BART Modeling Protocol

Public Service Company of New Mexico

San Juan Generating Station

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1.0 Introduction

1.1 Objectives

Under regional haze regulations, the Environmental Protection Agency (EPA) has issued final guidelines dated July 6, 2005 for Best Available Retrofit Technology (BART) determinations (70 FR 39104-39172). Sources are BART-eligible if they meet three criteria including potential emissions of at least 250 tons per year of a visibility-impairing pollutant, were put in place between August 7, 1962 and August 7, 1977, and fall within one of the 26 listed source categories in the guidance. A BART engineering evaluation using five statutory factors --1) existing controls; 2) cost; 3) energy and non-air environmental impacts; 4) remaining useful life of the source; 5) degree of visibility improvement expected from the application of controls --is required for any BART-eligible source that can be reasonably expected to cause or contribute to impairment of visibility in any of the 156 federal parks and wilderness (Class I) areas protected under the regional haze rule. Air quality modeling is an important tool available to the States to determine whether a source can be reasonably expected to contribute to visibility impairment in a Class I area.

The object of this source-specific protocol (hereinafter referred to as the PNM Protocol) is to describe the methodologies and procedures for visibility modeling to support BART engineering analysis for Public Service Company of New Mexico's (PNM) San Juan Generating Station (SJGS) Units 1, 2, 3, and 4. These units were identified as subject-to-BART by the State of New Mexico's Environmental Department's Air Quality Bureau (NMED) based on BART screening exemption modeling conducted by the Western Regional Air Partnership's (WRAP) Regional Modeling Center (RMC). The methodologies and databases referenced in this PNM Protocol are consistent with the *CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States* dated August 15, 2006, (hereinafter referred to as the WRAP Protocol). Furthermore, the geographic and meteorological data used in the WRAP RMC BART applicably modeling is available for use on their organization website. Therefore, for consistency these data will be used to formulate the bases for the PNM BART analysis for the SJGS. After NMED reviews and approves this PNM Protocol, it will provide the basis of mutually agreed upon procedures establishing the BART modeling methodology.

2.0 Source Description

The SJGS facility is located in Farmington, New Mexico within San Juan County. It has four existing pulverized coal units that are BART applicable, Units 1, 2, 3, and 4.

Units 1 and 2 are single walled fired Foster-Wheeler boilers and are rated at 360-MW and 350-MW gross, respectively. Each unit is equipped with primary and secondary preheaters, electrostatic precipitators (ESP), and a wet flue gas desulfurization (WFGD) system. Unit 1 is also equipped with a low NO_x burners

Units 3 and 4 are opposed wall fired Babcock & Wilcox boilers and each is rated at 544-MW gross. Each unit is equipped with low NO_x burners, primary and secondary preheaters, ESP, and a WFGD system.

2.1 Location of Sources vs. Relevant Class I Areas

There are many Class I areas within and surrounding New Mexico. On the basis of distance from BART applicable sources, topography, and meteorology the prior modeling conducted by WRAP RMC has determined that 16 Class I areas need to be addressed in Step 5 of the BART analyses. Applicable Class I areas included in the BART process are located within 300 km of the SJGS facility. The 16 Class I areas are identified in Table 2-1. The Class I areas are illustrated in Figure 2-1.

Table 2-1
Class I Areas

1. Mesa Verde National Park	9. West Elk Wilderness
2. Weminuche Wilderness	10. Arches National Park
3. San Pedro Parks Wilderness	11. Capitol Reef National Park
4. La Garita Wilderness	12. Pecos Wilderness
5. Canyonlands National Park	13. Wheeler Peak Wilderness
6. Black Canyon of the Gunnison National Park	14. Great Sand Dunes National Park
7. Bandelier National Monument	15. Maroon Bells-Snowmass Wilderness
8. Petrified Forest National Park	16. Grand Canyon National Park

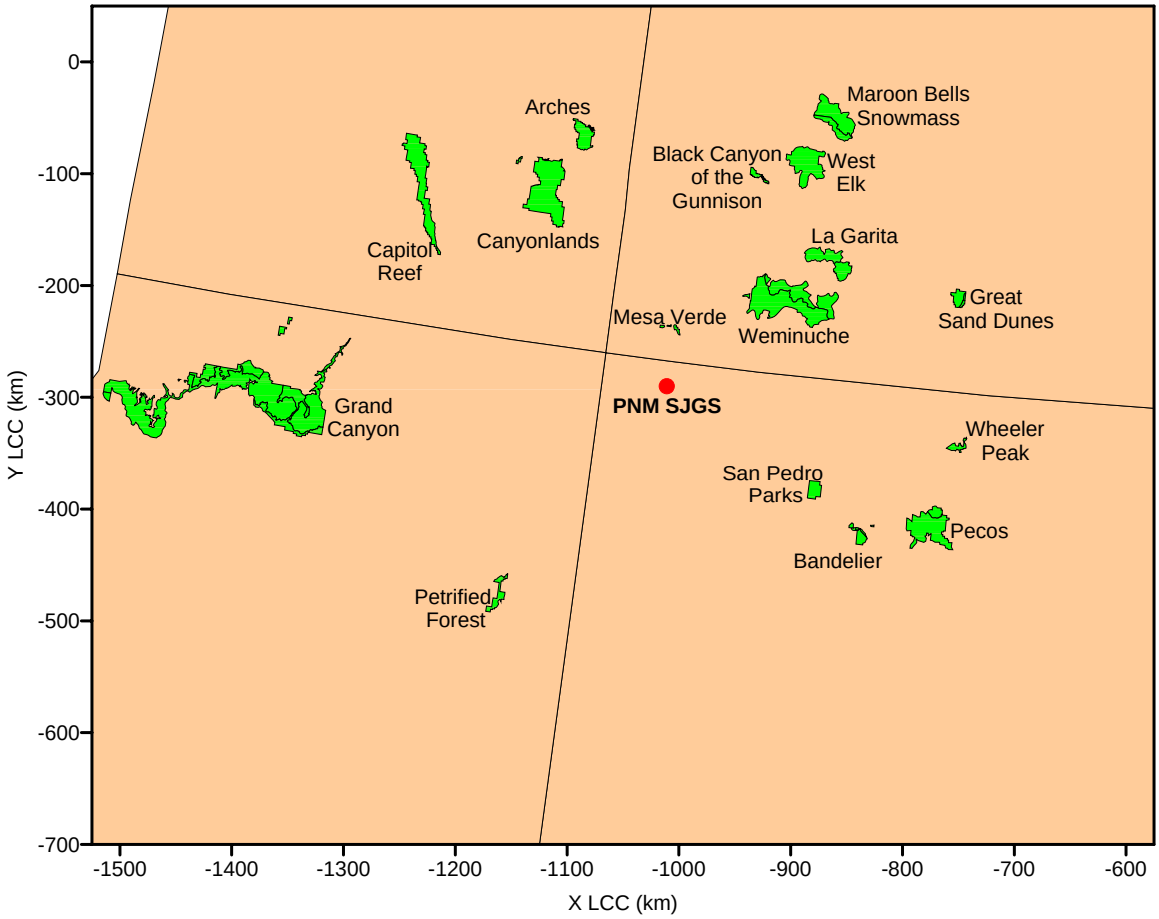

Figure 2-1
PNM Facility with respect to the Class I areas

2.2 Emission Data for Modeling

CALPUFF model input requires source (stack) – specific emission rates for each pollutant, and stack parameters (height, diameter, exit gas temperature, and exit gas velocity). Per EPA BART guidance, these parameters must be representative of maximum actual 24-hour average emitting conditions for baseline (existing) operation, and maximum proposed 24-hour average emissions for future (BART) operations. However, SJGS is operating under a consent decree filed May 10, 2005 which requires the facility to install NO_x and particulate air quality control equipment prior by 2010. Therefore, baseline operation for SJGS, and this analysis, will reflect post consent decree operation for Units 1-4. The stack parameters and emission rates used for baseline modeling are presented in Table 2-2.

2.2.1 Baseline Modeling

The SO_2, NO_x, and PM_{10} emissions that are to be included in the analyses, and representative of baseline operation of the units, shall be the maximum 24-hour emission rate of normal post-consent decree operations (excluding periods of startup, shutdown, and malfunction). As such, Black & Veatch will determine these emissions from data provided by PNM and through engineering calculations for each unit.

The PM_{10} emissions will be speciated into appropriate filterable and condensable particulate matter categories: elemental carbon (soot), "soil" (fine PM <= 2.5 µm diameter), coarse particulate matter (2.5-10 µm diameter), inorganics, and organics for modeling purposes. The aforementioned speciated categories are illustrated in Figure 2-2. The appropriate source-specific particulate matter speciation spreadsheets provided by the National Park Service (NPS) and available on their web site (http://www2.nature.nps.gov/air/Permits/ect/index.cfm) will be used to calculate the PM_{10} speciation emissions. For all four (4) Units, the NPS spreadsheet that represents a dry bottom PC boiler controlled by an fabric filter (FF) and FGD will be used. The PM_{10} emissions and speciation methodology to be used for the BART modeling is described below.

- Total heat input per year, per unit will be obtained from PNM from recent agency submittals and represent current and future operation. Filterable PM_{10} emissions in tons per year will be calculated based on post consent decree operations. Together, these two pieces of information (total annual filterable PM_{10} emissions and total annual heat input on a per unit, per year basis) will be used to derive emission factors for PM_{10} in lb/mmBtu.

- Filterable PM_{10} emissions derived above will be subdivided by size category using the appropriate NPS speciation spreadsheets. This is illustrated in Figure 2-2 as Elemental Carbon (EC) 0-0.625 µm diameter, Fine PM <= 2.5 µm diameter, and Course PM 2.5-10 µm diameter.

Table 2-2
CALPUFF Modeling Parameters
Baseline Scenario

Unit	Stack Location[1]		Stack Height (m)	Base Elevation (m)	Stack Diameter (m)	Stack Exit Velocity (m/s)	Stack Exit Temperature (K)	NO_x Emissions (lb/hr)	SO_2 Emissions (lb/hr)	PM_{10} Emissions (lb/hr)	Primary Particle Speciation[2]				
	LCC East (km)	LCC North (km)									EC (g/s)	Fine PM (g/s)	Coarse PM (g/s)	H_2SO_4[3] (g/s)	SOA (g/s)
SJGS 1	-1010.859	-290.127	121.92	1615.44	6.096										
SJGS 2	-1010.859	-290.127	121.92	1615.44	6.096										
SJGS 3	-1010.859	-290.127	121.92	1615.44	8.534										
SJGS 4	-1010.859	-290.127	121.92	1615.44	8.534										

[1] Stack Coordinates as included in the CALPUFF modeling
[2] Primary particulate speciated into the following categories using the NPS Speciation Spreadsheet: Elemental Carbon (EC), Fine PM, Coarse PM, Condensable Inorganic PM (SO_4), and Condensable Organic PM (SOA).
[3] H_2SO_4 emissions calculated using NPS Speciation Spreadsheet
Note: Missing modeling parameters will be provided with the final BART engineering report.

