m spacing from 100 to 250 m beyond the property line;
- 100-m spacing from 250 to 500 m beyond the property line;
- 250-m spacing from 500 m to 1 km beyond the property line;
- 500-m spacing within 1 to 2 km of project sources; and
- 1,000-m spacing within 2 to 10 km of project sources.

During the refined modeling analysis for operational Project emissions, if a maximum predicted concentration for a particular pollutant and averaging time is located within the portion of the receptor

grid with spacing greater than 25 m, a supplemental dense receptor grid will be placed around the original maximum concentration point and the model will be rerun. The dense grid will use 25-m spacing and will extend to the next grid point in all directions from the original point of maximum concentration.

Due to the large computation time required to run AERMOD, this receptor grid, with the additional dense nested grid points, was determined to best balance the need to predict maximum pollutant concentrations and allow the all operational modeling runs to be completed in less than one week.

Because construction emission sources release pollutants to the atmosphere from small equipment exhaust stacks or from soil disturbances at ground level, maximum predicted construction impacts for all pollutants and averaging times will occur within the first kilometer from the HECA site boundary. Accordingly, only the portion of the above grid with 25 m spacing out to a distance of 1 km will be used for the construction modeling.

The same receptor grid used in the criteria pollutant modeling for the operational project will be used in the HRA modeling, with additional receptors placed at all sensitive locations (e.g., schools, hospitals, etc.) out to 5 km (3 miles). Census receptors out to 10 km will also be included in the populated areas nearest to the proposed HECA facility. Finally, discrete receptors will be placed at the locations of all nearby residences.

A detailed project map and a 7 ½- minute U.S Geological Survey (USGS) map will be provided in the AFC showing the locations of the grid receptors. Actual Universal Transverse Mercator (UTM) coordinates will be used. The CAAQS and NAAQS apply to all locations outside the applicant's facility, i.e. everywhere where public access is not under the control of the applicant. Therefore, the fenceline will be placed along the facility's property boundary, and the receptors will be placed on and outside of the fenceline.

4.6 METEOROLOGICAL AND AIR QUALITY DATA

4.6.1 Meteorological Data

Meteorological data suitable for direct input to AERMOD were obtained from the SJVAPCD website. Hourly surface data for calendar years 2000, 2001, 2002, 2003, and 2004 were obtained from the SJVAPCD for the Bakersfield Airport meteorological station which is located, in the City of Bakersfield approximately 32.2 km (20 miles) ENE of the HECA site. These data have been pre-processed by the SJVAPCD with the Oakland upper air data to create an input data set specifically tailored for input to AERMOD.

The meteorological data recorded at Bakersfield Airport are acceptable for use at HECA facility for two reasons, proximity and terrain similarity. The terrain immediately surrounding the Project site can be categorized as a fairly flat, or gradually sloping rural area in an area with developed oil wells. The terrain around the Bakersfield Airport also consists of relatively flat, or gradually sloping rural or suburban areas. Thus the land use and the location with respect to near-field terrain features are similar. Additionally, there are no significant terrain features separating the Bakersfield Airport from the HECA facility site that would cause significant differences in wind or temperature conditions between these respective areas. Therefore the five years of meteorological data selected from the Bakersfield Airport were determined to

be representative for purposes of evaluating the Project's air quality impacts. The Bakersfield Airport is the closest full-time meteorological recording station to the HECA facility site, and thus meteorological conditions at the sites will be very similar.

Seasonal and annual wind roses based on the five years of Bakersfield Airport surface meteorological data are provided as Appendix A to this Protocol. Winds for all seasons and all years blow predominantly from the sector between northwest and north, although the directional pattern is more variable during the fall and winter seasons.

4.6.2 Air Quality Monitoring Data

Air quality monitoring data to represent existing air quality in the Project area were obtained from the USEPA AirData (2006) and the CARB-California Air Quality Data website (2006). The most recent three years of data (2004-2006) from the Taft-College, Shafter, Bakersfield Golden State Highway, and Bakersfield 5558 California Avenue monitoring stations were collected to determine the most representative baseline concentrations for each air pollutant and averaging period addressed in the California and National ambient air quality standards. The maximum concentration recorded at these monitoring stations over the three-year period will be used as a conservative representation of existing air quality condition at the proposed Project site.

The Taft-College monitoring station is located approximately 20 km to the south of the HECA facility site. The Taft-College station only monitors PM_{10}, and TSP (until 2005). The Bakersfield Golden Highway station is the closest station that monitors all the criteria pollutants, except SO_2, and is located approximately 39 km to the east of the HECA facility site. The Bakersfield 5558 California Avenue station also measures all pollutants except CO and SO_2. This station is located about 34 km east of the HECA site. The only station in the San Joaquin Valley Air Basin that monitors SO_2 is the CARB station at First Street in Fresno, located approximately 160 km (100 miles) to the north. SO_2 data have only been recorded in Fresno County for one of the last nine years (2003), a practice that is justified by the low levels that have been recorded for this pollutant when measurements have been made.

The selected maximum baseline concentrations for all pollutants are summarized in Table 4-3. These data will be added to the modeled maximum impacts due to project emissions for each pollutant and averaging time, and the totals will then be compared with the applicable AAQS. This is a conservative approach because it assumes that the highest recorded background values and the modeled maximum impacts occur at the same time and location for each pollutant and averaging time, a highly unlikely scenario. Note that the maximum background concentrations of PM_{10} and $PM_{2.5}$ in the project area currently exceed the corresponding CAAQS and NAAQS.

Table 4-3
Highest Monitored Pollutant Concentrations Near the Proposed HECA Site (2004 – 2006)

Pollutant	Averaging Time	Highest Monitoring Concentration	Monitoring Station Address	Year
CO	8-hour	2.6 ppm (2,889 μg/m^3)	Bakersfield Golden State Highway	2004
	1-hour	4.1 ppm (4,715 μg/m^3)	Bakersfield Golden State Highway	2004
NO_2	Annual	0.019 ppm (35.8 μg/m^3)	Shafter	2006
	1-hour	0.100 ppm (188.2 μg/m^3)	Shafter	2006
SO_2	Annual	0.002 ppm (5.33 μg/m^3)	Fresno Fremont School	2003
	24-hour	0.004 ppm (10.5 μg/m^3)	Fresno Fremont School	2003
	3-hour	0.006 ppm (15.6 μg/m^3)	Fresno Fremont School	2003
	1-hour	0.009 ppm (23.58 μg/m^3)	Fresno Fremont School	2003
PM_{10}[a] (Non-attainment area)	Annual	48.5 μg/m^3	Bakersfield 5558 California Avenue	2006
	24-hour	159.0 μg/m^3 [c]	Bakersfield 5558 California Avenue	2006
$PM_{2.5}$[b] (Non-attainment area)	Annual	22.4 μg/m^3	Bakersfield 5558 California Avenue	2005
	24-hour	102.1 μg/m^3	Bakersfield 5558 California Avenue	2005

Source: CARB ADAM website (Last access: January, 2008).

[a] Although EPA has determined that the San Joaquin Valley Air Basin has attained the federal PM_{10} standards, their determination does not constitute a redesignation to attainment per section 107(d)(3) of the Federal Clean Air Act. The Valley will continue to be designated nonattainment until all of the Section 107(d)(3) requirements are met. This area will be treated as the federal PM_{10} non-attainment area until future redesignation.

[b] The Valley is designated nonattainment for the 1997 $PM_{2.5}$ federal standards. EPA designations for the 2006 $PM_{2.5}$ standards will be finalized in December 2009. The District has determined, as of the 2004-06 PM 2.5 data, that the Valley has attained the 1997 24-Hour $PM_{2.5}$ standard. . This area will be treated as the federal $PM_{2.5}$ non-attainment area until future redesignation.

[c] An exceedance is not necessarily a violation.

4.7 FUMIGATION MODELING

Fumigation can occur when a stable layer of air lies a short distance above the release point of a plume and unstable air lies below. Especially on sunny mornings with light winds, the heating of the earth's surface causes a layer of turbulence, which grows in depth over time and may intersect an elevated exhaust plume. The transition from stable to unstable surroundings can rapidly draw a plume down to ground level and create relatively high pollutant concentrations for a short period. Typically, a fumigation analysis is conducted using the USEPA model SCREEN3 when the project site is rural and the stack height is greater than 10 m.

A fumigation analysis will be performed using SCREEN3 to calculate concentrations from inversion breakup fumigation; no shoreline fumigation modeling will be performed for the HECA location. A unit emission rate will be used (1 gram per second) in the fumigation modeling simulations to represent the plant emissions, and the model results will be scaled to reflect expected plant emissions for each pollutant. Inversion breakup fumigation concentrations will be calculated for 1- and 3-hour averaging times using USEPA-approved conversion factors. These multiple-hour model predictions are

conservative, since inversion breakup fumigation is a transitory condition that would most likely affect a given receptor location for only a few minutes at a time.

SECTION 5 AIR QUALITY IMPACT ANALYSIS FOR CLASS I AREAS

An evaluation of potential impacts in Class I areas within 100 km of the HECA site will be conducted, because HECA's potential emissions increases of some pollutants will be sufficiently high to be considered a Major Source, thus triggering the federal PSD program. A Major Source must evaluate impacts to visibility and other air quality related values (AQRV) at all Class I areas that are located within a 100-km radius of the facility. All pollutants for which Project emissions are above the Major Source threshold (in this case, 100 tpy) and all pollutants for which emissions are above the PSD Significant Emissions Rates must be evaluated. This section describes the dispersion models and modeling techniques that will be used in performing the Class I area air quality analyses for HECA. The objectives of the modeling are to demonstrate whether air emissions from HECA would cause or contribute to a PSD increment exceedance or cause a significant impact on visibility, regional haze or sulfur or nitrogen deposition in any Class I area.

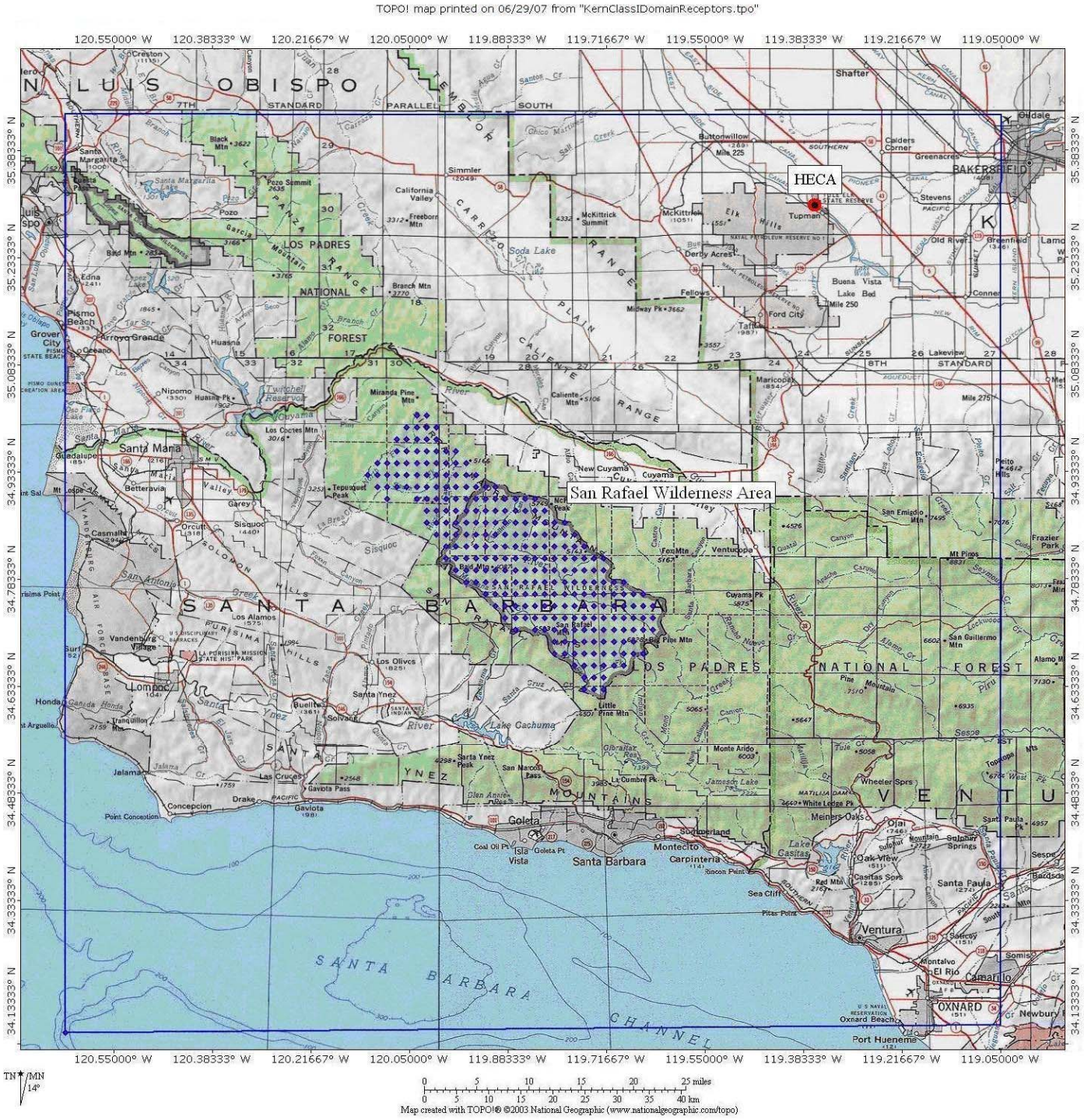
Three Class I areas are located within the region of the HECA site and require further evaluation: Dome Land Wilderness Area, Sequoia National Park, and San Rafael Wilderness Area. However, detailed review of the locations of these Class I areas relative to the HECA site shows that Dome Land Wilderness Area and Sequoia National Park are greater than 100 km from HECA . Therefore, these two Class I areas do not meet the criterion of being within 100 km and will not be included in the HECA analysis. The nearest parts of the San Rafael Wilderness are located beyond 50 km and within 100 km from the proposed facility, thus only this Class I area and only far-field AQRV analyses will need to be completed. The CALMET/CALPUFF (full-CALPUFF) model will be used to evaluate potential impacts in the far-field Class I area, including potential air quality impacts, sulfur and nitrogen deposition, and impacts to visibility.

Figure 3 shows the locations of the Class I areas relative to the proposed site for HECA and Table 5-1 lists the distances from HECA to the closest and farthest points in each Class I area. Figure 3 also shows the domain to be used for CALPUFF modeling of the San Rafael Wilderness Area (indicated by the blue rectangle). The federal authority in charge of the two Wilderness Areas is the United States Forest Service (USFS) and the National Park Service (NPS) has jurisdiction in Sequoia National Park. The AQRV analyses for the San Rafael Wilderness area will be conducted in a manner consistent with guidance from the NPS and USFS following the procedures set forth in the Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report (USFS, 2000) and the Calpuff Reviewer's Guideline (USFS and NPS, 2005).

Table 5-1
Class I Areas Evaluated with Respect to 100-km Radius of the Proposed HECA Facility

Class I areas	Distance from HECA (km)	
Dome Land Wilderness Area	Closest	110
	Farthest	132
Sequoia National Park	Closest	125
	Farthest	181
San Rafael Wilderness Area	Closest	62
	Farthest	81

Figure 4
Calpuff Domain and Receptor For the Class I Area Surrounding HECA



The CALPUFF modeling domain selected for the modeling analyses will extend at least 50 km past the farthest edge in all directions from any of the Class I area being analyzed in order to reduce the probability that mass will be lost due to possible wind recirculation (Figure 3).