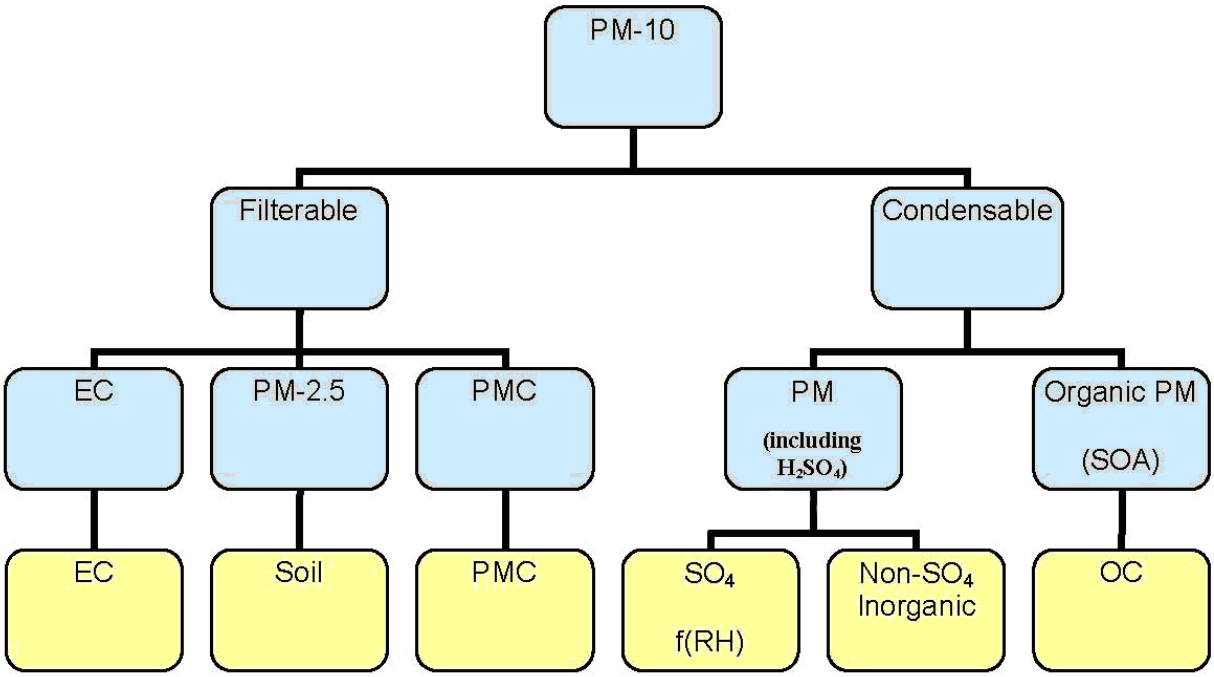

Figure 2-2
Speciation of PM_{10} Emissions

- All particulate modeling will be performed using 1 gram per second nominal emission rates in CALPUFF for the specific size ranges presented in the NPS speciation spreadsheets (i.e., $PM_{8.0}$, $PM_{4.25}$, $PM_{1.88}$, $PM_{1.25}$, $PM_{0.813}$, and $PM_{0.625}$). These modeled species will be grouped in POSTUTIL as to represent the appropriate visibility pollutants (e.g., PMcourse = $PM_{8.0}$ + $PM_{4.25}$ and PMfine = $PM_{1.88}$ + $PM_{1.25}$ + $PM_{0.813}$ + $PM_{0.625}$) and will be scaled with the emission rates derived from the NPS spreadsheets. EC and SOA will be derived from the $PM_{1.88}$ species and scaled with the emission rates derived from the NPS spreadsheets.

2.2.1.1 H_2SO_4 (SO_4) Emissions

Condensable PM_{10} will be subdivided into inorganic and organic compounds using the NPS speciation spreadsheets. The inorganic portion is by default assumed to be H_2SO_4 and will me modeled as SO_4. The organic portion will be modeled as secondary organic aerosols (SOA).

2.2.2 Post Control Modeling

As required by EPA guidance, each technically feasible BART control technology must be assessed to determine the degree of visibility improvement. These relative improvements from various technologies and/or control levels can then be factored into the BART decision. At this time, the evaluation of technically feasible controls (Step 4 of the BART process) has not been completed and it is unknown how many feasible control technologies options are available for consideration. However once determined, each technically feasible control for each pollutant will be modeled on a unit by unit basis.

For the purpose of this PNM Protocol NO_x and PM_{10} are the only pollutants subject to BART analyses. Due New Mexico participating in a trading program for SO_2, a SO_2 BART analysis is not required and will not be modeled as a separate feasible control technology option. However, SO_2 emissions will be included as a modeled pollutant as part of both the baseline and post control modeling scenarios. PM_{10} emissions will be speciated as described in the baseline modeling section. The stack parameters and emission rates used for the post control modeling for each unit, pollutant, and technology will be determined and presented in the final report submitted to NMED.

2.3 Model Versions

The versions of the CALPUFF modeling system suggested in the WRAP Protocol and used by WRAP RMC for the initial modeling will be used for these modeling analyses and are listed in Table 2-3.

Table 2-3 Model Versions				
Program	WRAP Protocol		PNM Analyses	
	Version	Level	Version	Level
CALMET	6.211	060414	6.211	060414
CALPUFF	6.112	060412	6.112	060412
POSTUTIL	N/A	N/A	1.52	060412
CALPOST	6.131	060410	6.131	060410

3.0 Geophysical and Meteorological Data

As previously noted, all the geophysical and meteorological data necessary to conduct the Class I visibility modeling is provided by WRAP RMC on their website http://pah.cert.ucr.edu/aqm/308/bart.shtml. All files will be downloaded from their website for use in the aforementioned analyses.

3.1 Modeling Domain

The modeling domain will be the same domain established in the GEO.DAT file describe in Section 3.5. The origin coordinates of the domain is Latitude 40.0 N, Longitude 97.0 W and will be assigned as the 0, 0 reference point of the domain. The southwest corner of the modeling domain is latitude 30.9 N, Longitude 111.3 W, which translates to -1368.0 km (X) and -900.0 (Y) in LCC coordinates. The domain will measure 864 km in the east-west (X) and north-south (Y) direction. At a refined grid spacing of 4-km, the number of X grid cells and the number of the Y grid cells will be 216. The modeling domain is shown in Figure 3-1.

3.2 Mesoscale Model Data

Pennsylvania State University in conjunction with the National Center for Atmospheric Research (NCAR) Assessment Laboratory have developed mesoscale meteorological data sets of prognostic wind fields, or "guess" fields, for the United States. The hourly meteorological variables used to create these data sets are extensive and are used to initialize the modeling domain with meteorological data. The daily MM5 meteorological data files provided on the WRAP RMC website for the years 2001, 2002, and 2003 will be utilized as input into CALMET.

The MM5 data sets, used to simulate atmospheric variables within the modeling domain in CALMET, although advanced, lack the fine detail of specific temporal and spatial meteorological variables and geophysical data. These variables were processed into the appropriate format and introduced into the CALMET model through the utilization of additional data files obtained from numerous sources. These ancillary data files are described in more detail in the following sections.

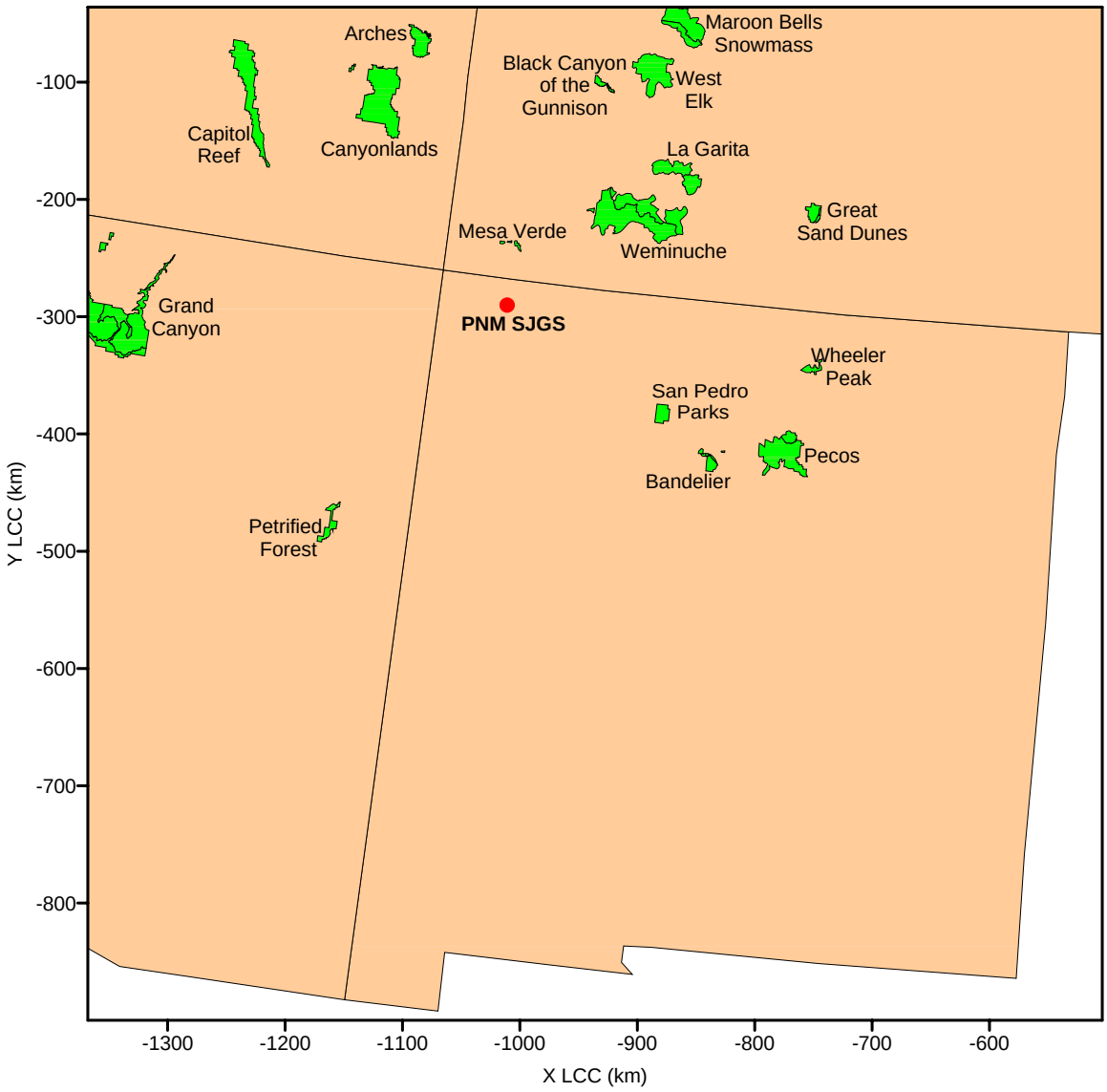

Figure 3-1
Geophysical and Meteorological Modeling Domain

3.3 Surface Data Station and Processing

The surface station data for the CALPUFF analysis consisted of data from National Weather Service (NWS) stations or Federal Aviation Administration (FAA) Flight Service stations within the CALMET domain. Figure 3-2 provides an illustration of the location of the surface stations used. The surface station parameters include wind speed, wind direction, cloud ceiling height, opaque cloud cover, dry bulb temperature, relative humidity, station pressure, and a precipitation code that is based on current weather conditions.

The CALMET ready surface station data will be downloaded from the WRAP RMC website for use in the modeling analyses. A listing of the surface stations is provided in Appendix A.

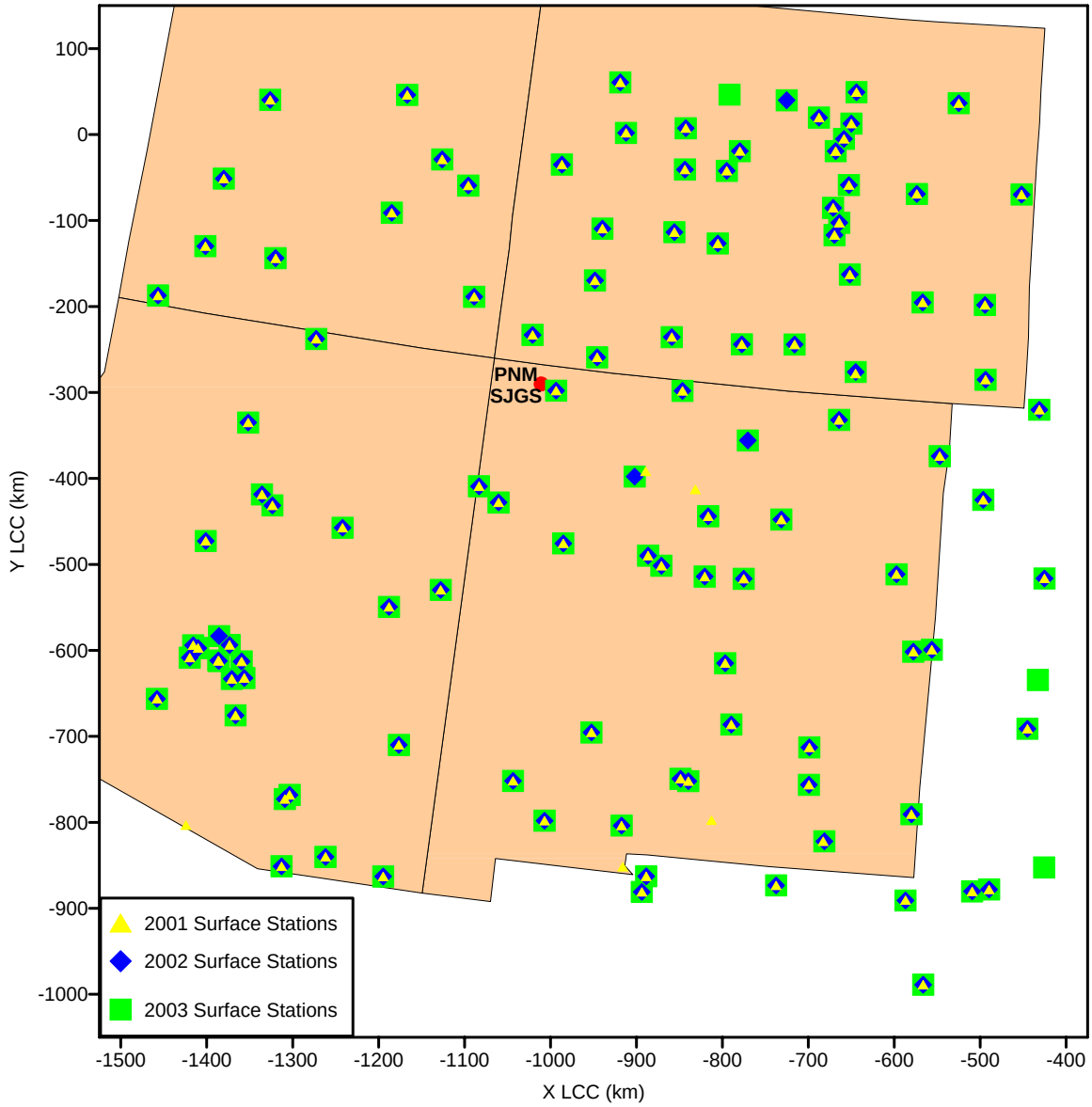

Figure 3-2
Surface Stations

3.4 Precipitation Data Stations and Processing

Precipitation data was processed from a network of hourly precipitation data files collected from NWS precipitation recording stations within the CALMET domain. Figure 3-3 provides an illustration of the location of the precipitation stations used.

The CALMET ready precipitation data will be downloaded from the WRAP RMC website for use in the modeling analyses. A listing of the precipitation stations is provided in Appendix A.

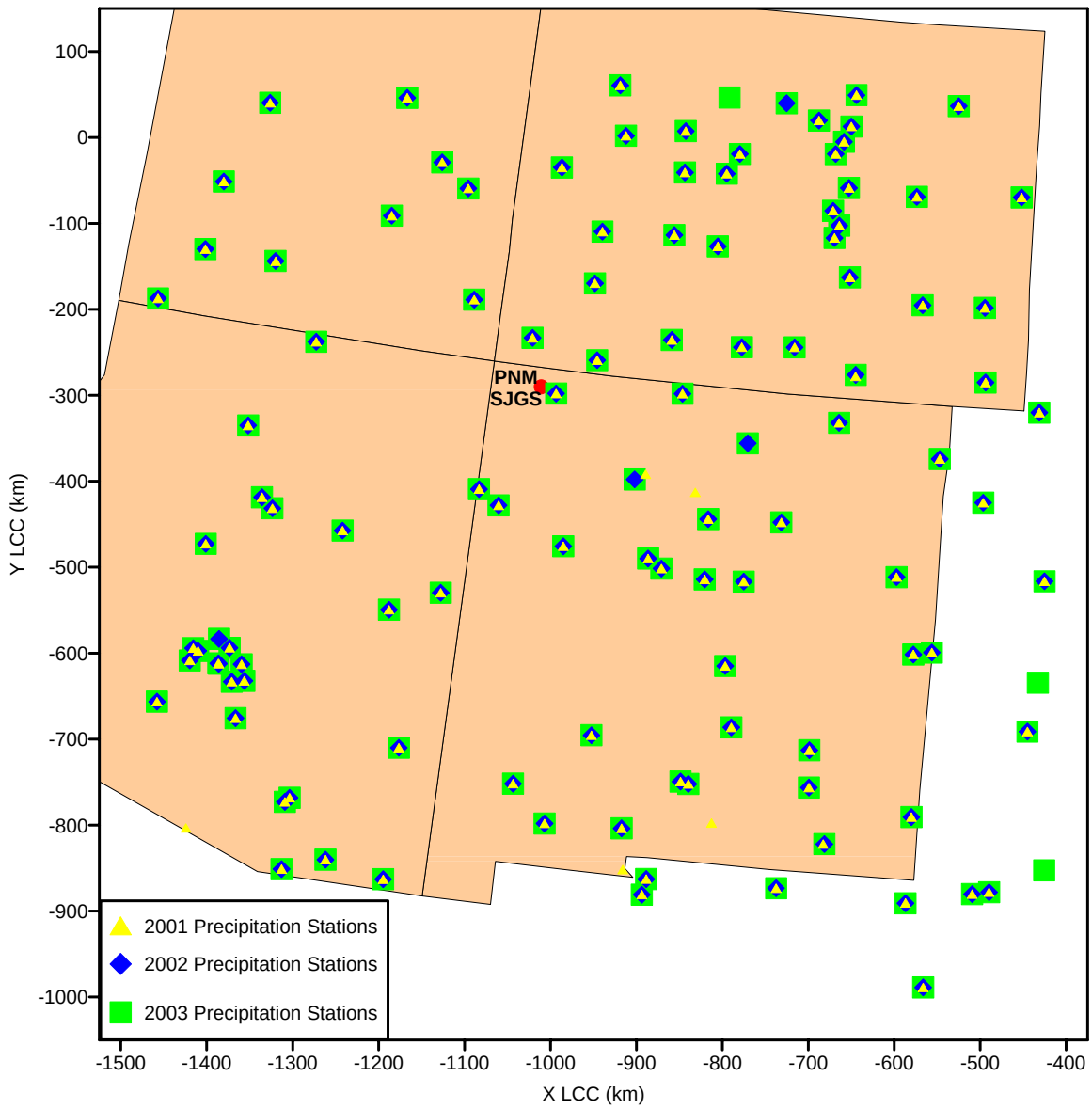

Figure 3-3
Precipitation Stations

3.5 Geophysical Data Processing (Terrain and Land Use)

Terrain and land use data was pre-processed by the WRAP RMC to create a CALMET ready GEO.DAT file. This GEO.DAT file will be downloaded from the WRAP RMC website for use in the analyses. Figure 3-4 depicts the terrain elevations in the domain while Figure 3-5 shows the land use of the domain.