5.1 NEAR-FIELD CLASS I AREAS AIR QUALITY IMPACT ANALYSIS

There are no Class I Areas within 50 km of the proposed project location; therefore, no near field AQRV analyses are necessary.

5.2 FAR-FIELD CLASS I AREA AIR QUALITY IMPACT ANALYSIS: CALPUFF MODELING

To analyze potential impact of project emissions to visibility, PSD increment and sulfur and nitrogen deposition in the Class I area located within 100 km from the proposed project site, the CALPUFF model will be used in conjunction with the CALMET diagnostic meteorological model. CALPUFF is a transport and dispersion model that simulates the advection and dispersion of "puffs" of material emitted from modeled sources. CALPUFF can incorporate three-dimensionally varying wind fields, wet and dry deposition, and atmospheric gas and particle phase chemistry. The CALMET model is used to prepare the necessary gridded wind fields for use in the CALPUFF model. CALMET can also accept as input; mesoscale meteorological (MM5) data, surface station, upper air, precipitation, cloud cover, and over-water meteorological data (all in a variety of input formats). These data are merged and the effects of terrain and land cover types are simulated. This process results in the generation of gridded 3-dimensional wind fields that account for the effects of slope flows, terrain blocking effects, flow channeling, and spatially varying land uses.

The USEPA-approved regulatory air quality dispersion model CALPUFF (version 5.8) will be used for all far-field Class I area impact analyses. In addition, all supporting Version 5.8 editions of the pre- and post-processors will be used. Recommendations from the regulatory guidance documents listed below will be followed.

- *Federal Land Managers Air Quality Related Values Workgroup (FLAG) Phase 1 Report. (USEPA December 2000),*
- *Interagency Workgroup on Air Quality Modeling (IWAQM), Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts. (USEPA December 1998)*, and
- *Calpuff Reviewer's Guide (Draft), (USFS and NPS, 2005).*

Model options will be based on FLM guidance from the above documents and direct discussions with NPS and USFS air quality staff.

Copies of the model input and output files generated in the preparation of this and all other modeling analyses described in this Protocol will be provided with the final application.

5.2.1 CALPUFF/CALMET Description

5.2.1.1 Location and Land-Use

The CALMET and CALPUFF models incorporate assumptions regarding land-use classification, leaf-area index, and surface roughness length to estimate deposition of emitted materials during atmospheric transport. U.S. Geological Survey (USGS) 1:250,000 scale digital elevation models (DEMs) and Land Use Land Cover (LULC) classification files will be used to develop the geophysical input files required by the CALMET model. Outputs of the terrain pre-processor (TERREL) and land use pre-processor (CTGPROC) will be combined in the geo-physical preprocessor (MAKEGEO) to prepare the CALMET geo-physical input file. The CALMET model will incorporate the necessary parameters in the CALMET output files for use in the CALPUFF model.

The CALPUFF modeling domain will extend from the HECA site 150 km to the west, 180 km to the north, 125 km to the east, and 150 km to the south. The grid-cells over this domain will be 4 km wide. The modeling domain will be specified using the Lambert Conformal Conic (LCC) projection system.

5.2.1.2 Meteorological Data

Pursuant to FLM guidance, a three-year meteorological data set will be developed using a combination of surface station and mesoscale meteorological (MM5) data for 2001-2003. Hourly CALMET data derived from the MM5 data for these three years will be obtained from the WRAP BART modeling for the Nevada-Utah domain. Surface meteorological, precipitation and ozone data will also be obtained from the WRAP BART modeling for the Nevada-Utah domain. No upper air stations will be used, since there are none within the domain shown in Figure 3 and the MM5 data provide a good first approximation of the vertical profile of the atmosphere.

CALMET wind fields will be generated using a combination of the MM5 data sets augmented with the surface data from the National Weather Service (NWS) stations described above. Per IWAQM guidance, the MM5 data will be interpolated to the CALMET fine-scale grid to create the “initial-guess” wind fields (IPROG = 14 for MM5).

5.2.1.3 Other Model Options

Size parameters for dry deposition of nitrate, sulfate, and PM_{10} particles will be based on default CALPUFF model options. Chemical parameters for gaseous dry deposition and wet scavenging coefficients will be based on default values presented in the CALPUFF User’s Guide. For the CALPUFF runs that incorporate deposition and chemical transformation rates (i.e. deposition and visibility), the full chemistry option of CALPUFF will be activated (MCHEM = 1). The nighttime loss for SO_2, NO_x and nitric acid (HNO_3) will be set at 0.2 percent per hour, 2 percent per hour and 2 percent per hour, respectively. CALPUFF will also be configured to allow predictions of SO_2, sulfate (SO_4), NO_x, HNO_3, nitrate (NO_3) and PM_{10} using the MESOPUFF II chemical transformation module.

Hourly ozone concentration files for the CALPUFF modeling will be obtained from the WRAP BART modeling data for the Nevada-Utah domain. Only data from the ozone monitoring stations within the HECA domain will be used.

The background ammonia concentration will be set to 10 ppb, which is representative for a grassland or agricultural site, per the FLAG guidelines.

The regulatory default setting for MDISP=3 which utilizes the Pasquill-Gifford dispersion coefficients will be used in the CALPUFF modeling.

5.2.1.4 Receptors

Discrete receptors for the CALPUFF modeling within the San Rafael Wilderness Area will be obtained from the NPS Class One Area receptor database. No modifications to the receptor locations or heights provided in the database will be made. Latitude/Longitude coordinates of the Class I receptors will be converted to Lambert Conformal Conic (LCC) coordinates, based on the domain setup shown in CALMET options. These receptor points are shown in Figure 3.

5.2.2 Far-Field Class I Area Visibility and Regional Haze Analysis

For the analysis of visibility effects due to emissions of air pollutants, CALPUFF requires project emission rate inputs for six pollutant species, i.e., directly emitted PM_{10}, NO_x, and SO_2, and secondary SO_4, HNO_3, and NO_3. The maximum 24-hour averaged emission rates of PM_{10}, NO_x and SO_2 from all sources of HECA will be used for the visibility analysis. The turbine/HRSG emissions of SO_2 will be specified to SO_2 and SO_4 as indicated in the NPS Particulate Matter Speciation (PMS) guidelines for gas fired combustion turbines (NPS, 2008). The total turbine/HRSG PM_{10} emissions will be specified to elemental carbon and organic carbon [emitted as Secondary Organic Aerosol (SOA)] per the PMS. Direct emissions of PM_{10}, NO_x, and SO_2 from the auxiliary boiler, emergency generators and fire pump will be modeled without speciation. The cooling towers will emit only PM_{10}. Direct emissions of the remaining species, HNO_3 and NO_3, are assumed to be zero for the natural gas burning sources of HECA.

Modeled impacts will be converted to visibility impacts using the CALPOST post processor. CALPOST will be used to post-process estimated 24-hour averaged concentrations of ammonium nitrate, ammonium sulfate, EC, and SOA into extinction coefficient values for each day at each modeled receptor.

CALPUFF also requires a background light extinction reference level. The analysis will be run using the FLAG recommended background extinction values for the Class I area. The background extinction coefficient is composed of hygroscopic scattering components, wherein the addition of water enhances particle light-scattering efficiencies, non-hygroscopic scattering components and Rayleigh scattering. Ammonium sulfate and ammonium nitrate compose the hygroscopic scattering components, while organic aerosols, soils, coarse particles, particle absorption from elemental carbon and absorption from gases (primarily from nitrogen dioxide) compose the non-hygroscopic scattering components.

In accordance with the FLAG guideline the total background extinction coefficient is calculated for the Class I area using the following equation:

$$b_{ext} = b_{hygro} \cdot f(RH) + b_{non\text{-}hygro} + b_{Ray}$$

where:

b_{hygro} = the hygroscopic scattering component (Mm^{-1})
= $3[(NH_4)_2SO_4 + NH_4NO_3]$
$b_{non\text{-}hygro}$ = the non-hygroscopic scattering component (Mm^{-1})
= $b_{OC} + b_{Soil} + b_{Course} + b_{ap} + b_{ag}$
b_{Ray} = the Rayleigh scattering component (Mm^{-1}) = 10 Mm^{-1} (FLAG)
f(RH) = relative humidity adjustment factor

In the CALPOST post-processing program, the monthly background concentration of ammonium sulfate is set to one-third of the hygroscopic scattering component, and the monthly background concentration of soil particles is set to the non-hygroscopic scattering component, as recommended in the FLAG report. The scattering coefficients that will be used in CALPUFF for the Class I areas are presented in Table 5-2.

The FLAG relative humidity (RH) adjustment factors (MVISBK=2) and the RHMAX = 95 % will be used as suggested by the NPS FLM.

The extinction coefficient percent change (background extinction coefficient vs. modeled extinction coefficient), predicted by CALPUFF will be compared to the level of acceptable change (LAC) of 5%. If the change in extinction is greater than 5%, but less than 10%, the conditions surrounding that prediction will be examined to determine if inclement weather may obscure actual viewing of the plume in the Class I area.

Table 5-2
Scattering Coefficients used in CALPUFF Analysis for the San Rafael Wilderness Class I Area

Class I Area	Total Background Extinction (Mm^{-1})				Hygroscopic Scattering Component (Mm^{-1}) = BKSO4	Non-hygroscopic Scattering Component (Mm^{-1}) = BKSOIL	Rayleigh Scattering (Mm^{-1})
	Winter	Spring	Summer	Fall			
San Rafael Wilderness Area	16.1	16.0	16.0	16.0	0.6	4.5	10.0

5.2.3 PSD Class I Significance Analysis

A PSD analysis of incremental air pollutant concentrations in the Class I area due to project emissions will be required, because HECA will be a Major Source as defined in the PSD regulations. Accordingly, the maximum predicted incremental criteria pollutant concentrations from HECA sources in the Class I area will be compared with the Proposed PSD significant impact level for Class I areas (see Table 5-3) for each pollutant.

Table 5-3
FLAG (Proposed) Class I Significance Impact Levels

Pollutant and Averaging Time	NO_x	PM_{10}		SO_2		
	Annual	24-hour	Annual	3-hour	24-hour	Annual
Concentration Threshold (µg/m³)	0.1	0.3	0.2	1	0.2	0.1

All NO_2 and PM_{10}, sources of the proposed project will be modeled at the full potential-to-emit (PTE) in the CALPUFF PSD modeling for each averaging time. The facility SO_2 emission rate will be portioned into SO_2 and SO_4 emissions according to the NPS PMS guidance for natural gas combustion turbines. The full chemistry option of CALPUFF will be activated (MCHEM =1, MESOPUFF II scheme), and deposition options will also be turned on (MWET = 1 and MDRY = 1).

5.2.4 Deposition Analysis

For the Class I area beyond 50 km from the facility, CALPUFF will be used to evaluate the potential for nitrogen and sulfur deposition due to HECA emissions of nitrogen and sulfur oxides emissions. Total deposition rates for each pollutant will be obtained by summing the modeled wet and/or dry deposition rates. The annual average pollutant emission rates for Project sources will be used in this analysis, since annual deposition rates are to be estimated.

For sulfur deposition, the wet and dry fluxes of sulfur dioxide (SO_2) and sulfate (SO_4) are calculated, normalized by the molecular weight of sulfur, and expressed as total sulfur. Total nitrogen deposition is the sum of nitrogen contributed by wet and dry fluxes of nitric acid (HNO_3), nitrate (NO_3^-), ammonium nitrate (NH_4NO_3), ammonium sulfate ($(NH_4)_2SO_4$) and the dry flux of NO_x.

The total modeled nitrogen and sulfur deposition rates will be compared to the NPS/USFS deposition analysis thresholds (DAT) for western states. The DAT values for nitrogen and sulfur are each 0.005 kilogram per hectare per year (kg/ha-yr), which converts to 1.59E-11 g/m^2/s.

5.2.5 Soils and Vegetation

The designated Class I area contains vegetative ecosystems that are identified by the Federal Land Managers (FLM) (USFS, 1992). For each ecosystem, sensitive species or groups of species will be designated to represent potential impacts to each vegetative species in the ecosystem. These species are impacted primarily by ozone but may also be impacted by nitrogen and sulfur compounds. Acidity in rain, snow, cloudwater, and dry deposition can affect soil fertility and nutrient cycling processes in watersheds, and can result in acidification of lakes and streams with low buffering capacity. Therefore, the soil and vegetation analysis will be conducted using the CALPUFF model to predict total sulfur and nitrogen deposition rates and monitored ozone concentrations at the nearest air quality monitoring stations. In order to protect sensitive species, the USFS (1992) recommends that short-term maximum SO_2 levels should not exceed 40 to 50 parts per billion (ppb). Annual average SO_2 concentrations should not exceed 8 to 12 ppb, and annual average NO_2 concentration should not exceed 15 ppb.

SECTION 6 PRESENTATION OF MODELING RESULTS

6.1 PSD, NAAQS AND CAAQS ANALYSES

The results of the PSD and AAQS analyses to evaluate the construction and operational impacts of the HECA facility will be presented in summary tables. A figure indicating the locations of the maximum predicted pollutant concentrations for each applicable pollutant and averaging time will be provided. The maximum modeled values of NO_2, SO_2 and CO will be compared with current Class II and proposed Class I SILs. If the model impact exceeds the SILs, the background concentrations (see Section 4.6.2) will be added to the maximum modeled values from the HECA sources to yield total concentrations, which will be compared with the NAAQS and CAAQS. The cumulative impact values from combination of project sources in HECA and new sources within 10 km (6 miles) of the proposed project site will be added to the background concentrations for the corresponding pollutants and averaging times and will be compared with the NAAQS and CAAQS.

6.2 HEALTH RISK ASSESSMENT ANALYSIS

Maps depicting the following data will be prepared:

- Elevated terrain within a 10-km radius of the project;
- The locations of sensitive receptors, including schools, pre-schools, hospitals, etc., within a 5 - km (3 miles) radius of the project, and the nearby residences included in the HRA;
- Isopleths for any areas where predicted exposures to air toxics result in estimated chronic non-cancer impacts and acute impacts equal to or exceeding a hazard index of 1; and
- Isopleths for any areas where exposures to air toxics lead to an estimated carcinogenic risk equal to or greater than one in one million.

Health risk assessment modeling results will be summarized to include maximum annual (chronic, carcinogenic, and non-carcinogenic) and hourly (acute) adverse health effects from HECA's toxic air contaminant emissions. The estimated cancer burden will be presented if the maximum off-site cancer risk is predicted to be greater than one in a million. Health risk values will be calculated and presented in the summary table for the points of maximum impact and the sensitive receptors with the maximum risk values.

6.3 CLASS I ANALYSIS

The results of the visibility, PSD and deposition analyses to evaluate the operational impacts of the HECA facility will be presented in summary tables and compared with all relevant significance thresholds. Isopleth drawing showing the predicted spatial distributions of criteria pollutant concentrations in the Class I areas due to the proposed project emissions will also be prepared.

6.4 DATA SUBMITTAL

Electronic copies of the modeling input and output files for all the analyses described in this Protocol will be provided to SJVAPCD, CEC and EPA Region IX, U.S. Forest Service and National Park Service.

SECTION 7 REFERENCES

American Meteorological Society. Journal of Applied Meteorology, 17(5): 636-643. "Correlation of Land Use and Cover with Meteorological Anomalies", August Auer Jr., May 1978.

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USDA Forest Service and National Park Service, 2005. CALPUFF Reviewer's Guide (DRAFT) prepared by Howard Gebhart. September 2005

Annual and Seasonal Windroses for the Bakersfield Airport (2000 through 2004)

2000-2004 Annual (Jan - Dec)

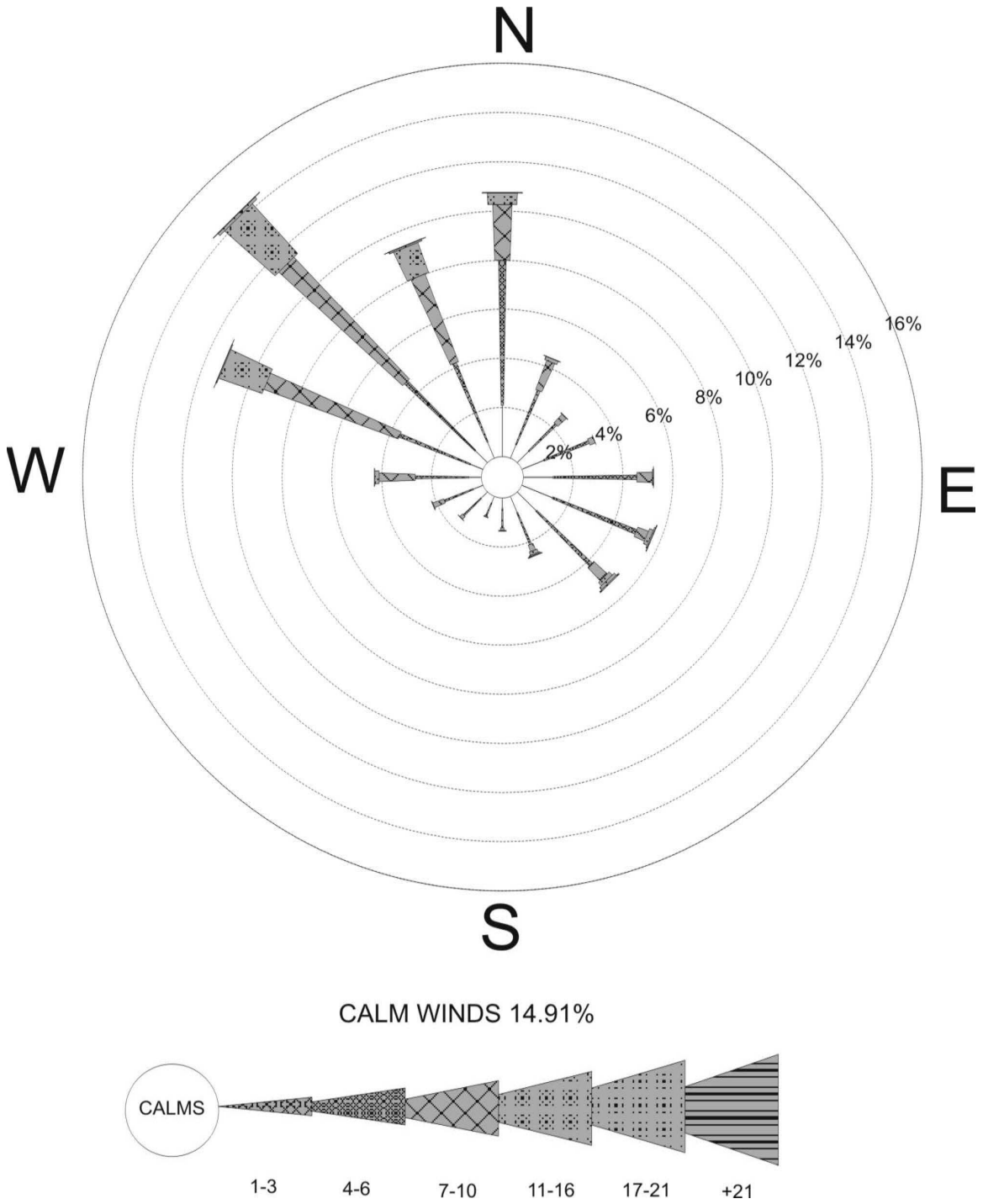

Figure A-1 Annual Windrose for Bakersfield Airport based on Surface Data for 2000-2004

2000-2004 Spring (Mar, Apr, May)

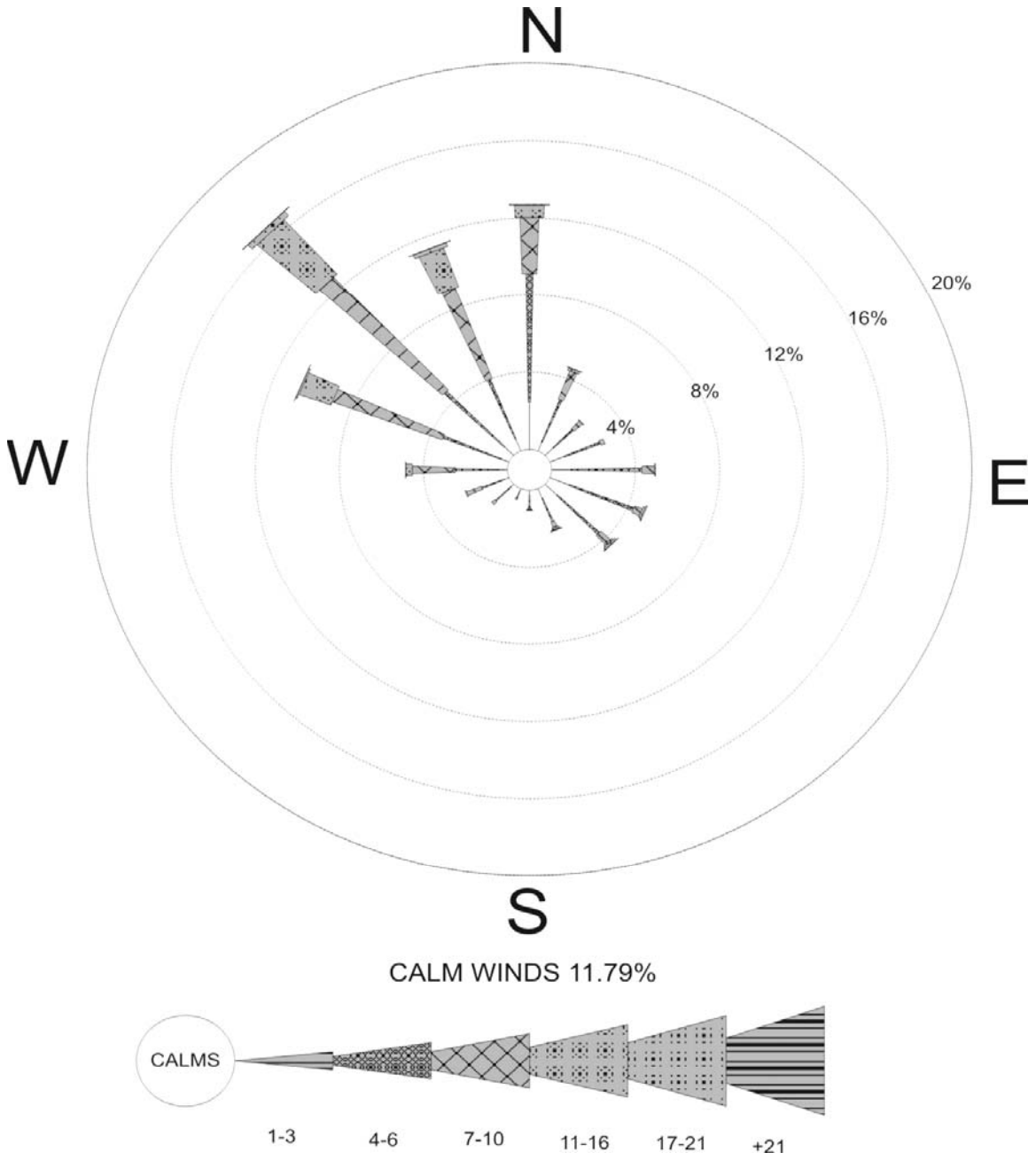

Figure A-2 Spring Season Windrose for Bakersfield Airport based on Surface Data for 2000-2004

2000-2004 Summer (Jun, July, Aug)

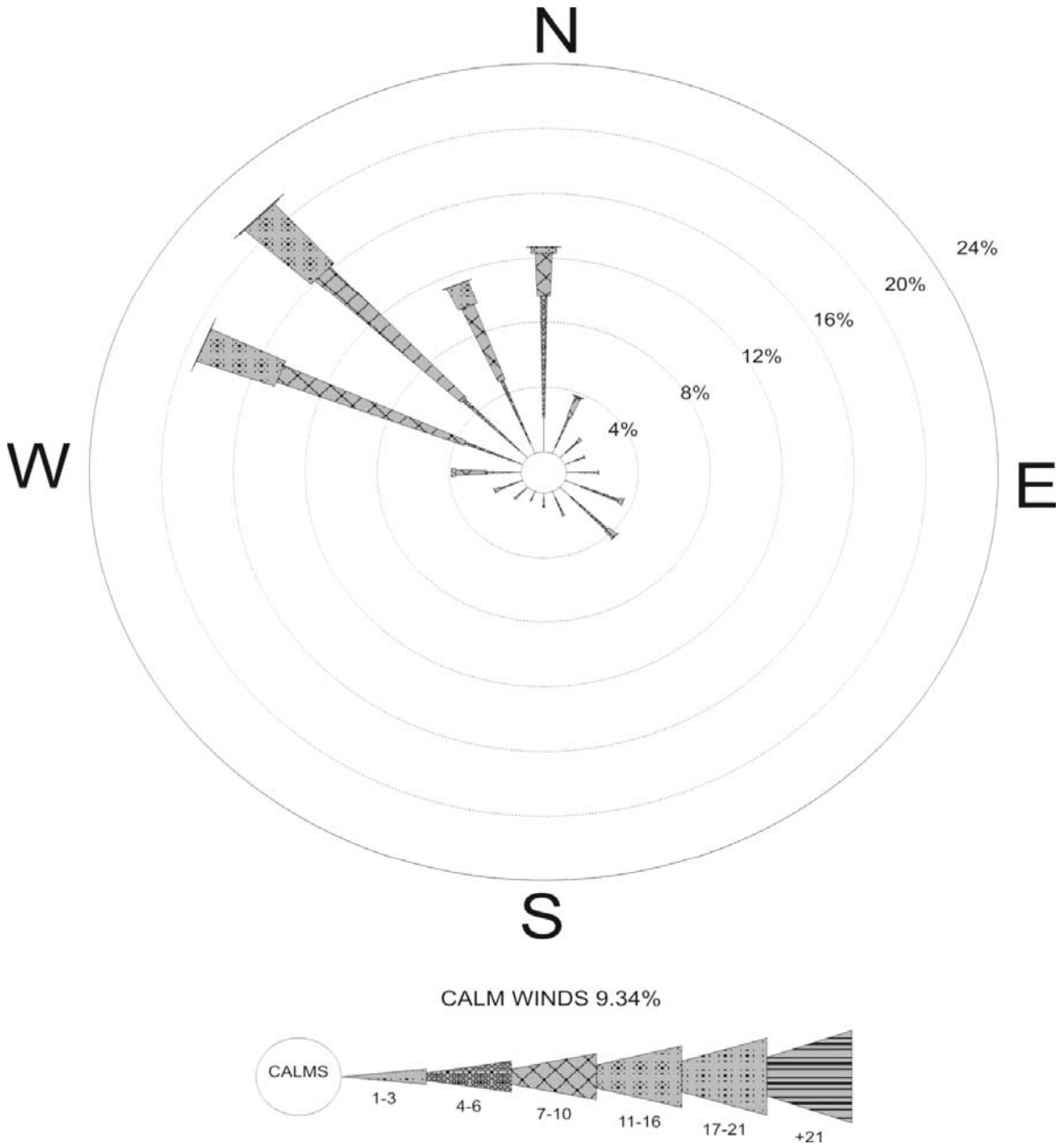

Figure A-3 Summer Season Windrose for Bakersfield Airport based on Surface Data for 2000-2004

2000-2004 Fall (Sep, Oct, Nov)

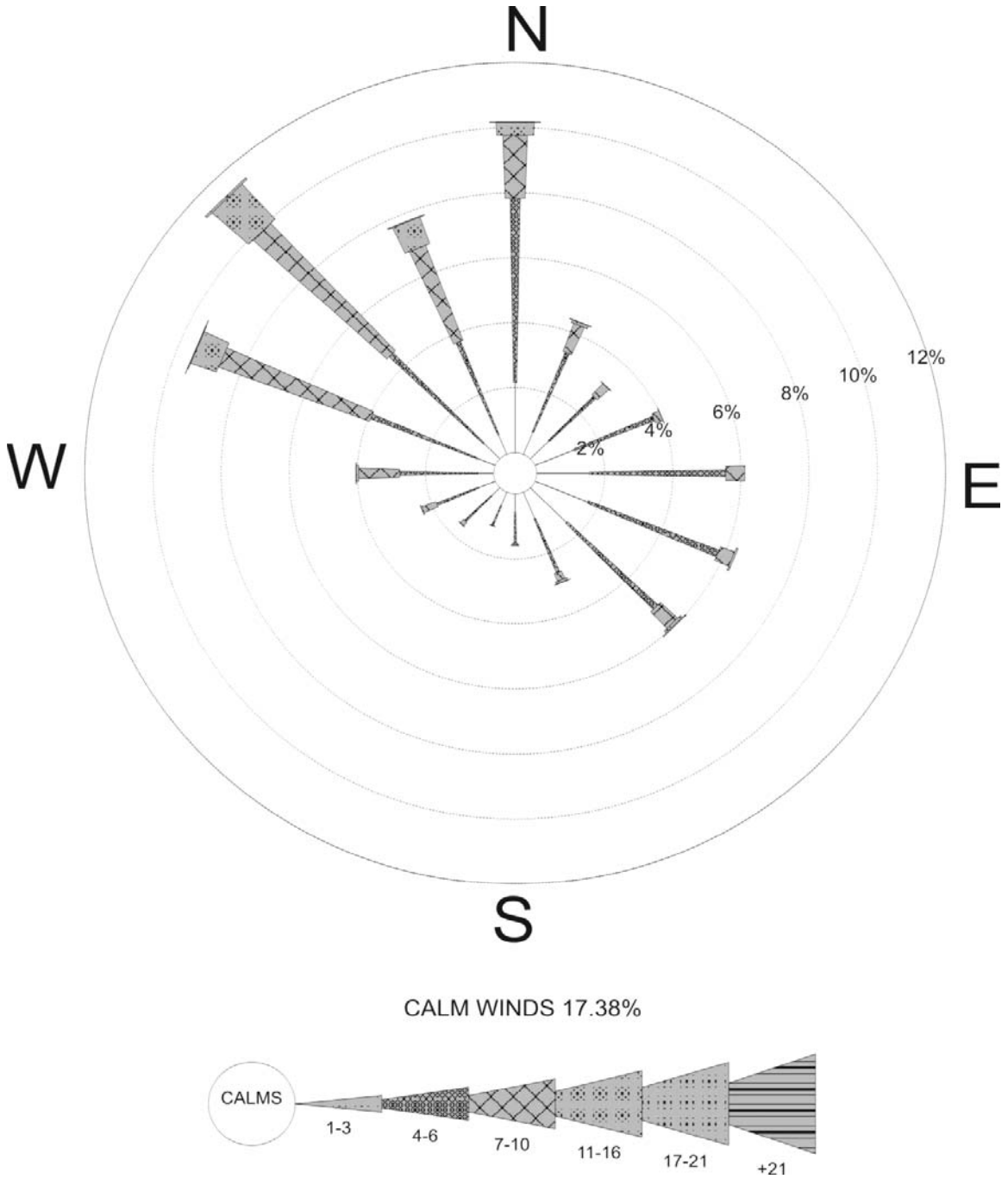

Figure A-4 Fall Season Windrose for Bakersfield Airport based on Surface Data for 2000-2004