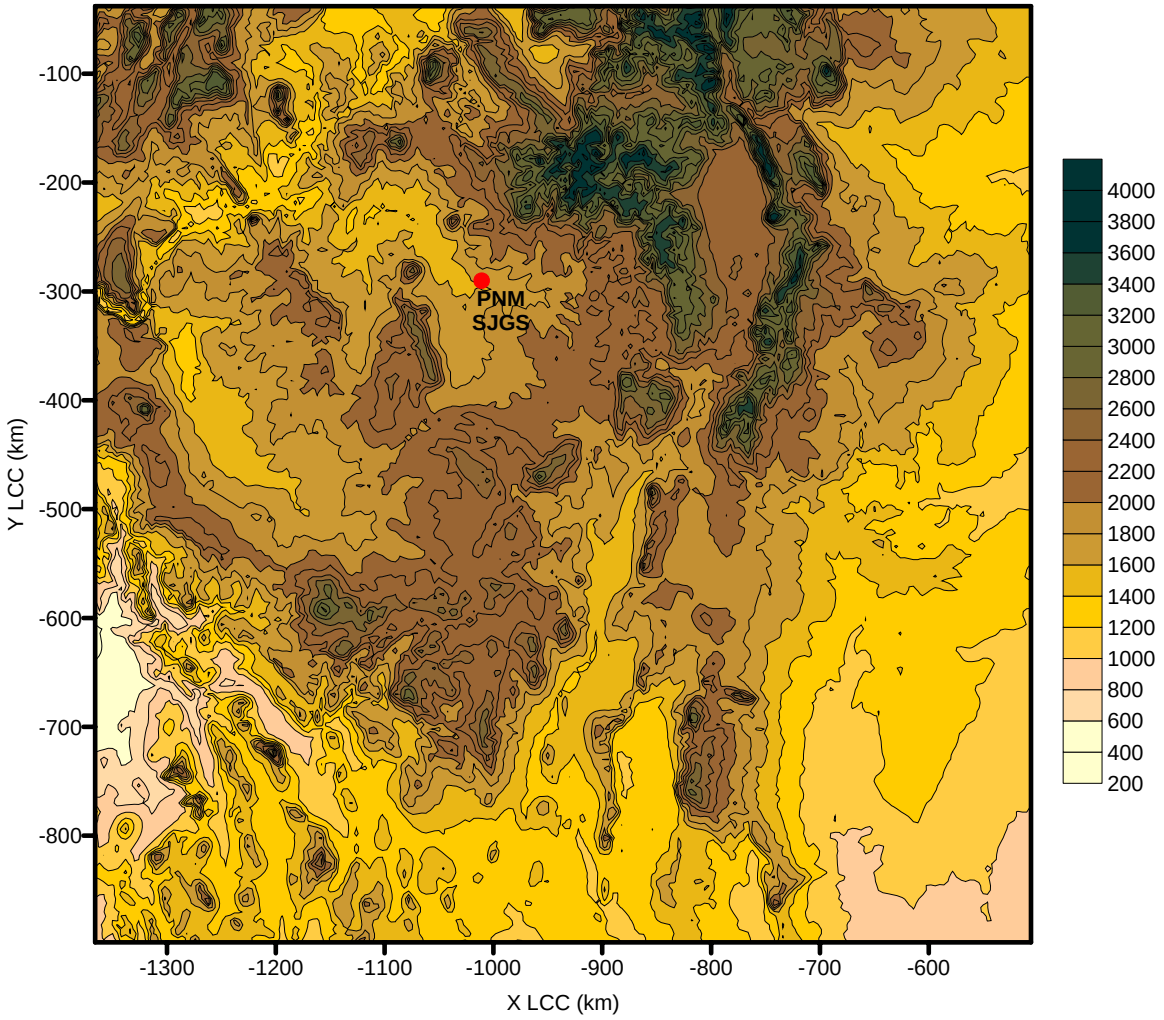

Figure 3-4
Terrain Elevation Plot

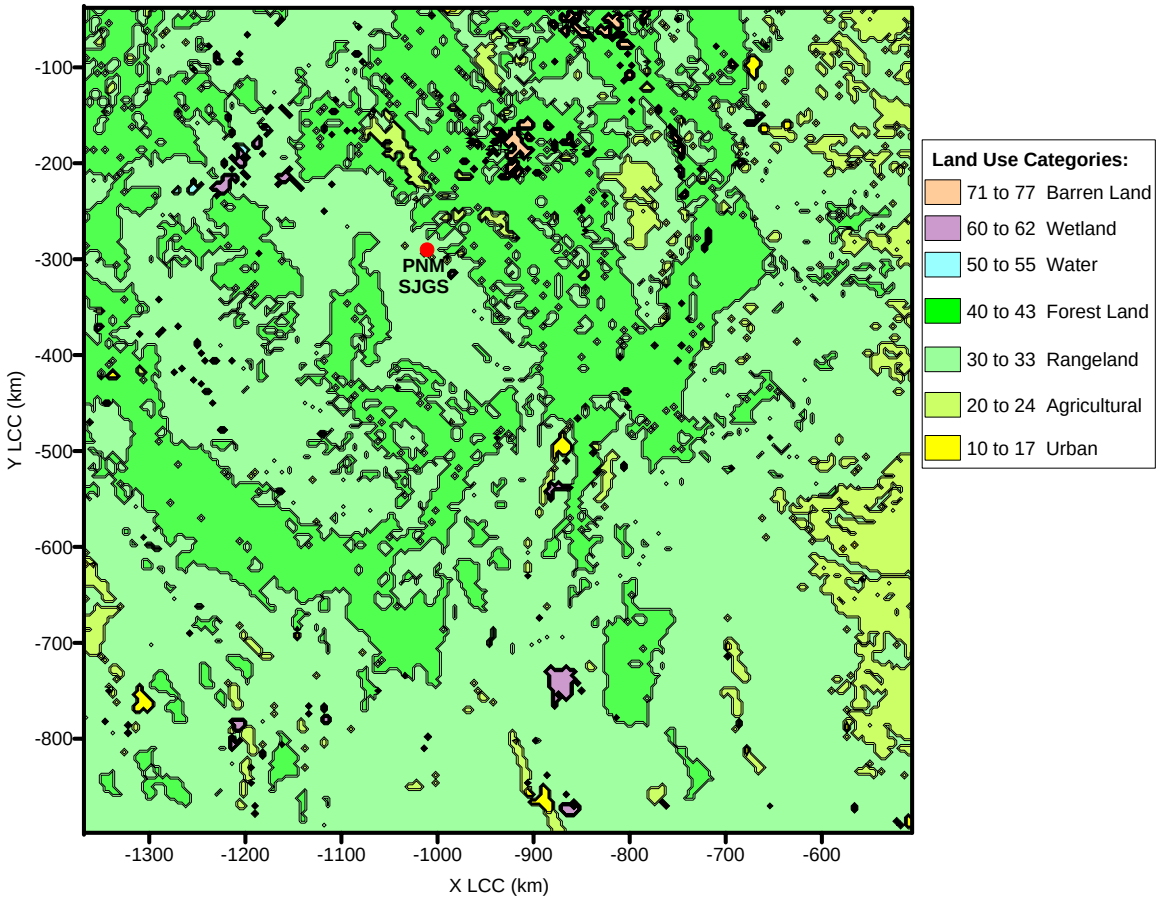

Figure 3-5
Land Use Plot

3.6 CALMET Variables

The selection of the specific variables and control options used in CALMET data processing is provided in Appendix B. These selections follow the guidance provided in the WRAP Protocol and the CALMET file obtained from WRAP RMC.

4.0 Air Quality Modeling Methodology

The CALPUFF modeling system is recommended as the preferred modeling approach for use in BART analyses. CALPUFF and its meteorological model, CALMET, are designed to handle the complexities posed by complex terrain, large source-receptor distances, chemical transformation and deposition, and other issues related to Class I visibility impacts. The CALPUFF modeling system has been adopted by the EPA as a Guideline Model for source-receptor distances greater than 50 km, and for use on a case-by-case basis in complex flow situations for shorter distances (68 FR 18440-18482). CALPUFF is recommended for Class I impact assessments by the Federal Land Managers Workgroup (FLAG 2000) and the Interagency Workgroup on Air Quality Modeling (IWAQM) (EPA 1998). The final BART guidance recommends CALPUFF as "the best modeling application available for predicting a singe source's contribution to visibility impairment" (70 FR 39122). Additionally, the WRAP Protocol recommends the use of CALPUFF for conducting BART analyses in New Mexico.

CALPUFF is a non-steady-state, Lagrangian, puff transport and dispersion model that advects Gaussian puffs of multiple pollutants from modeled sources. CALPUFF's algorithms have been designed to be applicable on spatial scales from a few tens of meters to hundreds of kilometers from a source. It includes algorithms for near-field effects such as building downwash, stack tip downwash and transitional plume rise as well as processes important in the far-field such as chemical transformation, wet deposition, and dry deposition. CALPUFF contains an option to allow puff splitting in the horizontal and vertical directions, which extends the distance range of the model. The primary outputs from CALPUFF are hourly concentrations and hourly deposition fluxes evaluated at user-specified receptor locations.

A set of post processing programs associated with CALPUFF computes visibility effects and allows cumulative source impacts to be assessed, including potential non-linear effects of ammonia limitation on nitrate formation. The CALPOST postprocessor contains several options for computing change in extinction and deciviews for visibility assessments. The POSTUTIL postprocessor includes options for summing contributions of individual sources or groups of sources to assess cumulative impacts. POSTUTIL also contains CALPUFF's nitric acid-nitrate chemical equilibrium module, which allows the cumulative effects of ammonia consumption by background sources to be assessed in the postprocessor. In addition, the combination of CALPUFF and POSTUTIL allows the effects of source emissions of ammonia to be incrementally added to background ammonia levels when determining nitrate formation.

4.1 CALPUFF Domain and Variables

The WRAP computational domain covered an extensive area, specifically, New Mexico, eastern Arizona, southeastern Utah, and southern Colorado. To reduce computational requirements of the model, the CALPUFF computational domain will be a subset of the CALMET domain established approximately to encompass the SJGS and the applicable 16 Class I areas. The CALPUFF computational domain is shown if Figure 4-1. The selection of the specific variables used in CALPUFF is provided in Appendix C.

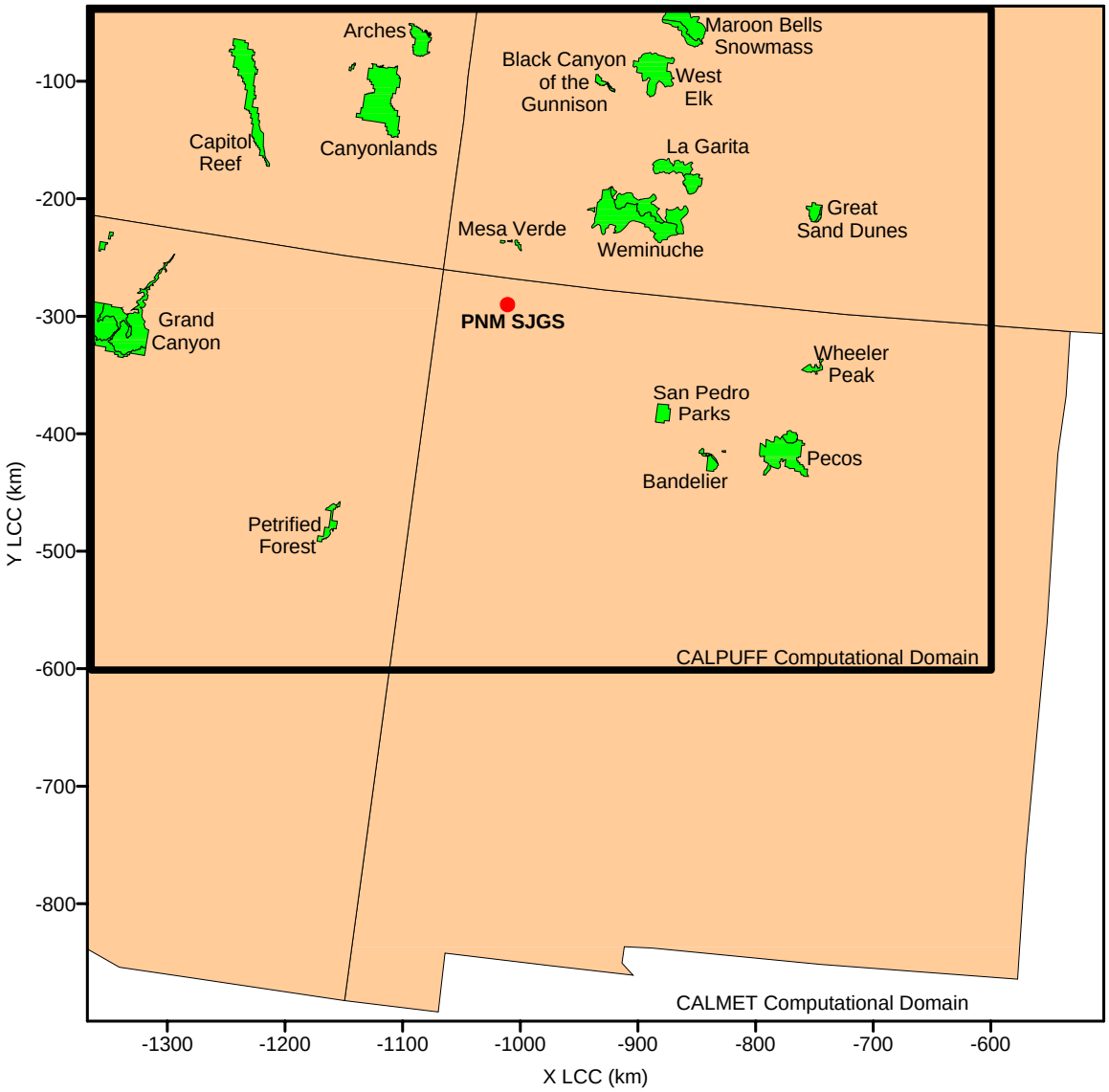

Figure 4-1
CALPUFF Computational Domain

4.2 Receptors

The CALPUFF analyses will use an array of discrete receptors with receptor elevations for the Class I areas, which were created and distributed by the NPS. Specifically, the array consists of receptors spaced to cover the extent of the Class I areas. Receptor elevations are included in the same NPS-provided receptor files. Appendix D provides illustrations of the receptors to be used in the modeling analysis for each Class I area.

4.3 Downwash

Because the modeling conducted for BART is concerned with long-range transport, not localized impacts, data regarding building heights and widths that are used to calculate building downwash will not be included in the modeling analyses. Stack tip downwash is a phenomenon different from building induced downwash and is additionally a regulatory default option (i.e., in order to turn stack tip downwash off, the user must also change the variable to skip regulatory checks of the model). As such, this PNM Protocol proposes that stack tip downwash remain "on" for this analysis as recommended by the WRAP Protocol.