2000-2004 (Dec, Jan, Feb)

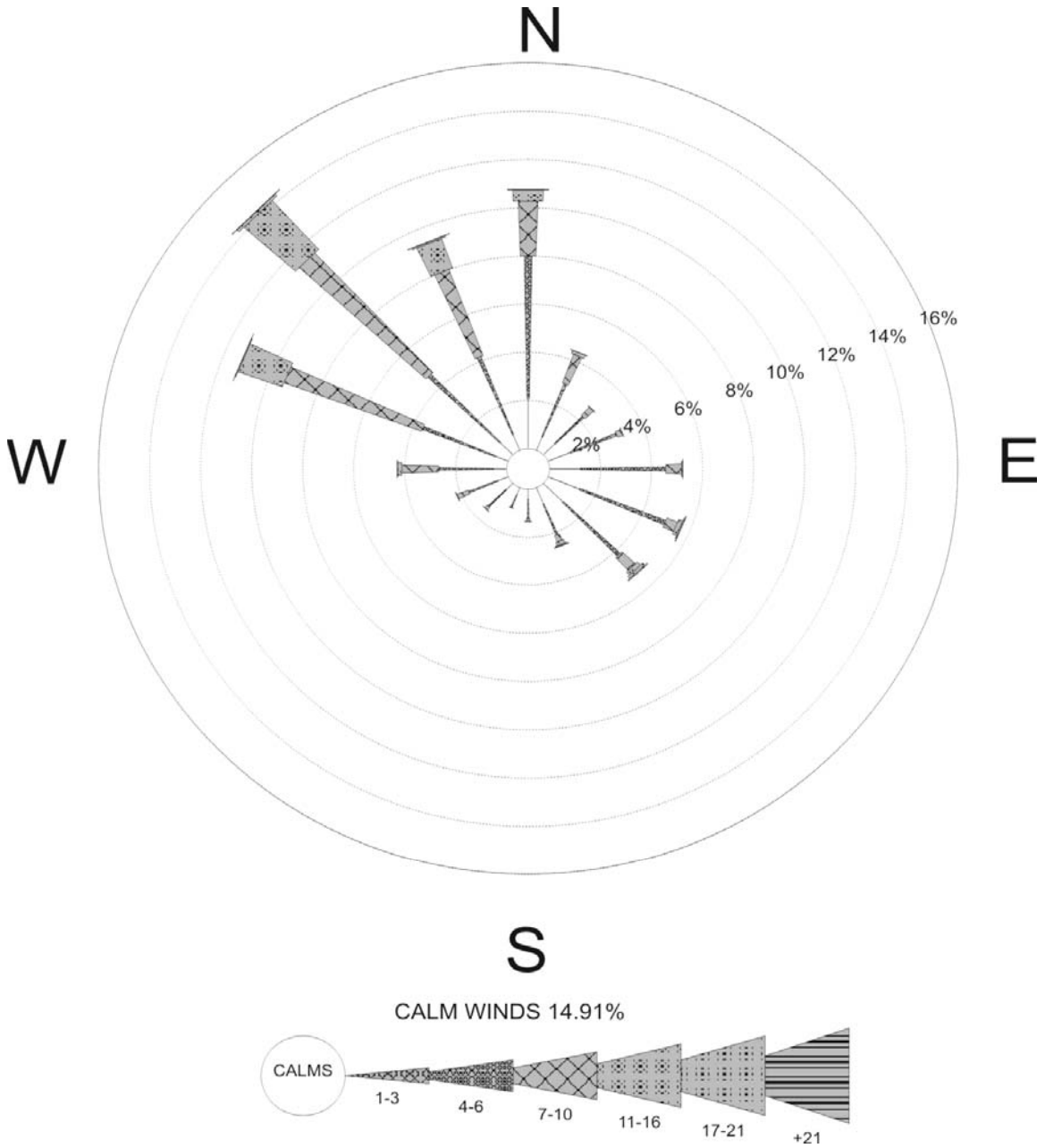

Figure A-5 Winter Season Windrose for Bakersfield Airport based on Surface Data for 2000-2004

Appendix C-2

Agency Comments on Modeling Protocol
CEC and EPA

CEC Comments on the Modeling Protocol for Hydrogen Energy California Project

Note: Applicant's Response provided in italic font following comment.

Ozone Limiting

On page 4-3, the modeling protocol states that the applicant will use ozone limiting method (OLM) to estimate NOx impacts. On page 4-8, the modeling protocol states that the applicant will use meteorological data from 2000 through 2004 and on page 4-9, the modeling protocol states that the applicant will use ambient ozone monitoring data from 2004 through 2006. It is not discussed in the protocol how the applicant intends to apply the OLM when using ambient monitoring data from one set of years (2004-2006) to the modeling results generated from a different set of years (2000-2004).

Applicant's Response – The modeling performed using the Ozone Limiting Method used ozone data from the same years corresponding to the meteorological data. The background monitoring data used to estimate criteria pollutant impacts used the highest reported value from the most recent three years of available data.

Project Description

In general, the modeling protocol demonstrates a reasonable approach, however, due to the number of sources and complexity of the proposed power plant, it is difficult to determine what sources are being modeled and under what operating conditions. For example, the project will have two cooling towers, one for the CTGs and one for the air separator. However, it is not possible for staff to determine which (or if both) towers are represented in Table 4-2 (on page 4-6)…which is simply labeled "Cooling Towers." Therefore, staff recommends that the applicant prepare a more detailed description of the proposed facility components, their expected emission rates, operation (startup, shutdown normal operation, power augmented, etc), and hours of operation per quarter. Additionally, the use of the LMS100 as a backup power source for the facility needs more explanation, what is the purpose of a 100 MW of backup power?

Applicant's Response – More detailed explanations of the sources and their operations including startup may be round in Section 2 Project Description, and Section 5.1 Air Quality, and in the Air Quality Appendix C. The Auxiliary Combustion Gas Turbine is to be used to supply additional peaking power both for HECA and for the external market.

EPA Comments on Hydrogen Energy Project, Kern County

Note: Applicant's Response provided in italic font following comment.

3.3 A discussion of a Class II visibility analysis should be included.

Applicant's Response – Please see the Visual Resources Section of the AFC for discussions on the visible plumes formed from the cooling towers and the HRSG turbine.

4.2 Please describe the methodology used to determine the surface characteristics for input to AERMET. The methodology should be consistent with the AERMOD Implementation Guide.

4.6.1 Please provide a more detailed justification for the representativeness of the meteorological data.

Applicant's Combined Response to 4.2 ad 4.6.1 – According to the Guidance for Air Dispersion Modeling - San Joaquin Valley Air Pollution Control District (08/06 Rev 1.2), the District prepared regional meteorological data sets for use in the AERMOD. The data set is available online. The District expressed that "The availability of standard meteorological data will reduce inconsistencies in data quality and requests to the regulatory agency on obtaining data." The District used the following meteorological elements in AERMET processing for the 5 year period from 2000 to 2004: ceiling height, wind speed, wind direction, air temperature, total cloud opacity, and total cloud amount. The surface data station used was Bakersfield and the upper air station used was Oakland, CA. The District assumed that surface conditions are the weighted average over a radius of 3 km from the meteorological station split into 8 sectors and it is described in section 5.4 in the guidance. Appendix E in the Guidance shows a detailed description of the surface characteristics (Albedo, Bowen Ratio and Surface roughness) processed.

The analysis used the "Bakersfield" meteorological data set available from the District's webpage: http://www.valleyair.org/busind/pto/Tox_Resources/AirQualityMonitoring.htm. The guidance shows "Bakersfield" data set is most applicable for all of Kern County area. The guidance also describes that "the District meteorological data provides a standard data set that can be used for air quality studies using AERMOD. The regional data sets should not be modified. Therefore, the HECA project used the District's model-ready AERMET data set.

5. The NPS has requested that "for future PSD applicants, we ask that large sources (large emissions) complete an air quality analyses for Class I areas beyond 100 km and we be given the opportunity to review the modeling protocol and PSD applications for large sources."

Applicant's Response – Comment Noted.

Appendix C-3

HECA Downwash Structure Information

Downwash Structures

HECA

Buildings

	Building Name	Comment	Number of Tiers	Tier Number	Base Elevation (ft)	Tier Height (ft)	Number of Corners	Corner 1 East (X) (m)	Corner 1 North (Y) (m)
1	KO_DRUM	Flare KO Drum	1	1	390	50	17	283359.4	3909633
2	GASIFIER	Gassifier Structure	1	1	390	200	4	283184.2	3909621
3	SLRYPREP	Slurry Preparation Building	1	1	390	185	4	283252	3909624
4	ASU_COMP	ASU Main Air Compressor Enclosure	1	1	420	40	4	282485.2	3909379
5	LOX_TANK	Liquid Oxygen Separation Tank	1	1	420	90	8	282542.7	3909332
6	HRSG	Heat Recovery Steam Generator	1	1	390	90	8	282683	3909552
7	CTG	Combustion Turbine Generator	1	1	390	50	18	282682.7	3909546
8	STG	Steam Turbine Generator Structure	1	1	390	50	28	282638	3909513
9	AGR	AGR Refrigeration Compressor Enclosure	1	1	390	40	4	283020.4	3909598
10	CO2	CO2 Compressor Enclosure	1	1	390	50	4	283014.4	3909521
11	FINESLAG	Fine Slag Handling Enclosure	1	1	390	70	4	283204.4	3909484
12	O_DEEP_1	Power Distribution Center - Deepwell Inj	1	1	390	25	4	282788.9	3909363
13	O_DEEP_2	Power Distribution Center - Deepwell Inj	1	1	390	25	4	282795.5	3909359
14	O_DEEP_3	Power Distribution Center - Deepwell Inj	1	1	390	25	4	282795.3	3909353
15	O_PBLK_1	Power Distribution Center - Power Block	1	1	390	25	4	282694.6	3909518
16	O_PBLK_2	Power Distribution Center - Power Block	1	1	390	25	4	282688.3	3909499
17	O_PBLK_3	Power Distribution Center - Power Block	1	1	390	25	4	282687.2	3909507
18	O_PBLK_4	Power Distribution Center - Power Block	1	1	390	25	4	282705.7	3909513
19	O_PBLK_5	Power Distribution Center - Power Block	1	1	390	25	4	282705.4	3909504
20	O_PBLK_6	Power Distribution Center - Power Block	1	1	390	25	4	282705.2	3909499
21	O_PBLK_7	Power Distribution Center - Power Block	1	1	390	25	4	282705	3909494
22	O_PBLK_8	Power Distribution Center - Power Block	1	1	390	25	4	282704.9	3909489
23	O_ASU	Power Distribution Center - ASU Area	1	1	420	25	4	282495	3909413
24	O_SULF_1	Power Distribution Center - Sulfur Loadi	1	1	390	25	4	282941.3	3909515
25	O_SULF_2	Power Distribution Center - Sulfur Loadi	1	1	390	25	4	282935.4	3909487
26	O_SULF_3	Power Distribution Center - Sulfur Loadi	1	1	390	25	4	282935.6	3909492
27	O_SULF_4	Power Distribution Center - Sulfur Loadi	1	1	390	25	4	282935.8	3909497
28	O_SULF_5	Power Distribution Center - Sulfur Loadi	1	1	390	25	4	282935.9	3909501
29	O_SULF_6	Power Distribution Center - Sulfur Loadi	1	1	390	25	4	282934.1	3909511

30	O_SULF_7	Power Distribution Center - Sulfur Loadi	1	1	390	25	4	282952.2	3909503
31	O_SULF_8	Power Distribution Center - Sulfur Loadi	1	1	390	25	4	282950.5	3909496
32	O_COOL_1	Power Distribution Center - Cooling Towe	1	1	390	25	4	282977.2	3909423
33	O_COOL_2	Power Distribution Center - Cooling Towe	1	1	390	25	4	282980.6	3909416
34	O_COOL_3	Power Distribution Center - Cooling Towe	1	1	390	25	4	282986.1	3909416
35	O_SOUR_1	Power Distribution Center - Sour Shift A	1	1	390	25	4	283097.7	3909531
36	O_SOUR_2	Power Distribution Center - Sour Shift A	1	1	390	25	4	283091.9	3909503
37	O_SOUR_3	Power Distribution Center - Sour Shift A	1	1	390	25	4	283092.1	3909508
38	O_SOUR_4	Power Distribution Center - Sour Shift A	1	1	390	25	4	283092.3	3909513
39	O_SOUR_5	Power Distribution Center - Sour Shift A	1	1	390	25	4	283092.4	3909518
40	O_SOUR_6	Power Distribution Center - Sour Shift A	1	1	390	25	4	283090.6	3909527
41	O_SOUR_7	Power Distribution Center - Sour Shift A	1	1	390	25	4	283108.7	3909520
42	O_SOUR_8	Power Distribution Center - Sour Shift A	1	1	390	25	4	283107	3909512
43	O_SLAG_1	Power Distribution Center - Fine Slag Ha	1	1	390	25	4	283185.2	3909536
44	O_SLAG_2	Power Distribution Center - Fine Slag Ha	1	1	390	25	4	283179.3	3909508
45	O_SLAG_3	Power Distribution Center - Fine Slag Ha	1	1	390	25	4	283179.5	3909512
46	O_SLAG_4	Power Distribution Center - Fine Slag Ha	1	1	390	25	4	283179.6	3909517
47	O_SLAG_5	Power Distribution Center - Fine Slag Ha	1	1	390	25	4	283179.8	3909522
48	O_SLAG_6	Power Distribution Center - Fine Slag Ha	1	1	390	25	4	283178	3909532
49	O_SLAG_7	Power Distribution Center - Fine Slag Ha	1	1	390	25	4	283196.1	3909524
50	O_SLAG_8	Power Distribution Center - Fine Slag Ha	1	1	390	25	4	283194.4	3909516
51	O_SILO_1	Power Distribution Center - Feedstock St	1	1	390	25	4	283647	3909453
52	O_SILO_2	Power Distribution Center - Feedstock St	1	1	390	25	4	283653.6	3909449
53	O_SILO_3	Power Distribution Center - Feedstock St	1	1	390	25	4	283653.4	3909443
54	O_PARK_1	Power Distribution Center - Parking Area	1	1	350	25	4	283911.7	3909429
55	O_PARK_2	Power Distribution Center - Parking Area	1	1	350	25	4	283915.5	3909434
56	O_PARK_3	Power Distribution Center - Parking Area	1	1	350	25	4	283921	3909434
57	ASU_COOL	ASU Cooling Towers	1	1	420	50	8	282468.1	3909277
58	PWR_COOL	Power Block and Gassification Cooling To	1	1	390	50	12	282836.5	3909401
59	EMER_GN1	Emergency Generator - 1	1	1	390	20	4	282720.5	3909516
60	EMER_GN2	Emergency Generator - 2	1	1	390	20	4	282720.1	3909506
61	AUX_BOIL	Auxiliary Boiler	1	1	390	80	4	282762.1	3909626
62	OFFICES	Control Room - Lab - Admin - Whse - Main	1	1	350	35	4	283866.9	3909394
63	AUX_CTG	Auxiliary CTG Structure	1	1	390	45	20	282638.6	3909621
64	O_WATR_1	Pwr Dist. Center - Water Treat. Area - 1	1	1	340	25	4	283836.6	3909665
65	O_WATR_2	Pwr Dist. Center - Water Treat. Area - 2	1	1	340	25	4	283845.9	3909669
66	O_WATR_3	Pwr Dist. Center - Water Treat. Area - 3	1	1	340	25	4	283838.9	3909670
67	CONTROL	Common Control - Admin - Lab	1	1	350	32	4	283865.1	3909344

68	EMERRESP	Emergency Response Medical Center	1	1	350	22	4	283867.8	3909419

Tanks

	Tank Name	Description	Base Elevation (ft)	Center East (X) (m)	Center North (Y) (m)	Tank Height (m)	Tank Diameter (m)
1	RAWWATER	Raw Water Tank	340	283933.9	3909529	14.63	42.69
2	TREATD_W	Treated Water Tank	340	283920.1	3909582	14.63	30.48
3	FIREWATR	Firewater Storage Tank	340	283882.6	3909502	12.19	33.54
4	OUTFAL_W	Outfall Water Tank	340	282792.9	3909291	12.19	15.24
5	CONDENSA	Condensate Storage Tank	390	282768.2	3909543	7.3148	12.19141
6	DEMINERA	Demineraized Storage Tank	390	282767.6	3909527	12.1914	12.19141
7	SOUR_WTR	Sour Water Stripper Feed Tank	390	282903	3909531	9.7531	10.97226
8	METHNL_W	Methanol Storage Tank - West	390	282996.5	3909445	12.1914	12.19141
9	METHNL_E	Methanol Storage Tank - East	390	283020.9	3909444	12.1914	12.19141
10	SETTLER	Settler	390	283232.7	3909517	10.668	37.15331
11	GREY_WTR	Grey Water Tank	390	283257.6	3909496	12.1914	18.28711
12	PROC_WTR	Process Water Treatment Feed Tank	390	283243	3909481	9.7531	18.28711
13	SILO_N	Feedstock Storage Silos - North	390	283621	3909500	53.3374	24.35233
14	SILO_C	Feedstock Storage Silos - Central	390	283620.1	3909474	53.3374	24.35233
15	SILO_S	Feedstock Storage Silos - South	390	283619.2	3909447	53.3374	24.35233
16	SLURTK_N	Slurry Run Tank - N	390	283243.3	3909600	22.86	11.73423
17	SLURTK_C	Slurry Run Tank - C	390	283242.8	3909585	22.86	11.73423
18	SLURTK_S	Slurry Run Tank - S	390	283242.2	3909570	22.86	11.73423
19	AIR_SEP	Air Separation Column Can	420	282469.5	3909336	62.48	8.88
20	AGR_COLM	AGR Methanol Wash Column	390	282998.9	3909635	71.6245	5.33374

Appendix C-4

CALMET/CALPUFF Air Quality Modeling Impact Analysis

CALMET/CALPUFF
Air Quality Modeling Impact Analysis for Far-Field Class I Areas

FOR THE

HYDROGEN ENERGY CALIFORNIA (HECA) PROJECT

Kern County, CA

Prepared for:

U.S. Environmental Protection Agency Region IX
U.S. Forest Service

Prepared by:

URS
1333 Broadway, Suite 800
Oakland, CA 94612

July 2008

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1.0 BACKGROUND

In accordance with comments from the National Park Service (NPS), U.S. Forest Service (USFS) and U.S. Environmental Protection Agency (USEPA) Region 9 regarding far-field air quality modeling analysis for the proposed Hydrogen Energy California (HECA) project, a refined CALPUFF modeling analysis was performed in conjunction with the CALMET diagnostic meteorological model. Based on the written comments from NPS and EPA and verbal comments from FS, the refined CALPUFF modeling considered only San Rafael Wilderness Class I PSD area for the analysis.

1.1 Model Selection and Setup

The CALPUFF air dispersion model is the preferred model for long-range transport recommended by the Federal Land Managers' Air Quality Related Value Workgroup (FLAG) guidance and the Interagency Working Group on Air Quality Modeling (IWAQM) phase 2 summary report. To estimate air quality impacts at distances greater than 50 km, the CALPUFF model was used in conjunction with the CALMET diagnostic meteorological model. CALPUFF is a puff-type model that can incorporate three-dimensionally varying wind fields, wet and dry deposition, and atmospheric gas and particle phase chemistry.

The CALMET model is used to prepare the necessary gridded wind fields for use in the CALPUFF model. CALMET can accept as input; mesoscale meteorological data (MM5 data), surface, upper air, precipitation, cloud cover, and over-water meteorological data (all in a variety of input formats). These data are merged and the effects of terrain and land cover types are estimated. This process results in the generation of gridded 3-D wind field that accounts for the effects of slope flows, terrain blocking effects, flow channelization, and spatially varying land use types.

The development of model inputs and options for CALMET/CALPUFF processor was based on guidance provided in following references:

- Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report (December 2000);
- Interagency Working Group on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts (December 1998);
- CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States (August 15, 2006);
- CALPUFF Reviewer's Guide (DRAFT) prepared for USDA Forest Service and National Park Service (September 2005); and
- Permit application PSD particulate matter speciation methodology developed by Don Shepherd, National Park Service (2008).

Key input and model options selected are discussed in the following sections.

The most recent EPA-approved version of the CALMET, CALPUFF, CALPOST system (version 5.8, version 5.8 and version 5.6394, respectively) was used.

1.2 Domain

The CALMET/CALPUFF modeling domain was specified using the Lambert Conformal Conic (LCC) Projection system in order to capture the earth curvature of the large modeling domain more accurately for this project. The false easting and northing at the projection origin were both set to zero. The latitude and longitude of the projection origin were set to 35.057 N and 119.643 W, respectively. Matching parallels of latitude 1 and 2 were defined as 34.38 N and 35.67 N, respectively. The choice of the matching parallels was made according to the latitudinal extent of the modeling domain, and therefore the parallels should be contained within the modeling domain in order to minimize distortion. An accepted rule-of-thumb is the rule of sixths which calls for one parallel to be placed 1/6th of the domain's north-south extent south of the domain's north edge, and an identical distance north of the domain's south edge (WDEQ, 2006). The modeling domain was defined using a grid-cell arrangement that is 52 cells in X (easting) direction and 54 cells in Y (northing) direction. The grid-cells are 4 kilometers wide. Therefore, the southwest corner of the gird cell (1,1) were set to -101 km and -110 km.

At least 50 km of buffer distance was set between the most outer-boundary of all Class I areas within the modeling domain in order to prevent the loss of mass outside the boundary under some meteorological scenarios that might be associated with transport to nearby Class I areas. The total CALMET/CALPUFF modeling domain is shown in Figure 1. The entire MM5 data set domain is shown for information only in Figure 2.

Figure 1
CALMET/CALPUFF Modeling Domain

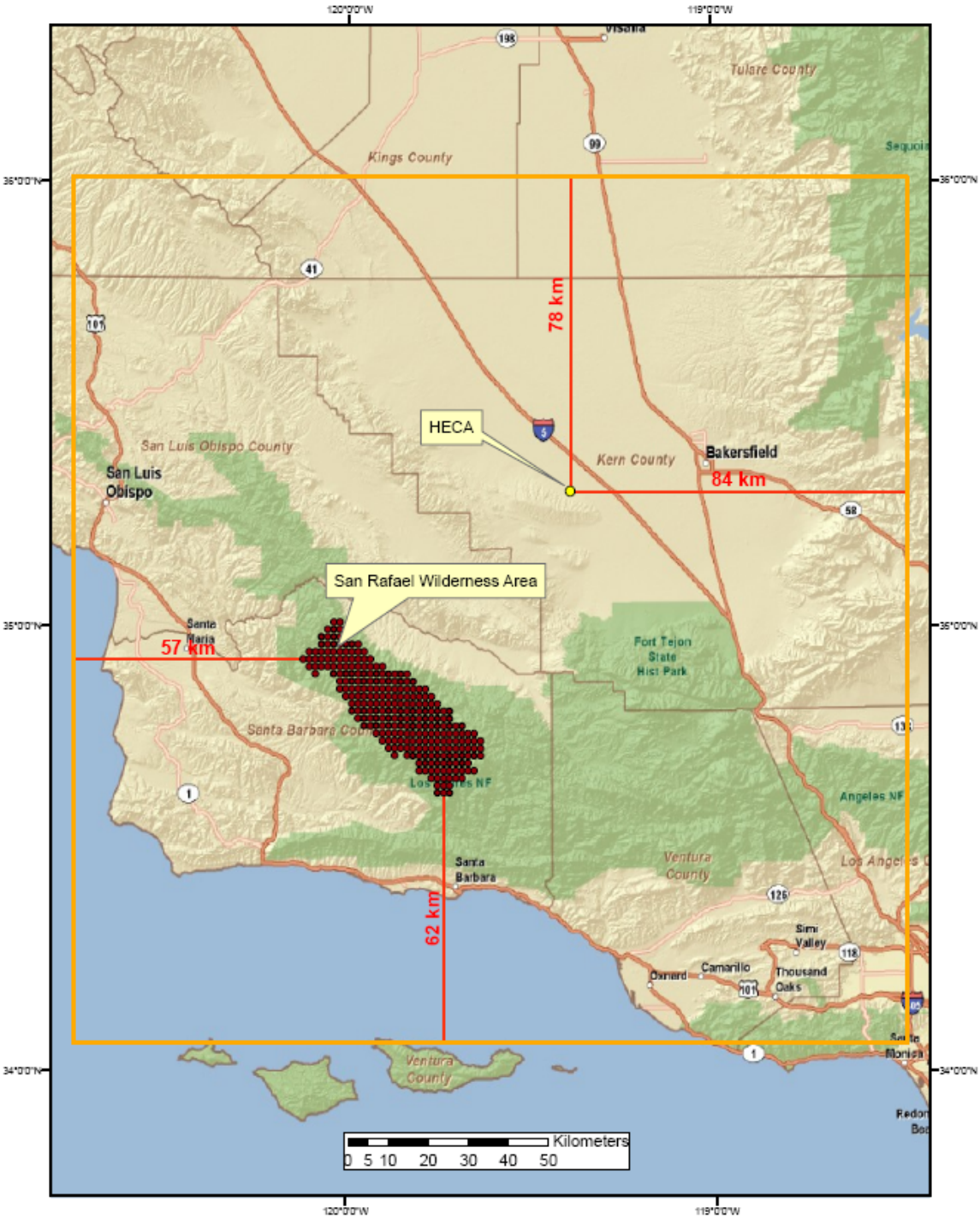


Figure 2
MM5 and CALMET/CALPUFF Modeling Domain

2.0 CALMET PROCESSING

2.1 MM5 Data

A Mesoscale Meteorological Model (MM5) data set was used in conjunction with the actual surface and precipitation meteorological data observations. Three years (2001-2003) of MM5 data were obtained from Western Regional Air Partnership (WRAP). This MM5 data were used for Utah and Nevada's Best Available Retrofit Technology (BART) analysis by WRAP (WRAP, 2006). The MM5 data had a 36 km resolution. Initial guess wind fields based on hourly 36 km MM5 meteorological fields for 2001, 2002 and 2003 (IPROG =14) was used. MM5 domain is shown in Figure 2.

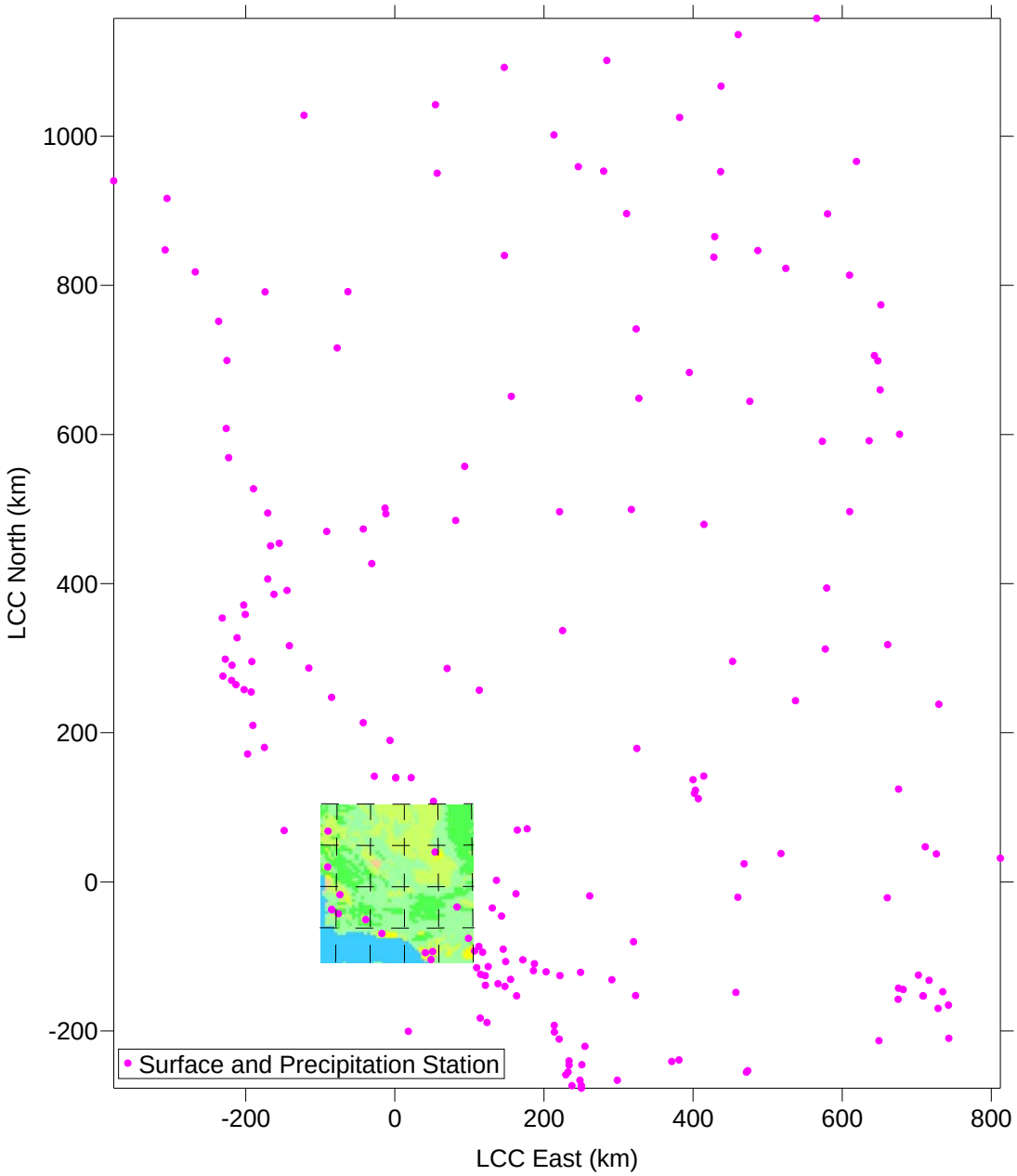
2.2 Hourly Surface and Precipitation Data

CALMET pre-processed hourly surface data were obtained from WRAP's CALPUFF BART website (WRAP, 2008). WRAP used approximately 190 different surface meteorological data stations for 3-year period (2001 through 2003) for BART analysis. Although thirteen (13) stations are located within the HECA CALPUFF modeling domain, all surface stations were used for this modeling analysis.

This modeling analysis considered the effects of chemical transformations and deposition processes on ambient pollutant concentrations; therefore, observation of precipitation was included in the CALMET analysis. CALMET pre-processed precipitation data was also collected from WRAP's BART website (WRAP, 2008). The precipitation stations are co-located with surface meteorological data stations. The inverse-distance-squared interpolation scheme was used to generate a gridded precipitation field with hourly precipitation data. The radius of influence for the interpolation method was set to 100 km.