4.4 Ozone Concentrations

Background ozone concentrations are important for the photochemical conversion of SO_2 and NO_x to sulfates (SO_4) and nitrates (NO_3), respectively. CALPUFF allows the use of a single background ozone value, monthly background ozone values, or spatial, hourly ozone data from one or more ozone monitoring stations (the preferred method) to represent the background ozone concentrations within the domain.

The hourly ozone concentrations files that were used by WRAP RMC in the initial modeling will be used for the BART technology evaluation. These hourly ozone data files will be obtained directly from the WRAP RMC website. In addition to the hourly ozone data, the same monthly average background ozone value of 80 ppb as used in the initial modeling will be used in this modeling for times when hourly ozone data are not available.

4.5 POSTUTIL and CALPOST

The two main postprocessors of interest for BART applications are the POSTUTIL and CALPOST programs. The POSTUTIL processor is a program that has several functions, including creating cumulative impacts of multiple sources from different simulations via summation, computing the difference between two sets of predicted impacts (useful for evaluating the benefits of BART controls), and evaluating the equilibrium relationship between nitric acid and nitrate aerosols via a chemistry module. The later function allows the potential non-linear effects of ammonia scavenging by sulfate and nitrate sources to be evaluated in the formation of nitrate from an individual source. As previously mentioned, the POSTUTIL postprocessor will be used to create the speciated components of PM_{10} based on the size distribution of the NPS speciation spreadsheet. The new concentration file created by POSTUTIL will then be used as input for the CALPOST postprocessor.

CALPOST is used to process the CALPUFF outputs by producing tabulations summarizing the results of the simulations, identifying, for example, the highest and second-highest hourly-average concentrations at each receptor. When performing visibility-related modeling, CALPOST uses concentrations from CALPUFF (or POSTUTIL) to compute light extinction and related measures of visibility (haze index in deciviews), reporting these for a 24-hour averaging time. The selections of the specific variables used in POSTUTIL and CALPOST are provided in Appendices E and F, respectively.

4.5.1 Light Extinction

Light extinction must be computed in order to calculate visibility. CALPOST has seven methods for computing light extinction. As recommended by the WRAP Protocol, this BART technology analyses will use Method 6, which computes extinction from speciated particulate matter with monthly Class I area-specific relative humidity adjustment factors. Relative humidity is an important factor in determining light extinction (and therefore visibility) because sulfate and nitrate aerosols, which absorb moisture from the air, have greater extinction efficiencies with greater relative humidity. This BART analysis will apply relative humidity correction factors [f(RH)s], obtained from Table A-3 of the EPA's *Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule* (EPA, 2003), to sulfate and nitrate concentrations outputs from CALPUFF. The f(RH) values for the Class I areas that will be assessed are provided in Table 4-1. The default Rayleigh scatter value (b_{ray}) of 10 Mm^{-1} will also be used. The light extinction equation is provided below.

$$b_{ext} = 3 * f(RH) * [(NH_4)_2SO_4] + 3* f(RH) * [NH_4NO_3] + 4*[OC] + 1* [PM_f] + 0.6*[PM_c] + 10* [EC] + b_{ray}$$

4.5.2 Natural Background

The EPA's default average annual aerosol concentrations for the eastern and western halves of the U.S., included in Table 2-1 of EPA's *Guidance for Estimating Natural Visibility Conditions Under Regional Haze Program*, will used to determine the natural background at each of the Class I areas. The values are provide in Table 4-2

4.5.3 Ammonia Concentrations

Ambient concentrations of nitrate (NO_3) are limited by the availability of ammonia, which is preferentially scavenged by sulfates (SO_4). Due to this preferential reaction between ammonia and sulfates, a lower ammonia concentration would tend to decrease particle nitrate concentrations prior to affecting particle sulfate concentrations.

In CALPUFF, a continuous emissions plume is represented by a series of puffs. The model allows the full amount of the background ammonia concentrations to be available to each emissions puff to form nitrate, which tends to overestimate nitrate formation. To compensate, the POSTUTIL utility program can be used to repartition HNO_3 and NO_3. However, the BART modeling will be performed using the same fixed background ammonia level of 1 ppb that was used for the initial modeling performed by WRAP RMC.

Table 4-1
Monthly Relative Humidity Factors[a]

Class I Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arches	2.6	2.3	1.8	1.6	1.6	1.3	1.4	1.5	1.6	1.6	2.0	2.3
Bandelier	2.2	2.1	1.8	1.6	1.6	1.4	1.7	2.1	1.9	1.7	2.0	2.3
Black Canyon of the Gunnison	2.4	2.2	1.9	1.9	1.9	1.6	1.7	1.9	2.0	1.8	2.1	2.3
Canyonlands	2.6	2.3	1.7	1.6	1.5	1.2	1.3	1.5	1.6	1.6	2.0	2.3
Capitol Reef	2.7	2.4	2.0	1.7	1.6	1.4	1.4	1.6	1.6	1.7	2.1	2.5
Grand Canyon	2.4	2.3	1.9	1.5	1.4	1.2	1.4	1.7	1.6	1.6	1.9	2.3
Great Sand Dunes	2.4	2.3	2.0	1.9	1.9	1.8	1.9	2.3	2.2	1.9	2.4	2.4
La Garita	2.3	2.2	1.9	1.8	1.8	1.6	1.7	2.1	2.0	1.8	2.2	2.3
Maroon Bells Snowmass	2.2	2.1	2.0	2.0	2.1	1.7	1.9	2.2	2.1	1.8	2.1	2.1
Mesa Verde	2.5	2.3	1.9	1.5	1.5	1.3	1.6	2.0	1.9	1.7	2.1	2.3
Pecos	2.3	2.1	1.8	1.7	1.7	1.5	1.8	2.1	2.0	1.7	2.0	2.2
Petrified Forest	2.4	2.2	1.7	1.4	1.3	1.2	1.5	1.8	1.7	1.6	1.9	2.3
San Pedro Parks	2.3	2.1	1.8	1.6	1.6	1.4	1.7	2.0	1.9	1.7	2.1	2.2
West Elk	2.3	2.2	1.9	1.9	1.9	1.7	1.8	2.1	2.0	1.8	2.1	2.2
Weminuche	2.4	2.2	1.9	1.7	1.7	1.5	1.6	2.0	1.9	1.7	2.1	2.3
Wheeler Peak	2.3	2.2	1.9	1.8	1.8	1.6	1.8	2.2	2.1	1.8	2.2	2.3

[a] Table A-3 of the EPA's *Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule*

Table 4-2
Average Annual Natural Background Levels[a]

Component	Average Annual Natural Background ($\mu g/m^3$)
Ammonium Sulfate	0.12
Ammonium Nitrate	0.10
Organic Carbon Mass	0.47
Elemental Carbon	0.02
Soil	0.50
Coarse Mass	3.0

[a] Table 2-1 of the EPA's *Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule*

5.0 Results

A report on the BART visibility analysis will be included as Step 5 of the final BART engineering report that clearly compares impacts for each post-control control option and the resulting emissions from each unit to those for the baseline scenario. For each feasible control option determined from Steps 1-4, and for each applicable Class I area where the impact of the source exceeded 0.5 dv, the change in visibility impact from the source as a result of the control option will be reported. The effectiveness of candidate control options will be compared to each other, not to a specific target improvement.

6.0 Review Process

The purpose of the review process is to establish procedures for ensuring that products produced by the application of the modeling techniques for BART studies satisfy the regulatory objective of the BART program. Since the modeling analyses are using pre-defined CALMET files and CALPUFF templates provided by the WRAP RMC, the quality assurance process will be straightforward.

The basic procedures that will apply to all CALMET/CALPUFF model applications will include a confirmation of the source data, including units, verification of the correct source and receptor locations, including datum and projection, confirmation of the switch selections relative to modeling guidance, checks of the program switches and file names for the various processing steps, and confirmation of the use of the proper version and level of each model program. The CALPUFF modeling system contains built-in features to facilitate review of the modeling results, including the automatic production of "QA" files for the various data listed above.

The amount of effort for end-users performing QA for the pre-defined meteorological fields will be reduced from what is required in developing source-specific meteorological fields. The development of these CALMET datasets developed by the WRAP RMC were subject to a QA program as part of their development, so the necessary quality assurance activity of end-users is again reduced from what would be required in the development of a representative dataset.

Most of the CALPUFF input variables contain default values. Appendix B of the IWAQM report contains a list of recommended CALPUFF switch settings. Except as modified in the WRAP Protocol, the IWAQM guidance will be used in setting up the CALPUFF simulations.

CALPOST is run separately for each Class I area in order to obtain the necessary visibility statistics for evaluating compliance with the BART modeling thresholds. The inputs to CALPOST involve selection of the visibility method, entry of Class I area-specific data for computing background extinction and monthly relative humidity factors for hygroscopic aerosols. The CALPOST inputs that need to be carefully checked as part of the CALPOST quality assurance are:

- Visibility technique: Method 6
- Monthly Class I-specific relative humidity factors for Method 6
- Class I specific background light extinction values
- Inclusion of all appropriate species from modeled sources.
- Appropriate species names for coarse PM used
- Extinction efficiencies for each species
- Appropriate Rayleigh scattering term (10 Mm^{-1} for initial modeling but Class I area specific value for finer grid modeling)

In addition, a model project CD will be created that contains all of the data and program files needed to reproduce the model results presented in the submittal. The model list files from each step will be included on the project CD. This information will allow independent checking and confirmation of the modeling process.

Appendix A
Surface and Precipitation Stations

Surface and Precipitation Stations

Surface Meteorological Stations 2001					
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)	Time Zone	Anemometer Height
1	K4BL	-1088.794	-188.74	7	10
2	K4CR	-796.753	-614.946	7	10
3	K4HV	-1184.701	-91.019	7	10
4	K4MY	-820.552	-514.181	7	10
5	KABQ	-870.967	-501.552	7	10
6	KAEG	-886.431	-489.863	7	10
7	KAKO	-524.951	36.397	7	10
8	KALM	-839.633	-752.147	7	10
9	KALS	-777.382	-244.023	7	10
10	KAMA	-425.225	-516.367	7	10
11	KAPA	-668.169	-19.352	7	10
12	KASE	-843.56	-40.773	7	10
13	KATS	-699.341	-756.355	7	10
14	KBCE	-1319.635	-144.072	7	10
15	KBJC	-687.645	19.671	7	10
16	KBKF	-658.539	-5.076	7	10
17	KCAO	-547.124	-374.102	7	10
18	KCDC	-1401.542	-129.849	7	10
19	KCEZ	-1020.893	-233.136	7	10
20	KCGZ	-1366.468	-675.581	7	10
21	KCHD	-1370.847	-633.186	7	10
22	KCNM	-682.759	-822.078	7	10
23	KCNY	-1095.593	-59.385	7	10
24	KCOS	-663.999	-102.631	7	10
25	KCQC	-775.182	-516.728	7	10
26	KCVN	-556.268	-599.276	7	10
27	KCVS	-577.834	-601.516	7	10
28	KDEN	-649.924	12.691	7	10
29	KDHT	-496.517	-424.942	7	10
30	KDMA	-1303.576	-768.169	7	10
31	KDMN	-1006.923	-798.125	7	10
32	KDRO	-945.713	-259.162	7	10
33	KDUG	-1194.674	-862.991	7	10
34	KDVT	-1424.153	-803.334	7	10
35	KEEO	-918.793	60.596	7	10
36	KEGE	-842.6	7.317	7	10
37	KEHA	-431.288	-320.167	7	10
38	KELP	-888.697	-862.785	7	10
39	KFFZ	-1359.37	-612.92	7	10
40	KFGZ	-1335.662	-418.569	7	10
41	KFLG	-1323.565	-431.409	7	10
42	KFMN	-993.475	-297.941	7	10