The locations of both surface and precipitation stations used in this analysis are illustrated in Figure 3.

Figure 3
Locations of Surface and Precipitation Data Stations



2.3 Upper Air Data

No observed upper-air meteorological observations were used as they are redundant to the MM5 data and may introduce spurious artifacts in the wind field (WRAP, 2006). WRAP explains that the twice daily upper-air meteorological observations are used as input with the MM5 model estimates nudged to the observations as part of the Four Dimensional Data Assimilation (FDDA) in the application of the MM5. This results in higher temporal (hourly vs. 12-hour) and spatial (36km vs. ~300 km) resolution upper-air meteorology in the MM5 field that is dynamically

balanced than contained in the upper-air observations. Therefore, the use of the upper-air observations with CALMET is not needed and in fact will upset the dynamic balance of the meteorological fields potentially producing spurious vertical velocities (WRAP, 2006).

2.4 CALMET ZFACE and ZIMAX Settings

Eleven vertical layers were used with vertical cell face (ZFACE) heights at 0, 20, 100, 200, 350, 500, 750, 1000, 2000, 3000, 4000, and 5000 meters. Maximum mixing height (ZIMAX) was set to 4500 meters based on the WRAP modeling analysis. WRAP introduced Colorado Department of Public Health and Environment (CDPHE) analyses of soundings for summer ozone events in the Denver area (CDPHE 2005). The CDPHE analysis suggests mixing heights in the Denver area are often well above the CALMET default value of 3,000 meters during the summer. A 3,000 m AGL maximum mixing height might be appropriate in the eastern U.S., however in the western U.S. in the summer mixing heights may exceed this value. WRAP expected that mixing heights in excess of the 3,000 m AGL CALMET default maximum would occur in the western States (WRAP, 2006).

2.5 Wind Field Model Options

In general, CALMET involves two steps in developing the final wind field. First, the prognostic wind field (such as MM5) is introduced into CALMET as the initial guess field. CALMET then adjusts this field by accounting for the kinematic terrain effects, slope flows, blocking effects, and three-dimensional divergence minimization. The wind field resulting from this step is called the Step 1 wind field. Second, CALMET further adjusts the Step 1 wind field by applying an objective analysis procedure with observational data from selected surface, upper air, and precipitation stations. This step generates the final (Step 2) wind field. The “Diagnostic Wind Module” (DWM) option follows this two-step procedure. In this study, the DWM option was chosen in order to reflect the terrain effects in the wind field. Because several mountain ranges occur within the modeling domain, it was expected that terrain effects would be significant.

The MM5 data were used as the initial guess wind field. The extrapolation of the surface wind data aloft (IEXTRP =-4) was used as recommended by USEPA.

Wind speed and wind direction data from observation stations were only allowed to influence the Step 1 wind field at a distance determined by setting the radius-of-influence parameter. The radius of influence for the surface (RMAX1) was set to 100 km as FLM recommended. The distance from a surface observation station at which the observations and Step 1 wind field were weighted was set to 50 km, which is within the FLM’s recommended range of 20-80 km. Radius of influence for terrain features was set to 10 km. All of these radius-of-influence parameters were set based on CALPUFF Reviewer’s Guide (2005).

2.6 LULC and TERREL processing

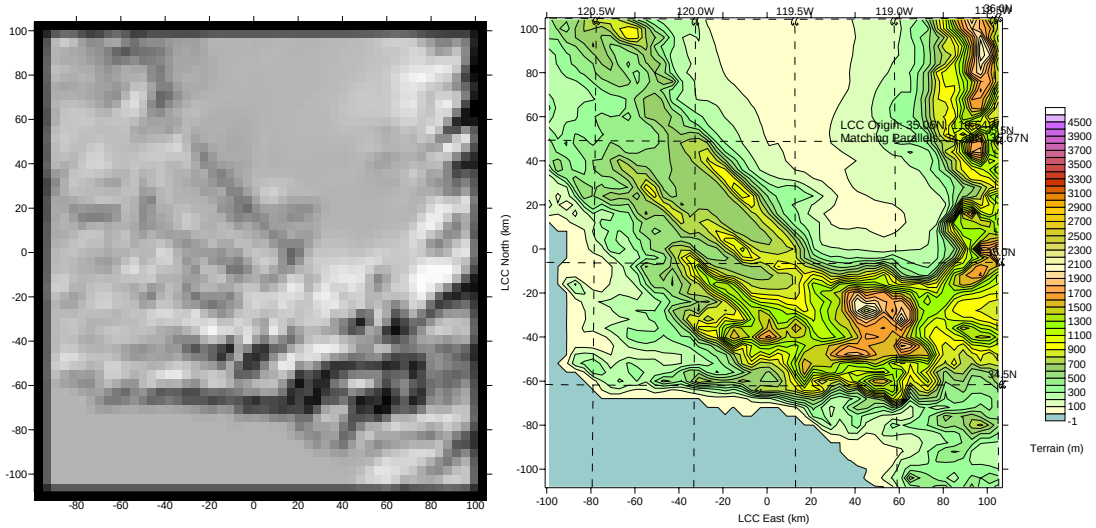
The CALMET and CALPUFF models incorporate assumptions regarding land-use classification, leaf-area index, and surface roughness length to estimate deposition during transport. These parameters were calculated with a 4 km grid spacing for the modeling domain. U.S. Geological Survey (USGS) 1:250,000 scale digital elevation models (DEMs) and Land Use Land Cover (LULC) classification files were obtained and used to develop the geophysical input files

required by the CALMET model. U.S. Geological Survey (USGS) 1:250,000 scale (1-degree) DEMs data with 90 meters resolution were obtained from the USGS ftp site: http://edcftp.cr.usgs.gov/pub/data/DEM/250/. Using nine (9) 1-degree DEM data files obtained, terrain pre-processor (TERREL) was processed to produce gridded fields of terrain elevation in the formats compatible with the CALMET. The names of 1 degree DEM quadrangles are as follows: Bakersfield-e, Bakersfield-w, Fresno-e, Fresno-w, Los_angeles-e, Log_angeles-w, Montery-e, San_luis_obispo-e, Santa_maria-e. Figure 4 shows the elevation contours calculated within the model domain.

LULC data (*.gz) were obtained from USGS 250K site, http://edcftp.cr.usgs.gov/pub/data/LULC/. Land Use Data Preprocessors, CTGCOMP and CTGPROC were processed to compress six (6) 250K LULC data files obtained. After processing, the data were quality checked to ensure land use was accurately represented. USGS land use data contains 38 land use categories. These were mapped to 14 categories read by CALMET. The names of 250K LULC quadrangles are as follows: Bakersfield, Fresno, Los_Angeles, Montery, San_luis_obispo, and Santa_maria. Figure 5 shows the plot of land use data.

The outputs of TERREL and CTGPROC were combined in the geo-physical preprocessor (MAKEGEO) to prepare the CALMET geo-physical input file. These inputs include land use type, elevation, surface parameters (surface roughness, length, albedo, bowen ratio, soil heat flux parameter, and vegetation leaf area index) and anthropogenic heat flux.

Figure 4
3-D Terrain Elevation Contours



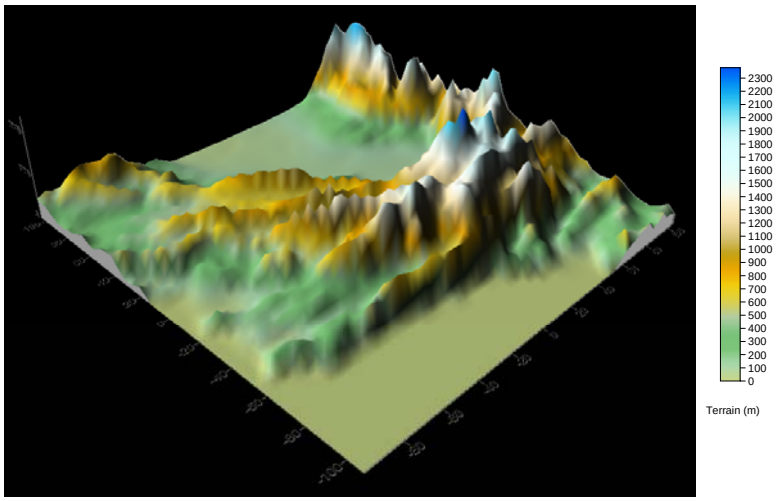
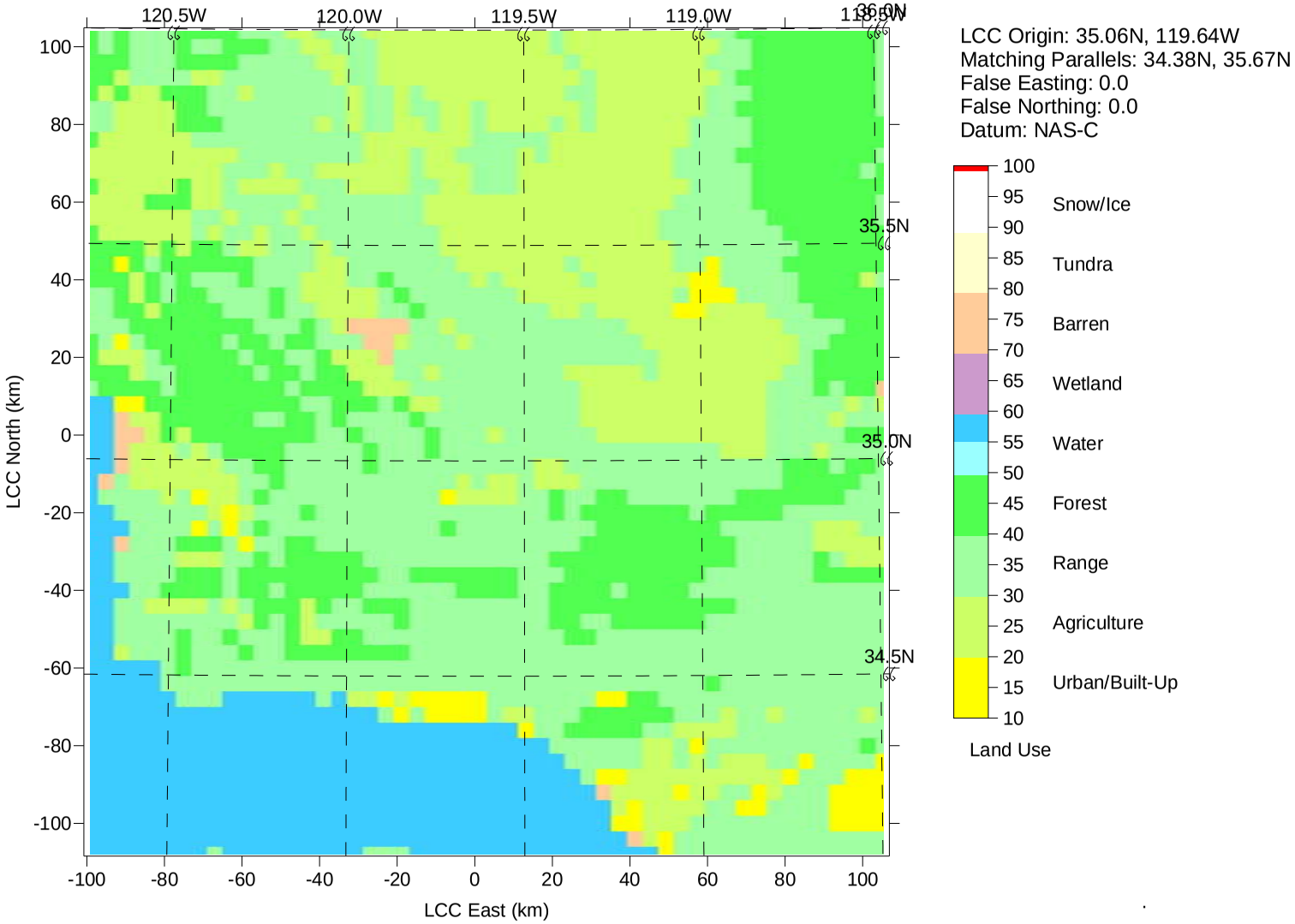


Figure 5
Land Use Land Cover



3.0 CALPUFF PROCESSING

3.1 Receptors of Class I Areas

Receptors for all refined CALPUFF modeling of each Class I area were obtained from the National Park Service (NPS)'s Class I Areas Receptor database (NPS, 2008). No modifications to the receptor locations or heights, as provided in the database, were made. Latitude/Longitude of the Class I receptor coordinates were converted to Lambert Conformal Conic (LCC) coordinate based on domain setup described in section 1.2.

Three Class I areas are located within the region of the Project site: Dome Land Wilderness Area, Sequoia National Park, and San Rafael Wilderness Area. Table 1 lists the distances from the project site to the closest and farthest points of each Class I area.

Table 1
Class I Areas nearby Project Site

Class I Areas	Distance from the Project Site (km)		Model Included?
San Rafael Wilderness Area	Closest	62	Yes
	Farthest	81	Yes
Dome Land Wilderness Area	Closest	110	No
	Farthest	132	No
Sequoia National Park	Closest	125	No
	Farthest	181	No

National Park Service does not believe there will be any significant air quality impact at Sequoia National Park based on the distance (125km) from the Project facility and the low emissions from proposed Project facility. Dome Land Wilderness Area is located in the range of 110 km and 132 km distance from the Project Site. Based on the distance, the low emissions from proposed Project facility, and the dominant wind direction at Bakersfield monitoring station (dominant wind is blowing from northwest while the Dome Land Wilderness Area is located northeast of the Project Site), it was not anticipated that there will be any significant air quality impact at Dome Land Wilderness Area. Therefore, these two Class I areas were not included in the Project analysis. The nearest parts of the San Rafael Wilderness are located beyond 31.1 miles (50 km) and within 62.1 miles (100 km) from the proposed facility, thus only San Rafael Wilderness Class I area was included in the AQRV analysis.

3.2 Sources Included in CALPUFF Modeling

Required emissions in CALPUFF correspond with the needed analysis and include maximum short-term rates for increment and visibility impacts, as well as maximum annual emissions for species deposition and increment comparison. Because of the various operations involved and potential occurrence during a specific period, the CALPUFF modeled sources and emissions included potential overlapping operations.

The maximum emission rate for each averaging time period is shown in Table 2. The maximum emission rates shown in Table 2 in units of grams per second were converted from the corresponding maximum emission rates expressed in units of either pounds per hour, pounds per

day or tons per year contained in the emissions inventory. The stack parameters of all sources are shown in Table 3.

The CALPUFF modeling included speciation of emissions according to the National Park Service (NPS)'s Particulate Matter Speciation (PMS) method for natural gas combustion turbines. Applying the PMS methodology, 67% of total SO_2 was speciated into SO_2 and 33% of total SO_2 was speciated into SO_4. Also, the total PM_{10} emission from HRSG/Turbine was speciated into Elemental Carbon (EC) and Secondary Organic Aerosol (SOA). The SOA was speciated again into $PM_{0.05}$, $PM_{0.01}$, $PM_{0.15}$, $PM_{0.20}$, $PM_{0.25}$, and $PM_{1.0}$ (indicated as PM0005, PM0010, PM0015, PM0020, PM0025, and PM0100 in the modeling, respectively). The PM_{10} emissions from other sources were modeled directly as PM_{10}. Direct emissions of the remaining species, HNO_3 and NO_3, were assumed to be zero for the natural gas burning sources of the project. The modeled emissions are shown in Table 4 (3-hour averaged), Table 5 (24-hour averaged), and Table 6 (annual averaged). The SOA size distribution is shown in Table 7. In addition, total PM emission was separately modeled as INCPM without speciation for incremental PM analysis.

The 3-hour averaged emission rate was used for the 3-hour SO_2 impact analysis. The 24-hour averaged emission rate was used for the 24-hour SO_2 and 24-hour PM_{10} impact analyses, and visibility impairment impact analysis. The annual emission rate was used for the annual NO_x, annual SO_2, and annual PM_{10} impact analyses as well as nitrogen and sulfur deposition analyses.

Table 2
Maximum Emission Rates of Each Averaging Time Period

Source	3-hr (g/s)	24-hr (g/s)			Annual (g/s)		
	SO_2	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
ASUCOOL1	-	-	-	0.0285	-	-	0.0271
ASUCOOL2	-	-	-	0.0285	-	-	0.0271
ASUCOOL3	-	-	-	0.0285	-	-	0.0271
ASUCOOL4	-	-	-	0.0285	-	-	0.0271
PWCOOL1	-	-	-	0.0382	-	-	0.0363
PWCOOL2	-	-	-	0.0382	-	-	0.0363
PWCOOL3	-	-	-	0.0382	-	-	0.0363
PWCOOL4	-	-	-	0.0382	-	-	0.0363
PWCOOL5	-	-	-	0.0382	-	-	0.0363
PWCOOL6	-	-	-	0.0382	-	-	0.0363
PWCOOL7	-	-	-	0.0382	-	-	0.0363
PWCOOL8	-	-	-	0.0382	-	-	0.0363
PWCOOL9	-	-	-	0.0382	-	-	0.0363
PWCOOL10	-	-	-	0.0382	-	-	0.0363
PWCOOL11	-	-	-	0.0382	-	-	0.0363
PWCOOL12	-	-	-	0.0382	-	-	0.0363
PWCOOL13	-	-	-	0.0382	-	-	0.0363
GASCOOL1	-	-	-	0.0300	-	-	0.0285
GASCOOL2	-	-	-	0.0300	-	-	0.0285
GASCOOL3	-	-	-	0.0300	-	-	0.0285
GASCOOL4	-	-	-	0.0300	-	-	0.0285
EMERGEN1 [a]	0.0024	-	-	-	0.0022	0.00002	0.0001
EMERGEN2 [a]	-	-	-	-	-	-	-
HRSGSTK	0.8600	3.7618	0.1929	2.3939	4.8092	0.8131	2.8695
FIREPUMP [b]	0.0005	-	-	-	0.0026	0.000008	0.000026
AUX_BOIL [c]	-	-	-	-	0.0492	0.0091	0.0224
TAIL_TO	0.2546	0.3276	0.2546	0.0202	0.1694	0.2521	0.0104
CO_2_VENT	-	-	-	-	-	-	-
EL_FLARE	2.1933	0.0720	0.2742	0.0018	0.0049	0.0016	0.0001
GD_FLARE	0.0001	6.6150	0.0001	0.0002	0.1239	0.0001	0.0002
GASVENTA [d]	-	-	-	-	-	-	-
GASVENTB	0.0454	0.2948	0.0454	0.0181	0.0606	0.0093	0.0037
GASVENTC [d]	-	-	-	-	-	-	-
AUX_CTG [e]	0.2343	-	-	-	0.5011	0.1100	0.5912
DC1	-	-	-	0.0511	-	-	0.0109
DC2	-	-	-	0.0759	-	-	0.0163
DC3	-	-	-	0.0759	-	-	0.0163
DC4	-	-	-	0.0012	-	-	0.0010
DC5	-	-	-	0.0141	-	-	0.0112
DC6	-	-	-	0.0126	-	-	0.0099
DC7	-	-	-	0.0105	-	-	0.0083
DC8	-	-	-	0.0129	-	-	0.0102
DC9	-	-	-	0.0003	-	-	0.0003

Notes:
a. Assumed that emergency generators will not run on worst case day.
b. Assumed that firewater pump will not run on worst case day.
c. Auxiliary boiler is not fired at the same time that the HRSG is operating.

d. There are three gasifiers. Only one gasifier warming will be operated at any one time. The emission is from GASVENTB, which results worst impact among three gasifiers.
e. Assumed that auxiliary turbine will not run on worst case day.
f. Average sulfur content of the natural gas combusted in the HRSG is assumed.

(g/s) = grams per second
NO_x = oxides of nitrogen
PM_{10} = particulate matter 10 microns in diameter
SO_2 = sulfur dioxide

Table 3
Source Location and Parameters

Source ID	Source Description	UTM Easting	UTM Northing	LCC X	LCC Y	Base Elevation	Stack Height	Stack Temperature	Stack Velocity	Stack Diameter
		(m)	(m)	(km)	(km)	(m)	(m)	(K)	(m/s)	(m)
ASUCOOL1	ASU Cooling Tower	282476	3909286	22.7903	27.5323	128.0	17.24	299.9	7.98	9.14
ASUCOOL2	ASU Cooling Tower	282491	3909286	22.8055	27.5322	128.0	17.24	299.9	7.98	9.14
ASUCOOL3	ASU Cooling Tower	282506	3909285	22.8207	27.5320	128.0	17.24	299.9	7.98	9.14
ASUCOOL4	ASU Cooling Tower	282521	3909285	22.8360	27.5319	128.0	17.24	299.9	7.98	9.14
PWCOOL1	Power Block Cooling Tower	282844	3909392	23.1553	27.6477	118.9	17.24	299.9	7.98	9.14
PWCOOL2	Power Block Cooling Tower	282859	3909391	23.1706	27.6476	118.9	17.24	299.9	7.98	9.14
PWCOOL3	Power Block Cooling Tower	282874	3909391	23.1858	27.6475	118.9	17.24	299.9	7.98	9.14
PWCOOL4	Power Block Cooling Tower	282890	3909390	23.2010	27.6473	118.9	17.24	299.9	7.98	9.14
PWCOOL5	Power Block Cooling Tower	282905	3909390	23.2163	27.6472	118.9	17.24	299.9	7.98	9.14
PWCOOL6	Power Block Cooling Tower	282920	3909389	23.2315	27.6471	118.9	17.24	299.9	7.98	9.14
PWCOOL7	Power Block Cooling Tower	282935	3909389	23.2468	27.6469	118.9	17.24	299.9	7.98	9.14
PWCOOL8	Power Block Cooling Tower	282951	3909388	23.2620	27.6468	118.9	17.24	299.9	7.98	9.14
PWCOOL9	Power Block Cooling Tower	282966	3909388	23.2772	27.6467	118.9	17.24	299.9	7.98	9.14
PWCOOL10	Power Block Cooling Tower	282981	3909387	23.2925	27.6465	118.9	17.24	299.9	7.98	9.14
PWCOOL11	Power Block Cooling Tower	282996	3909386	23.3077	27.6464	118.9	17.24	299.9	7.98	9.14
PWCOOL12	Power Block Cooling Tower	283011	3909386	23.3230	27.6462	118.9	17.24	299.9	7.98	9.14
PWCOOL13	Power Block Cooling Tower	283027	3909385	23.3382	27.6461	118.9	17.24	299.9	7.98	9.14
GASCOOL1	Gasification Cooling Tower	283042	3909385	23.3534	27.6460	118.9	17.24	299.9	7.98	9.14
GASCOOL2	Gasification Cooling Tower	283057	3909384	23.3687	27.6458	118.9	17.24	299.9	7.98	9.14
GASCOOL3	Gasification Cooling Tower	283072	3909384	23.3839	27.6457	118.9	17.24	299.9	7.98	9.14
GASCOOL4	Gasification Cooling Tower	283088	3909383	23.3992	27.6456	118.9	17.24	299.9	7.98	9.14
EMERGEN1	Emergency Generator1	282735	3909508	23.0438	27.7611	121.9	6.10	677.6	67.38	0.37
EMERGEN2	Emergency Generator2	282735	3909508	23.0438	27.7611	121.9	6.10	677.6	67.38	0.37
HRSGSTK	HRSG Stack	282728	3909548	23.0350	27.8005	118.9	65.00	344.3	11.55	6.10
FIREPUMP	Fire Water Pump Diesel Engine	283877	3909536	24.1842	27.8194	103.6	6.10	727.6	47.52	0.21
AUX_BOIL	Auxiliary Boiler	282803	3909613	23.1084	27.8673	118.9	24.38	422.0	9.20	1.37
TAIL_TO	Tail Gas Thermal Oxidizer	282897	3909483	23.2056	27.7401	118.9	50.29	922.0	7.45	0.76
CO_2_VENT	CO_2 Vent	283457	3909546	23.7640	27.8181	118.9	87.78	291.5	55.92	1.07

Table 3
Source Location and Parameters (Continued)

Source ID	Source Description	UTM Easting	UTM Northing	LCC X	LCC Y	Base Elevation	Stack Height	Stack Temperature	Stack Velocity	Stack Diameter
		(m)	(m)	(km)	(km)	(m)	(m)	(K)	(m/s)	(m)
EL_FLARE	Elevated Flare	282881	3909512	23.1896	27.7689	118.9	65.00	1273.0	20.00	1.05
GD_FLARE	Ground Flare	283357	3909552	23.6634	27.8218	118.9	24.38	1144.3	9.93	15.24
GASVENTA	Gasifier Warming Vent A	283205	3909611	23.5106	27.8762	118.9	64.01	338.7	26.39	0.30
GASVENTB	Gasifier Warming Vent B	283204	3909586	23.5104	27.8518	118.9	64.01	338.7	26.39	0.30
GASVENTC	Gasifier Warming Vent C	283203	3909562	23.5102	27.8274	118.9	64.01	338.7	26.39	0.30
AUX_CTG	AuxiliaryCombustionGasTurbine	282624	3909632	22.9293	27.8821	118.9	33.53	677.6	15.31	4.88
DC1	FeedStock-DustCollection	283267	3909240	23.5827	27.5073	121.5	15.00	291.9	20.97	0.76
DC2	FeedStock-DustCollection	283628	3909468	23.9371	27.7448	108.8	60.35	291.9	21.66	0.91
DC3	FeedStock-DustCollection	283613	3909479	23.9213	27.7557	108.8	60.35	291.9	21.66	0.91
DC4	FeedStock-DustCollection	283633	3909515	23.9405	27.7917	108.8	7.01	291.9	22.70	0.23
DC5	FeedStock-DustCollection	283635	3909607	23.9404	27.8836	107.0	24.08	291.9	12.58	0.66
DC6	FeedStock-DustCollection	283614	3909614	23.9192	27.8903	107.0	24.08	291.9	21.82	0.61
DC7	FeedStock-DustCollection	283278	3909609	23.5833	27.8765	118.9	59.44	291.9	21.56	0.56
DC8	FeedStock-DustCollection	283281	3909588	23.5869	27.8556	118.9	42.37	291.9	8.00	0.56
DC9	FeedStock-DustCollection	283279	3909601	23.5845	27.8679	118.9	59.44	291.9	22.60	0.41

Notes:
Assumed that the temperature of cooling tower and dust collection is the annual averaged value from the AERMET meteorological data at Bakersfield monitoring station.b.

K = Kelvin
km = kilometer
LCC = Lambert Conformal Conic
m = meter
UTM = Universal Transverse Mercator

Table 4
3-hour Averaged Emission Inventory for CALPUFF (3-hour SO_2)

Sources (g/s)	SO_2	SO_4	NO_x	HNO_3	NO_3	INCPM	PM_{10}	SOA						EC
								PM0005	PM0010	PM0015	PM0020	PM0025	PM0100	
EMERGEN1	2.35E-03	-	-	-	-	-	-	-	-	-	-	-	-	-
HRSGSTK	5.73E-01	4.30E-01	2.10E+01	-	-	2.39E+00	-	2.05E-01	3.41E-01	3.14E-01	2.05E-01	1.50E-01	1.50E-01	5.98E-01
FIREPUMP	4.70E-04	-	2.32E-01	-	-	-	-	-	-	-	-	-	-	-
TAIL_TO	2.55E-01	-	3.28E-01	-	-	2.02E-02	2.02E-02	-	-	-	-	-	-	-
EL_FLARE	2.19E+00	-	5.44E-01	-	-	1.80E-03	1.80E-03	-	-	-	-	-	-	-
GD_FLARE	1.29E-04	-	7.94E+00	-	-	1.58E-04	1.58E-04	-	-	-	-	-	-	-
GASVENTB	4.54E-02	-	2.95E-01	-	-	1.81E-02	1.81E-02	-	-	-	-	-	-	-
AUX_CTG	1.56E-01	1.17E-01	2.60E+00	-	-	-	-	-	-	-	-	-	-	-

Notes:
(g/s) = grams per second
EC = Elemental Carbon
HNO_3 = nitric acid
INCPM = total particulate matter emission
NO_x = oxides of nitrogen
NO_3 = nitrate
PM0005 – PM0100 = particulate matter 5 to 100 microns in diameter
PM_{10} = particulate matter 10 microns in diameter
SO_2 = sulfur dioxide
SO_4 = sulfate compound
SOA = Secondary Organic Aerosol

Table 5
24-hour Averaged Emission Inventory for CALPUFF (24-hour NO_x, SO_2, and PM_{10} and Visibility)

Sources (g/s)	SO_2	SO_4	NO_x	HNO_3	NO_3	INCPM	PM_{10}	SOA						EC
								PM0005	PM0010	PM0015	PM0020	PM0025	PM0100	
ASUCOOL1	-	-	-	-	-	2.85E-02	2.85E-02	-	-	-	-	-	-	-
ASUCOOL2	-	-	-	-	-	2.85E-02	2.85E-02	-	-	-	-	-	-	-
ASUCOOL3	-	-	-	-	-	2.85E-02	2.85E-02	-	-	-	-	-	-	-
ASUCOOL4	-	-	-	-	-	2.85E-02	2.85E-02	-	-	-	-	-	-	-
PWCOOL1	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL2	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL3	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL4	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL5	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL6	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL7	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL8	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL9	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL10	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL11	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL12	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
PWCOOL13	-	-	-	-	-	3.82E-02	3.82E-02	-	-	-	-	-	-	-
GASCOOL1	-	-	-	-	-	3.00E-02	3.00E-02	-	-	-	-	-	-	-
GASCOOL2	-	-	-	-	-	3.00E-02	3.00E-02	-	-	-	-	-	-	-
GASCOOL3	-	-	-	-	-	3.00E-02	3.00E-02	-	-	-	-	-	-	-
GASCOOL4	-	-	-	-	-	3.00E-02	3.00E-02	-	-	-	-	-	-	-
HRSGSTK	1.29E-01	9.65E-02	3.76E+00	-	-	2.39E+00	-	-	4.25E-01	3.91E-01	2.55E-01	1.87E-01	1.87E-01	5.98E-01
TAIL_TO	2.55E-01	-	3.28E-01	-	-	2.02E-02	2.02E-02	-	-	-	-	-	-	-
EL_FLARE	2.74E-01	-	7.20E-02	-	-	1.80E-03	1.80E-03	-	-	-	-	-	-	-
GD_FLARE	1.07E-04	-	6.62E+00	-	-	1.58E-04	1.58E-04	-	-	-	-	-	-	-
GASVENTB	4.54E-02	-	2.95E-01	-	-	1.81E-02	1.81E-02	-	-	-	-	-	-	-
DC1	-	-	-	-	-	5.11E-02	5.11E-02	-	-	-	-	-	-	-
DC2	-	-	-	-	-	7.59E-02	7.59E-02	-	-	-	-	-	-	-
DC3	-	-	-	-	-	7.59E-02	7.59E-02	-	-	-	-	-	-	-
DC4	-	-	-	-	-	1.23E-03	1.23E-03	-	-	-	-	-	-	-
DC5	-	-	-	-	-	1.41E-02	1.41E-02	-	-	-	-	-	-	-
DC6	-	-	-	-	-	1.26E-02	1.26E-02	-	-	-	-	-	-	-
DC7	-	-	-	-	-	1.05E-02	1.05E-02	-	-	-	-	-	-	-
DC8	-	-	-	-	-	1.29E-02	1.29E-02	-	-	-	-	-	-	-
DC9	-	-	-	-	-	3.02E-04	3.02E-04	-	-	-	-	-	-	-