Surface and Precipitation Stations

Surface Meteorological Stations 2001					
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)	Time Zone	Anemometer Height
43	KFST	-566.391	-988.873	7	10
44	KGDP	-737.521	-873.407	7	10
45	KGJT	-986.737	-34.971	7	10
46	KGNT	-985.121	-475.597	7	10
47	KGUC	-855.846	-113.585	7	10
48	KGUP	-1060.45	-427.996	7	10
49	KGXY	-644.007	49.181	7	10
50	KGYR	-1419.716	-608.461	7	10
51	KINK	-586.879	-890.621	7	10
52	KINW	-1241.942	-457.351	7	10
53	KITR	-451.837	-69.8	7	10
54	KIWA	-1356.255	-632.196	7	10
55	KLAA	-494.483	-198.304	7	10
56	KLBB	-445.079	-691.2	7	10
57	KLHX	-567.01	-195.279	7	10
58	KLIC	-573.7	-69.147	7	10
59	KLRU	-917.261	-803.759	7	10
60	KLVS	-731.441	-447.785	7	10
61	KLXV	-794.908	-42.221	7	10
62	KMAF	-489.696	-878.105	7	10
63	KMLF	-1380.148	-51.293	7	10
64	KMTJ	-939.546	-109.53	7	10
65	KODO	-509.4	-880.305	7	10
66	KOLS	-1312.937	-851.17	7	10
67	KPGA	-1272.618	-237.748	7	10
68	KPHX	-1385.892	-612.301	7	10
69	KPRC	-1401.151	-472.762	7	10
70	KPSR	-1386.494	-611.852	7	10
71	KPUB	-651.703	-162.851	7	10
72	KPUC	-1166.723	46.049	7	10
73	KRIL	-912.112	1.889	7	10
74	KROW	-698.85	-712.895	7	10
75	KRQE	-1083.18	-409.162	7	10
76	KRTN	-664.239	-331.996	7	10
77	KSAD	-1176.466	-709.996	7	10
78	KSAF	-816.558	-444.045	7	10
79	KSDL	-1373.418	-593.724	7	10
80	KSGU	-1456.647	-187.285	7	10
81	KSJN	-1127.733	-529.673	7	10
82	KSKX	-812.696	-797.619	7	10
83	KSOW	-1187.951	-549.427	7	10
84	KSPD	-493.802	-285.159	7	10
85	KSRR	-789.624	-686.256	7	10

Surface and Precipitation Stations

Surface Meteorological Stations 2001					
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)	Time Zone	Anemometer Height
86	KSVC	-1043.578	-751.807	7	10
87	KTAD	-645.048	-278.061	7	10
88	KTCC	-597.363	-511.501	7	10
89	KTCS	-952.322	-695.439	7	10
90	KTUS	-1309.084	-772.955	7	10
91	KU24	-1326.193	40.266	7	10
92	KGCN	-1351.769	-335.037	7	10
93	KHOB	-580.048	-790.648	7	10
94	KTEX	-948.259	-169.74	7	10
95	KE33	-846.39	-298.154	7	10
96	MMCS	-893.759	-880.938	7	10
97	K4SL	-889.332	-391.854	7	10
98	KAFF	-671.158	-85.372	7	10
99	KU28	-1126.008	-28.962	7	10
100	KFHU	-1261.816	-840.209	7	10
101	KHMN	-848.745	-749.371	7	10
102	KGBN	-1457.891	-656.39	7	10
103	KLAM	-831.464	-412.856	7	10
104	KLUF	-1415.707	-594.125	7	10
105	KFCS	-669.55	-116.96	7	10
106	KGEU	-1409.993	-597.351	7	10
107	KEPZ	-915.897	-851.724	7	10
108	KCCU	-779.686	-19.32	7	10
109	KCPW	-858.907	-235.621	7	10
110	KMYP	-805.328	-126.737	7	10
111	KVTP	-715.975	-244.241	7	10
112	KMNH	-652.817	-58.825	7	10

Surface and Precipitation Stations

Surface Meteorological Stations 2002					
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)	Time Zone	Anemometer Height
1	K4BL	-1088.794	-188.74	7	10
2	K4CR	-796.753	-614.946	7	10
3	K4HV	-1184.701	-91.019	7	10
4	K4MY	-820.552	-514.181	7	10
5	K4SL	-902.016	-397.882	7	10
6	KABQ	-870.967	-501.552	7	10
7	KAEG	-886.431	-489.863	7	10
8	KAKO	-524.951	36.397	7	10
9	KALM	-839.633	-752.147	7	10
10	KALS	-777.382	-244.023	7	10
11	KAMA	-425.225	-516.367	7	10
12	KAPA	-668.169	-19.352	7	10
13	KASE	-843.56	-40.773	7	10
14	KATS	-699.341	-756.355	7	10
15	KBCE	-1319.974	-143.768	7	10
16	KBJC	-687.645	19.671	7	10
17	KBKF	-658.539	-5.076	7	10
18	KCAO	-547.124	-374.102	7	10
19	KCDC	-1401.542	-129.849	7	10
20	KCEZ	-1020.893	-233.136	7	10
21	KCGZ	-1366.468	-675.581	7	10
22	KCHD	-1370.847	-633.186	7	10
23	KCNM	-681.361	-822.067	7	10
24	KCNY	-1095.593	-59.385	7	10
25	KCOS	-663.999	-102.631	7	10
26	KCQC	-775.182	-516.728	7	10
27	KCVN	-556.268	-599.276	7	10
28	KCVS	-577.834	-601.516	7	10
29	KDEN	-649.924	12.691	7	10
30	KDHT	-496.517	-424.942	7	10
31	KDMN	-1006.923	-798.125	7	10
32	KDRO	-945.713	-259.162	7	10
33	KDUG	-1194.674	-862.991	7	10
34	KDVT	-1385.653	-583.401	7	10
35	KEEO	-918.793	60.596	7	10
36	KEGE	-842.6	7.317	7	10
37	KEHA	-431.288	-320.167	7	10
38	KELP	-888.697	-862.785	7	10
39	KFFZ	-1359.37	-612.92	7	10
40	KFGZ	-1335.662	-418.569	7	10
41	KFHU	-1261.816	-840.209	7	10

Surface and Precipitation Stations

Surface Meteorological Stations 2002					
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)	Time Zone	Anemometer Height
42	KFLG	-1323.565	-431.409	7	10
43	KFMN	-993.475	-297.941	7	10
44	KFST	-566.391	-988.873	7	10
45	KGCN	-1351.769	-335.037	7	10
46	KGDP	-737.521	-873.407	7	10
47	KGEU	-1409.993	-597.351	7	10
48	KGJT	-986.737	-34.971	7	10
49	KGNT	-985.121	-475.597	7	10
50	KGUC	-855.846	-113.585	7	10
51	KGUP	-1060.45	-427.996	7	10
52	KGXY	-644.007	49.181	7	10
53	KGYR	-1419.716	-608.461	7	10
54	KHOB	-580.048	-790.648	7	10
55	KINK	-586.978	-890.95	7	10
56	KINW	-1241.942	-457.351	7	10
57	KITR	-451.837	-69.8	7	10
58	KIWA	-1356.255	-632.196	7	10
59	KLAA	-494.483	-198.304	7	10
60	KLBB	-445.079	-691.2	7	10
61	KLHX	-567.01	-195.279	7	10
62	KLIC	-573.7	-69.147	7	10
63	KLRU	-917.261	-803.759	7	10
64	KLVS	-731.441	-447.785	7	10
65	KLXV	-794.908	-42.221	7	10
66	KMAF	-489.696	-878.105	7	10
67	KMLF	-1380.148	-51.293	7	10
68	KMTJ	-939.546	-109.53	7	10
69	KODO	-509.4	-880.305	7	10
70	KOLS	-1312.937	-851.17	7	10
71	KPGA	-1272.618	-237.748	7	10
72	KPHX	-1385.892	-612.301	7	10
73	KPRC	-1401.151	-472.762	7	10
74	KPSR	-1386.494	-611.852	7	10
75	KPUB	-651.703	-162.851	7	10
76	KPUC	-1166.723	46.049	7	10
77	KRIL	-912.112	1.889	7	10
78	KROW	-698.85	-712.895	7	10
79	KRQE	-1083.18	-409.162	7	10
80	KRTN	-664.239	-331.996	7	10
81	KSAD	-1176.466	-709.996	7	10
82	KSAF	-816.558	-444.045	7	10
83	KSDL	-1373.418	-593.724	7	10

Surface and Precipitation Stations

Surface Meteorological Stations 2002					
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)	Time Zone	Anemometer Height
84	KSGU	-1456.647	-187.285	7	10
85	KSJN	-1127.733	-529.673	7	10
86	KSKX	-770.438	-355.856	7	10
87	KSOW	-1187.951	-549.427	7	10
88	KSPD	-493.802	-285.159	7	10
89	KSRR	-789.624	-686.256	7	10
90	KSVC	-1043.578	-751.807	7	10
91	KTAD	-644.899	-276.219	7	10
92	KTCC	-597.363	-511.501	7	10
93	KTCS	-952.322	-695.439	7	10
94	KTEX	-948.259	-169.74	7	10
95	KTUS	-1309.084	-772.955	7	10
96	KU24	-1326.193	40.266	7	10
97	KDMA	-1303.576	-768.169	7	10
98	MMCS	-893.759	-880.938	7	10
99	KE33	-846.39	-298.154	7	10
100	KU28	-1126.008	-28.962	7	10
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102	KHMN	-848.745	-749.371	7	10
103	KLUF	-1415.707	-594.125	7	10
104	KGBN	-1457.891	-656.39	7	10
105	KAFF	-671.158	-85.372	7	10
106	KCCU	-779.686	-19.32	7	10
107	KCPW	-858.907	-235.621	7	10
108	KMYP	-805.328	-126.737	7	10
109	KVTP	-715.975	-244.241	7	10
110	KMNH	-652.817	-58.825	7	10
111	KCRV	-725.218	39.791	7	10

Surface and Precipitation Stations

Surface Meteorological Stations 2003					
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1	K4BL	-1088.794	-188.74	7	10
2	K4CR	-796.753	-614.946	7	10
3	K4HV	-1184.701	-91.019	7	10
4	K4MY	-820.552	-514.181	7	10
5	K4SL	-902.016	-397.882	7	10
6	KABQ	-870.967	-501.552	7	10
7	KAEG	-886.431	-489.863	7	10
8	KAKO	-524.951	36.397	7	10
9	KALM	-839.633	-752.147	7	10
10	KALS	-777.382	-244.023	7	10
11	KAMA	-425.225	-516.367	7	10
12	KAPA	-668.169	-19.352	7	10
13	KASE	-843.56	-40.773	7	10
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17	KBKF	-658.539	-5.076	7	10
18	KCAO	-547.124	-374.102	7	10
19	KCCU	-779.686	-19.32	7	10
20	KCDC	-1401.542	-129.849	7	10
21	KCEZ	-1020.893	-233.136	7	10
22	KCGZ	-1366.468	-675.581	7	10
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34	KDMA	-1303.576	-768.169	7	10
35	KDMN	-1006.923	-798.125	7	10
36	KDRO	-945.713	-259.162	7	10
37	KDUG	-1194.674	-862.991	7	10
38	KDVT	-1385.653	-583.401	7	10
39	KEEO	-918.793	60.596	7	10
40	KEGE	-842.6	7.317	7	10
41	KEHA	-431.288	-320.167	7	10