Notes:
(g/s) = grams per second
EC = Elemental Carbon
HNO_3 = nitric acid
INCOM = total particulate matter emission
NO_x = oxides of nitrogen
NO_3 = nitrate
PM0005 – PM0100 = particulate matter 5 to 100 microns in diameter
SO_2 = sulfur dioxide
SO_4 = sulfate compound
SOA = Secondary Organic Aerosol

Table 6
Annual Averaged Emission Inventory for CALPUFF (Annual NO_x, SO_2, and PM_{10} and Deposition)

Sources (g/s)	SO_2	SO_4	NO_x	HNO_3	NO_3	INCPM	PM_{10}	SOA						EC
								PM0005	PM0010	PM0015	PM0020	PM0025	PM0100	
ASUCOOL1	-	-	-	-	-	2.71E-02	2.71E-02	-	-	-	-	-	-	-
ASUCOOL2	-	-	-	-	-	2.71E-02	2.71E-02	-	-	-	-	-	-	-
ASUCOOL3	-	-	-	-	-	2.71E-02	2.71E-02	-	-	-	-	-	-	-
ASUCOOL4	-	-	-	-	-	2.71E-02	2.71E-02	-	-	-	-	-	-	-
PWCOOL1	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL2	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL3	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL4	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL5	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL6	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL7	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL8	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL9	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL10	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL11	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL12	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
PWCOOL13	-	-	-	-	-	3.63E-02	3.63E-02	-	-	-	-	-	-	-
GASCOOL1	-	-	-	-	-	2.85E-02	2.85E-02	-	-	-	-	-	-	-
GASCOOL2	-	-	-	-	-	2.85E-02	2.85E-02	-	-	-	-	-	-	-
GASCOOL3	-	-	-	-	-	2.85E-02	2.85E-02	-	-	-	-	-	-	-
GASCOOL4	-	-	-	-	-	2.85E-02	2.85E-02	-	-	-	-	-	-	-
EMERGEN1	2.01E-05	-	2.22E-03	-	-	1.15E-04	1.15E-04	-	-	-	-	-	-	-
HRSGSTK	5.42E-01	4.07E-01	4.81E+00	-	-	2.87E+00	-	2.62E-01	4.36E-01	4.01E-01	2.62E-01	1.92E-01	1.92E-01	7.17E-01
FIREPUMP	8.05E-06	-	2.64E-03	-	-	2.64E-05	2.64E-05	-	-	-	-	-	-	-
AUX_BOIL	9.13E-03	-	4.92E-02	-	-	2.24E-02	2.24E-02	-	-	-	-	-	-	-
TAIL_TO	2.52E-01	-	1.69E-01	-	-	1.04E-02	1.04E-02	-	-	-	-	-	-	-
EL_FLARE	1.58E-03	-	4.91E-03	-	-	1.23E-04	1.23E-04	-	-	-	-	-	-	-
GD_FLARE	1.29E-04	-	1.24E-01	-	-	1.89E-04	1.89E-04	-	-	-	-	-	-	-
GASVENTB	9.32E-03	-	6.06E-02	-	-	3.73E-03	3.73E-03	-	-	-	-	-	-	-
AUX_CTG	7.33E-02	5.50E-02	5.01E-01	-	-	5.91E-01	-	5.83E-02	9.71E-02	8.93E-02	5.83E-02	4.27E-02	4.27E-02	1.48E-01
DC1	-	-	-	-	-	1.09E-02	1.09E-02	-	-	-	-	-	-	-
DC2	-	-	-	-	-	1.63E-02	1.63E-02	-	-	-	-	-	-	-
DC3	-	-	-	-	-	1.63E-02	1.63E-02	-	-	-	-	-	-	-
DC4	-	-	-	-	-	9.69E-04	9.69E-04	-	-	-	-	-	-	-
DC5	-	-	-	-	-	1.12E-02	1.12E-02	-	-	-	-	-	-	-
DC6	-	-	-	-	-	9.94E-03	9.94E-03	-	-	-	-	-	-	-
DC7	-	-	-	-	-	8.25E-03	8.25E-03	-	-	-	-	-	-	-
DC8	-	-	-	-	-	1.02E-02	1.02E-02	-	-	-	-	-	-	-
DC9	-	-	-	-	-	3.02E-04	3.02E-04	-	-	-	-	-	-	-

Notes:
(g/s) = grams per second
EC = Elemental Carbon
HNO_3 = nitric acid
INCOM = total particulate matter emission
NO_x = oxides of nitrogen
NO_3 = nitrate
PM0005 – PM0100 = particulate matter 5 to 100 microns in diameter
PM_{10} = particulate matter 10 microns in diameter
SO_2 = sulfur dioxide
SO_4 = sulfate compound
SOA = Secondary Organic Aerosol

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Table 7
Size Distribution of SOA (NPS, 2008)

Species Name	Size Distribution (%)	Geometric Mass Mean Diameter (microns)	Geometric Std. Deviation (microns)
SO_4	100	0.48	0.50
NO_3	100	0.48	0.50
PM0005	15	0.05	0.00
PM0010	40	0.10	0.00
PM0015	63	0.15	0.00
PM0020	78	0.20	0.00
PM0025	89	0.25	0.00
PM0100	100	1.00	0.00

Notes:
NO_3 = nitrate
NPS = National Park Service
PM0005 – PM0100 = particulate matter 5 to 100 microns in diameter
SO_4 = sulfate compound
SOA = Secondary Organic Aerosol

3.3 CALPUFF Parameters

The CALPUFF options were selected to follow EPA's recommended settings for regulatory modeling or WRAP's BART modeling.

Size parameters for dry deposition of nitrate, sulfate, and PM_{10} particles were based on default CALPUFF model options. Chemical parameters for gaseous dry deposition and wet scavenging coefficients were based on default values presented in the CALPUFF User's Guide. Calculation of total nitrogen deposition includes the contribution of nitrogen resulting from the ammonium ion of the ammonium sulfate compound. For the CALPUFF runs that incorporate deposition and chemical transformation rates (i.e. deposition and visibility), the full chemistry option of CALPUFF was turned on (MCHEM = 1). The nighttime loss for SO_2, NO_x and nitric acid (HNO_3) was set at 0.2 percent per hour, 2 percent per hour and 2 percent per hour, respectively. CALPUFF was also configured to allow predictions of SO_2, sulfate (SO_4), NO_x, HNO_3, nitrate (NO_3) and PM_{10} using the MESOPUFF II chemical transformation module.

Hourly ozone concentration files (OZONE.DAT) were obtained from the WRAP's BART modeling website for the same years (2001 through 2003) as the meteorological data. Monthly background ozone concentration for missing data from hourly ozone concentration file was set to 80ppb. The monthly background ammonia concentration was set to 10 ppb.

As described in Section 3.2, emissions were speciated in accordance with the National Park Service (NPS)'s Particular Matter Speciation (PMS) guideline (http://www2.nature.nps.gov/air/permits/ect/index.cfm). In doing so, the sulfur emissions were speciated to relative sulfur constituents of SO_2 and SO_4 to better account for gas to particulate conversion and visibility effects.

3.4 PSD Class I Increment Significance Analysis

CALMET/CALPUFF (Refined CALPUFF) was used to model ambient air impacts of NO_2, PM_{10}, and SO_2 from the emission sources and the modeling results were compared to PSD Class I Increment modeling significance thresholds. The sources were modeled at full potential-to-emit (PTE) for this analysis. The full chemistry option of CALPUFF was turned on (MCHEM =1, MESOPUFF II scheme), and a deposition option was turned on (MWET = 1 and MDRY = 1). The 3-hour averaged maximum SO_2 emission rate were modeled for 2-hour SO_2 increment analysis. The 24-hour averaged maximum emission rates were modeled for 24-hour SO_2 and PM_{10} increment analyses. The annual averaged emission rates were modeled for annual averaged NO_x, SO_2, and PM_{10} increment analyses. For 24-hour and annual PM incremental analyses, the total PM emission ("INCPM" in the modeling) was modeled without speciation, and the INCPM was treated as fine particulate matter in terms of geometric characteristics.

3.5 Class I Area Visibility Reduction Analysis

Refined CALPUFF was used to evaluate the potential for visibility reduction. All sources were modeled at full PTE for this analysis. Emissions of total SO_2 and PM_{10} from the natural gas turbines were speciated based on National Park Service (NPS)'s Particulate Matter Speciation (PMS) guideline as described.

The emissions of twelve chemical species, SO_2, SO_4, NO_x, HNO_3, NO_3, $PM_{0.05}$, $PM_{0.01}$, $PM_{0.15}$, $PM_{0.20}$, $PM_{0.25}$, $PM_{1.0}$, EC and PM_{10}, were modeled in CALPUFF to predict the visibility impact based on PMS for natural gas turbine. Because only SO_2 emissions estimates were provided, one-third of the estimated SO_2 emission was assumed to be SO_4 emissions, and the remaining two-thirds remained as SO_2 emissions. For HRSG and Turbine, the total PM_{10} emissions were speciated into Elemental Carbon (EC) and Secondary Organic Aerosol (SOA). The SOA is speciated again into $PM_{0.05}$, $PM_{0.01}$, $PM_{0.15}$, $PM_{0.20}$, $PM_{0.25}$, and $PM_{1.0}$ (indicated as PM0005, PM0010, PM0015, PM0020, PM0025, and PM0100 in the modeling, respectively). For the other sources such as cooling towers, the total PM_{10} emissions were modeled as PM_{10} without speciation.

CALPOST was used to post-process the estimated 24-hour averaged ammonium nitrate, ammonium sulfate, elemental carbon, SOA, and PM_{10} concentrations into an extinction coefficient value for each day at each modeled receptor, using the three years of CALMET meteorological data. To do so, it required the use of extinction efficiency values.

All the PM species ($PM_{0.05}$, $PM_{0.01}$, $PM_{0.15}$, $PM_{0.20}$, $PM_{0.25}$, and $PM_{1.0}$) were grouped as SOA. The extinction efficiency of SOA was set as 4.0. Default extinction efficiencies of PM_{10} (Coarse Particulate), EC, soil, ammonium sulfate, and ammonium nitrate were used.

Background visibility and extinction coefficient values from the Federal Land Managers Air Quality Related Values Working Group (FLAG) Phase I Report (December 2000) were used for the visibility reduction analysis. Background values for hygroscopic concentration, without adjustment for relative humidity (RH), (0.6 $\mu g/m^3$) and the non-hygroscopic concentration (4.5 $\mu g/m^3$) are reported for western wilderness areas. Therefore, BKSO4 = hygroscopic 0.6/3 = 0.2 and BKSOIL = non-hygroscopic = 4.5 were used. Modeled visibility reductions for each modeled year were compared to the level of acceptable change (LAC) of 5.0 percent.

3.6 Total Nitrogen and Sulfur Deposition Analysis

Refined CALPUFF was used to evaluate the potential for nitrogen and sulfur deposition. All sources were modeled at full PTE for this analysis. The annual average emission rates were used for the annual averaged nitrogen and sulfur deposition analyses. The NPS's PMS for natural gas combustion turbines was applied to speciate the emissions of SO_2 and PM from HRSG and turbine as it was done for increment and visibility analyses.

The total deposition rates for each pollutant were obtained by summing the modeled wet and/or dry deposition rates as follows.

For sulfur (S) deposition, the wet and dry fluxes of sulfur dioxide and sulfate are calculated, normalized by the molecular weight of S, and expressed as total S. Total nitrogen (N) deposition is the sum of N contributed by wet and dry fluxes of nitric acid (HNO_3), nitrate (NO_3^-), ammonium sulfate ($(NH_4)_2SO_4$), and ammonium nitrate (NH_4NO_3) and the dry flux of oxides of nitrogen (NO_x).

The total modeled nitrogen and sulfur deposition rates were compared to the National Park Service (NPS)/Fish and Wildlife Service (FWS) Deposition Analysis Threshold (DAT) for western states. The DAT for nitrogen and sulfur are each 0.005 kilogram per hectare per year (kg/ha-yr), which is equal to 1.59E-11 $g/m^2/s$.

4.0 MODELING RESULTS

4.1 CALPUFF Modeling Results

Three years of CALPUFF modeling results are provided in Table 8 through Table 10. The model-predicted criteria pollutant increment concentrations were compared to the proposed Class I area Significant Impact Levels (SIL). Each criteria pollutant concentration is less than the corresponding SIL for the San Rafael Wilderness Class I area.

Modeled visibility reductions for each modeled year were compared to the level of acceptable extinction change (LAC) of 5.0 % at each modeled area for each year. The visibility impact is less than 5 percent. Deposition thresholds of total N and total S are both 0.005 kg/ha/yr, which is equal to 1.59E-11 $g/m^2/s$. Total N and S deposition impact do not exceed the threshold.

None of the modeled results (criteria pollutant, deposition, visibility) exceeded the threshold; therefore, the proposed Project sources will not have a significant impact on ambient air quality of the San Rafael Wilderness Class I area. Since the criteria pollutant concentration and deposition is less than its corresponding significance level, the Project sources will not have a significant impact on either terrestrial resources such as soil and vegetation or aquatic resources. Therefore, no further analyses, including additional Air Quality Related Value (AQRV) impacts were conducted.

Table 8
PSD Class I Increment Significance Analysis – CALPUFF Results

Class I Area	Pollutant	Annual NO_x	3-hr SO_2	24-hr SO_2	Annual SO_2	24-hr PM	Annual PM
	Unit	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**µg/m³**	**Annual**
	Threshold	**0.1**	**1**	**0.2**	**0.08**	**0.32**	**0.16**
San Rafael Wilderness Area	2001	3.98E-03	2.37E-01	1.17E-02	8.23E-04	7.72E-02	4.38E-03
	2002	4.58E-03	2.70E-01	1.75E-02	9.99E-04	7.97E-02	5.20E-03
	2003	4.60E-03	3.13E-01	1.81E-02	9.97E-04	7.43E-02	5.12E-03
Exceed?		No	No	No	No	No	No

Notes:
µg/m³ = micrograms per cubic meter
NO_x = oxides of nitrogen
PM = particulate matter
PSD = Prevention of Significant Deterioration
SO_2 = sulfur dioxide

Table 9
Visibility Analysis – CALPUFF Results

Class I Area	Pollutant	No.of Days > 5%	Max Extinction Change	Day of Maximum Extinction Change
	Unit	**Days**	**%**	**Day**
	Threshold	**0**	**5**	
San Rafael Wilderness Area	2001	0	4.42	308
	2002	0	4.72	287
	2003	0	3.68	247
Exceed?		No	No	No

Table 10
Total Nitrogen and Sulfur Deposition Analysis – CALPUFF Results

Class I Area	Pollutant	Deposition N	Deposition S
	Unit	**g/m²/s**	**g/m²/s**
	Threshold	**1.59E-11**	**1.59E-11**
San Rafael Wilderness Area	2001	1.06E-12	4.41E-13
	2002	1.40E-12	6.00E-13
	2003	1.34E-12	5.23E-13
Exceed?		No	No

5.0 REFERENCES

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