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45	KFLG	-1323.565	-431.409	7	10
46	KFMN	-993.475	-297.941	7	10
47	KFST	-566.391	-988.873	7	10
48	KGCN	-1351.769	-335.037	7	10
49	KGDP	-737.521	-873.407	7	10
50	KGEU	-1409.993	-597.351	7	10
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57	KHOB	-580.048	-790.648	7	10
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68	KLXV	-794.908	-42.221	7	10
69	KMAF	-489.696	-878.105	7	10
70	KMLF	-1380.148	-51.293	7	10
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76	KPGA	-1272.618	-237.748	7	10
77	KPHX	-1385.892	-612.301	7	10
78	KPRC	-1401.151	-472.762	7	10
79	KPSR	-1386.494	-611.852	7	10
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82	KRIL	-912.112	1.889	7	10
83	KROW	-698.85	-712.895	7	10

Surface and Precipitation Stations

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85	KRTN	-664.239	-331.996	7	10
86	KSAD	-1176.466	-709.996	7	10
87	KSAF	-816.558	-444.045	7	10
88	KSDL	-1373.418	-593.724	7	10
89	KSGU	-1456.647	-187.285	7	10
90	KSJN	-1127.733	-529.673	7	10
91	KSKX	-770.438	-355.856	7	10
92	KSOW	-1187.951	-549.427	7	10
93	KSPD	-493.802	-285.159	7	10
94	KSRR	-789.624	-686.256	7	10
95	KSVC	-1043.578	-751.807	7	10
96	KTAD	-644.899	-276.219	7	10
97	KTCC	-597.363	-511.501	7	10
98	KTCS	-952.322	-695.439	7	10
99	KTEX	-948.259	-169.74	7	10
100	KTUS	-1309.084	-772.955	7	10
101	KU24	-1326.193	40.266	7	10
102	KVTP	-715.975	-244.241	7	10
103	MMCS	-893.759	-880.938	7	10
104	KE33	-846.39	-298.154	7	10
105	KU28	-1126.008	-28.962	7	10
106	KHMN	-848.745	-749.371	7	10
107	KAFF	-671.158	-85.372	7	10
108	KFCS	-669.55	-116.96	7	10
109	KFHU	-1261.816	-840.209	7	10
110	KGBN	-1457.891	-656.39	7	10
111	KLUF	-1415.707	-594.125	7	10
112	KBPG	-425.646	-852.529	7	10
113	KPVW	-432.871	-634.402	7	10
114	K20V	-791.766	46.384	7	10

Surface and Precipitation Stations

Precipitation Stations 2001			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
1	K4BL	-1088.794	-188.74
2	K4CR	-796.753	-614.946
3	K4HV	-1184.701	-91.019
4	K4MY	-820.552	-514.181
5	KABQ	-870.967	-501.552
6	KAEG	-886.431	-489.863
7	KAKO	-524.951	36.397
8	KALM	-839.633	-752.147
9	KALS	-777.382	-244.023
10	KAMA	-425.225	-516.367
11	KAPA	-668.169	-19.352
12	KASE	-843.56	-40.773
13	KATS	-699.341	-756.355
14	KBCE	-1319.635	-144.072
15	KBJC	-687.645	19.671
16	KBKF	-658.539	-5.076
17	KCAO	-547.124	-374.102
18	KCDC	-1401.542	-129.849
19	KCEZ	-1020.893	-233.136
20	KCGZ	-1366.468	-675.581
21	KCHD	-1370.847	-633.186
22	KCNM	-682.759	-822.078
23	KCNY	-1095.593	-59.385
24	KCOS	-663.999	-102.631
25	KCQC	-775.182	-516.728
26	KCVN	-556.268	-599.276
27	KCVS	-577.834	-601.516
28	KDEN	-649.924	12.691
29	KDHT	-496.517	-424.942
30	KDMA	-1303.576	-768.169
31	KDMN	-1006.923	-798.125
32	KDRO	-945.713	-259.162
33	KDUG	-1194.674	-862.991
34	KDVT	-1424.153	-803.334
35	KEEO	-918.793	60.596
36	KEGE	-842.6	7.317
37	KEHA	-431.288	-320.167
38	KELP	-888.697	-862.785
39	KFFZ	-1359.37	-612.92
40	KFGZ	-1335.662	-418.569
41	KFLG	-1323.565	-431.409

Surface and Precipitation Stations

Precipitation Stations 2001			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
42	KFMN	-993.475	-297.941
43	KFST	-566.391	-988.873
44	KGDP	-737.521	-873.407
45	KGJT	-986.737	-34.971
46	KGNT	-985.121	-475.597
47	KGUC	-855.846	-113.585
48	KGUP	-1060.45	-427.996
49	KGXY	-644.007	49.181
50	KGYR	-1419.716	-608.461
51	KINK	-586.879	-890.621
52	KINW	-1241.942	-457.351
53	KITR	-451.837	-69.8
54	KIWA	-1356.255	-632.196
55	KLAA	-494.483	-198.304
56	KLBB	-445.079	-691.2
57	KLHX	-567.01	-195.279
58	KLIC	-573.7	-69.147
59	KLRU	-917.261	-803.759
60	KLVS	-731.441	-447.785
61	KLXV	-794.908	-42.221
62	KMAF	-489.696	-878.105
63	KMLF	-1380.148	-51.293
64	KMTJ	-939.546	-109.53
65	KODO	-509.4	-880.305
66	KOLS	-1312.937	-851.17
67	KPGA	-1272.618	-237.748
68	KPHX	-1385.892	-612.301
69	KPRC	-1401.151	-472.762
70	KPSR	-1386.494	-611.852
71	KPUB	-651.703	-162.851
72	KPUC	-1166.723	46.049
73	KRIL	-912.112	1.889
74	KROW	-698.85	-712.895
75	KRQE	-1083.18	-409.162
76	KRTN	-664.239	-331.996
77	KSAD	-1176.466	-709.996
78	KSAF	-816.558	-444.045
79	KSDL	-1373.418	-593.724
80	KSGU	-1456.647	-187.285
81	KSJN	-1127.733	-529.673
82	KSKX	-812.696	-797.619
83	KSOW	-1187.951	-549.427

Surface and Precipitation Stations

Precipitation Stations 2001			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
84	KSPD	-493.802	-285.159
85	KSRR	-789.624	-686.256
86	KSVC	-1043.578	-751.807
87	KTAD	-645.048	-278.061
88	KTCC	-597.363	-511.501
89	KTCS	-952.322	-695.439
90	KTUS	-1309.084	-772.955
91	KU24	-1326.193	40.266
92	KGCN	-1351.769	-335.037
93	KHOB	-580.048	-790.648
94	KTEX	-948.259	-169.74
95	KE33	-846.39	-298.154
96	MMCS	-893.759	-880.938
97	K4SL	-889.332	-391.854
98	KAFF	-671.158	-85.372
99	KU28	-1126.008	-28.962
100	KFHU	-1261.816	-840.209
101	KHMN	-848.745	-749.371
102	KGBN	-1457.891	-656.39
103	KLAM	-831.464	-412.856
104	KLUF	-1415.707	-594.125
105	KFCS	-669.55	-116.96
106	KGEU	-1409.993	-597.351
107	KEPZ	-915.897	-851.724
108	KCCU	-779.686	-19.32
109	KCPW	-858.907	-235.621
110	KMYP	-805.328	-126.737
111	KVTP	-715.975	-244.241
112	KMNH	-652.817	-58.825

Surface and Precipitation Stations

Precipitation Stations 2002			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
1	K4BL	-1088.794	-188.74
2	K4CR	-796.753	-614.946
3	K4HV	-1184.701	-91.019
4	K4MY	-820.552	-514.181
5	K4SL	-902.016	-397.882
6	KABQ	-870.967	-501.552
7	KAEG	-886.431	-489.863
8	KAKO	-524.951	36.397
9	KALM	-839.633	-752.147
10	KALS	-777.382	-244.023
11	KAMA	-425.225	-516.367
12	KAPA	-668.169	-19.352
13	KASE	-843.56	-40.773
14	KATS	-699.341	-756.355
15	KBCE	-1319.974	-143.768
16	KBJC	-687.645	19.671
17	KBKF	-658.539	-5.076
18	KCAO	-547.124	-374.102
19	KCDC	-1401.542	-129.849
20	KCEZ	-1020.893	-233.136
21	KCGZ	-1366.468	-675.581
22	KCHD	-1370.847	-633.186
23	KCNM	-681.361	-822.067
24	KCNY	-1095.593	-59.385
25	KCOS	-663.999	-102.631
26	KCQC	-775.182	-516.728
27	KCVN	-556.268	-599.276
28	KCVS	-577.834	-601.516
29	KDEN	-649.924	12.691
30	KDHT	-496.517	-424.942
31	KDMN	-1006.923	-798.125
32	KDRO	-945.713	-259.162
33	KDUG	-1194.674	-862.991
34	KDVT	-1385.653	-583.401
35	KEEO	-918.793	60.596
36	KEGE	-842.6	7.317
37	KEHA	-431.288	-320.167
38	KELP	-888.697	-862.785
39	KFFZ	-1359.37	-612.92
40	KFGZ	-1335.662	-418.569
41	KFHU	-1261.816	-840.209
42	KFLG	-1323.565	-431.409
43	KFMN	-993.475	-297.941
44	KFST	-566.391	-988.873
45	KGCN	-1351.769	-335.037
46	KGDP	-737.521	-873.407

Surface and Precipitation Stations

Precipitation Stations 2002			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
47	KGEU	-1409.993	-597.351
48	KGJT	-986.737	-34.971
49	KGNT	-985.121	-475.597
50	KGUC	-855.846	-113.585
51	KGUP	-1060.45	-427.996
52	KGXY	-644.007	49.181
53	KGYR	-1419.716	-608.461
54	KHOB	-580.048	-790.648
55	KINK	-586.978	-890.95
56	KINW	-1241.942	-457.351
57	KITR	-451.837	-69.8
58	KIWA	-1356.255	-632.196
59	KLAA	-494.483	-198.304
60	KLBB	-445.079	-691.2
61	KLHX	-567.01	-195.279
62	KLIC	-573.7	-69.147
63	KLRU	-917.261	-803.759
64	KLVS	-731.441	-447.785
65	KLXV	-794.908	-42.221
66	KMAF	-489.696	-878.105
67	KMLF	-1380.148	-51.293
68	KMTJ	-939.546	-109.53
69	KODO	-509.4	-880.305
70	KOLS	-1312.937	-851.17
71	KPGA	-1272.618	-237.748
72	KPHX	-1385.892	-612.301
73	KPRC	-1401.151	-472.762
74	KPSR	-1386.494	-611.852
75	KPUB	-651.703	-162.851
76	KPUC	-1166.723	46.049
77	KRIL	-912.112	1.889
78	KROW	-698.85	-712.895
79	KRQE	-1083.18	-409.162
80	KRTN	-664.239	-331.996
81	KSAD	-1176.466	-709.996
82	KSAF	-816.558	-444.045
83	KSDL	-1373.418	-593.724
84	KSGU	-1456.647	-187.285
85	KSJN	-1127.733	-529.673
86	KSKX	-770.438	-355.856
87	KSOW	-1187.951	-549.427
88	KSPD	-493.802	-285.159
89	KSRR	-789.624	-686.256

Surface and Precipitation Stations

Precipitation Stations 2002			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
90	KSVC	-1043.578	-751.807
91	KTAD	-644.899	-276.219
92	KTCC	-597.363	-511.501
93	KTCS	-952.322	-695.439
94	KTEX	-948.259	-169.74
95	KTUS	-1309.084	-772.955
96	KU24	-1326.193	40.266
97	KDMA	-1303.576	-768.169
98	MMCS	-893.759	-880.938
99	KE33	-846.39	-298.154
100	KU28	-1126.008	-28.962
101	KFCS	-669.55	-116.96
102	KHMN	-848.745	-749.371
103	KLUF	-1415.707	-594.125
104	KGBN	-1457.891	-656.39
105	KAFF	-671.158	-85.372
106	KCCU	-779.686	-19.32
107	KCPW	-858.907	-235.621
108	KMYP	-805.328	-126.737
109	KVTP	-715.975	-244.241
110	KMNH	-652.817	-58.825
111	KCRV	-725.218	39.791

Surface and Precipitation Stations

Precipitation Stations 2003			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
1	K4BL	-1088.794	-188.74
2	K4CR	-796.753	-614.946
3	K4HV	-1184.701	-91.019
4	K4MY	-820.552	-514.181
5	K4SL	-902.016	-397.882
6	KABQ	-870.967	-501.552
7	KAEG	-886.431	-489.863
8	KAKO	-524.951	36.397
9	KALM	-839.633	-752.147
10	KALS	-777.382	-244.023
11	KAMA	-425.225	-516.367
12	KAPA	-668.169	-19.352
13	KASE	-843.56	-40.773
14	KATS	-699.341	-756.355
15	KBCE	-1319.974	-143.768
16	KBJC	-687.645	19.671
17	KBKF	-658.539	-5.076
18	KCAO	-547.124	-374.102
19	KCCU	-779.686	-19.32
20	KCDC	-1401.542	-129.849
21	KCEZ	-1020.893	-233.136
22	KCGZ	-1366.468	-675.581
23	KCHD	-1370.847	-633.186
24	KCNM	-681.361	-822.067
25	KCNY	-1095.593	-59.385
26	KCOS	-663.999	-102.631
27	KCPW	-858.907	-235.621
28	KCQC	-775.182	-516.728
29	KCRV	-725.218	39.791
30	KCVN	-556.268	-599.276
31	KCVS	-577.834	-601.516
32	KDEN	-649.924	12.691
33	KDHT	-496.517	-424.942
34	KDMA	-1303.576	-768.169
35	KDMN	-1006.923	-798.125
36	KDRO	-945.713	-259.162
37	KDUG	-1194.674	-862.991
38	KDVT	-1385.653	-583.401
39	KEEO	-918.793	60.596
40	KEGE	-842.6	7.317
41	KEHA	-431.288	-320.167
42	KELP	-888.697	-862.785
43	KFFZ	-1359.37	-612.92
44	KFGZ	-1335.662	-418.569
45	KFLG	-1323.565	-431.409
46	KFMN	-993.475	-297.941

Surface and Precipitation Stations

Precipitation Stations 2003			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
47	KFST	-566.391	-988.873
48	KGCN	-1351.769	-335.037
49	KGDP	-737.521	-873.407
50	KGEU	-1409.993	-597.351
51	KGJT	-986.737	-34.971
52	KGNT	-985.121	-475.597
53	KGUC	-855.846	-113.585
54	KGUP	-1060.45	-427.996
55	KGXY	-644.007	49.181
56	KGYR	-1419.716	-608.461
57	KHOB	-580.048	-790.648
58	KINK	-586.978	-890.95
59	KINW	-1241.942	-457.351
60	KITR	-451.837	-69.8
61	KIWA	-1356.255	-632.196
62	KLAA	-494.483	-198.304
63	KLBB	-445.079	-691.2
64	KLHX	-567.01	-195.279
65	KLIC	-573.7	-69.147
66	KLRU	-917.261	-803.759
67	KLVS	-731.441	-447.785
68	KLXV	-794.908	-42.221
69	KMAF	-489.696	-878.105
70	KMLF	-1380.148	-51.293
71	KMNH	-652.817	-58.825
72	KMTJ	-939.546	-109.53
73	KMYP	-805.328	-126.737
74	KODO	-509.4	-880.305
75	KOLS	-1312.937	-851.17
76	KPGA	-1272.618	-237.748
77	KPHX	-1385.892	-612.301
78	KPRC	-1401.151	-472.762
79	KPSR	-1386.494	-611.852
80	KPUB	-651.703	-162.851
81	KPUC	-1166.723	46.049
82	KRIL	-912.112	1.889
83	KROW	-698.85	-712.895
84	KRQE	-1083.18	-409.162
85	KRTN	-664.239	-331.996
86	KSAD	-1176.466	-709.996
87	KSAF	-816.558	-444.045
88	KSDL	-1373.418	-593.724
89	KSGU	-1456.647	-187.285

Surface and Precipitation Stations

Precipitation Stations 2003			
Station Number	Station Name	Lambert Coordinate X (km)	Lambert Coordinate Y (km)
90	KSJN	-1127.733	-529.673
91	KSKX	-770.438	-355.856
92	KSOW	-1187.951	-549.427
93	KSPD	-493.802	-285.159
94	KSRR	-789.624	-686.256
95	KSVC	-1043.578	-751.807
96	KTAD	-644.899	-276.219
97	KTCC	-597.363	-511.501
98	KTCS	-952.322	-695.439
99	KTEX	-948.259	-169.74
100	KTUS	-1309.084	-772.955
101	KU24	-1326.193	40.266
102	KVTP	-715.975	-244.241
103	MMCS	-893.759	-880.938
104	KE33	-846.39	-298.154
105	KU28	-1126.008	-28.962
106	KHMN	-848.745	-749.371
107	KAFF	-671.158	-85.372
108	KFCS	-669.55	-116.96
109	KFHU	-1261.816	-840.209
110	KGBN	-1457.891	-656.39
111	KLUF	-1415.707	-594.125
112	KBPG	-425.646	-852.529
113	KPVW	-432.871	-634.402
114	K20V	-791.766	46.384

Appendix B
CALMET Control File Inputs

CALMET Control File Inputs

Variable	Description	PNM Value	Agreement with Default	Comments
INPUT GROUP 0: Input and Output				
NUSTA	Number of Upper air stations	10	n/a	
NOWSTA	Number of over water met stations	0	n/a	Not using over water met stations
INPUT GROUP 1: General Run Control Parameters				
IBYR	Starting year of the CALPUFF run	2001	n/a	2002 and 2003 are the other years modeled
IBMO	Starting month	1	n/a	
IBDY	Starting day	1	n/a	
IBHR	Starting hour	0	n/a	
IBTZ	Base time zone	7	n/a	Mountain Standard Time
IRLG	Length of run (hours)	744	n/a	CALMET run in daily increments 31 days = 744 hours 30 days = 720 hours 28 days = 672 hours
IRTYPE	Run Type	1	Y	Must be 1 to run CALPUFF
LCALGRD	Compute variables used by both CALGRID and CALPUFF	T	Y	Compute all fields required by CALPUFF
ITEST	Stop run after SETUP to do input QA	2	Y	
INPUT GROUP 2: Map Projection and Grid Control Parameters				
PMAP	Map Projection	LCC	UTM	
FEAST	False Easting at the projection origin	0.00	Y	
FNORTH	False Northing at the projection origin	0.00	Y	
IUTMZN	UTM zone	n/a	n/a	
UTMHEM	Hemisphere for UTM projection	n/a	n/a	
RLATO	Latitude (dec. degrees) of projection origin	40.0 N	n/a	
RLONO	Longitude (dec. degrees) of projection origin	97.0 W	n/a	
XLAT1	Matching parallel(s) of latitude projection	33.0 N	n/a	
XLAT2	Matching parallel(s) of latitude projection	45.0 N	n/a	
DATUM	Datum region for output coordinates	NWS-84	n/a	
NX	Number of X grid cells in meteorological grid	216	n/a	
NY	Number of Y grid cells in meteorological grid	216	n/a	
DGRIDKM	Grid spacing, km	4	n/a	Refined grid spacing
XORIGKM	Ref. Coordinate of SW corner of grid cell (1,1)	-1368	n/a	
YORIGKM	Ref. Coordinate of SW corner of grid cell (1,1)	-900	n/a	
NZ	No. of vertical layers	10	n/a	

CALMET Control File Inputs

Variable	Description	PNM Value	Agreement with Default	Comments
ZFACE	Cell face heights in arbitrary vertical grid, m	0,20, 100,200,350,500, 750,1000,2000, 3000,4000,5000	n/a	WRAP BART Modeling Protocol Recommended Values
INPUT GROUP 3: Output Options				
LSAVE	Disk output option	T	Y	
IFORMO	Type of unformatted output type	1	Y	
LPRINT	Print met fields	F	Y	
IPRINF	Print intervals	1	Y	
IUVOUT(NZ)	Specify layers of u,v wind components to print	NZ*0	Y	
IWOUT(NZ)	Specify layers of w wind components to print	NZ*0	Y	
ITOUT(NZ)	Specify layers of 3-D temperature field to print	NZ*0	Y	
LDB	Print input met data and variables	F	Y	
NN1	First time step for debug data to be printed	1	Y	Not used
NN2	Last time step for debug data to be printed	2	N	Not used
IOUTD	Control 1variable for writing test/debug wind fields	0	Y	
NZPRN2	Number of levels starting at surface to print	1	Y	
IPR0	Print interpolated wind components	0	Y	
IPR1	Print terrain adjusted surface wind components	0	Y	
IPR2	Print initial divergence fields	0	Y	
IPR3	Print final wind speed and direction	0	Y	
IPR4	Print final divergence fields	0	Y	
IPR5	Print winds after kinematic effects	0	Y	
IPR6	Print winds after Froude number adjustment	0	Y	
IPR7	Print winds after slope flows are added	0	Y	
IPR8	Print final field components	0	Y	
INPUT GROUP 4: Meteorological Data Options				
NOOBS	1= Use of surface and precipitation (no upper air observations); use MM5 for upper air data	1	Y	
NSSTA	Number of meteorological	112	n/a	111 stations for 2002

CALMET Control File Inputs

Variable	Description	PNM Value	Agreement with Default	Comments
	surface stations			114 stations for 2003
NPSTA	Number of precipitation stations	112	n/a	111 stations for 2002 114 stations for 2003
ICLOUD	Gridded cloud fields	0	N	
IFORMS	Formatted surface meteorological data file	2	Y	
IFORMP	Formatted surface precipitation data file	2	Y	
IFORMC	Formatted cloud data file	2	Y	No additional cloud data used in the model.
INPUT GROUP 5: Windfield Options and Parameters				
IWFCOD	Model selection variable	1	Y	
IFRADJ	Compute Froude number adjustment factor	1	Y	
IKINE	Compute kinematic effects	0	Y	WRAP BART Modeling Protocol Recommended Value
IOBR	Use O'Brien (1970) vertical velocity adjustment	0	Y	
ISLOPE	Compute slope flow effects	1	Y	
IEXTRP	Extrapolate surface wind obs to upper level	1	N	WRAP BART Modeling Protocol Recommended Value
ICALM	Extrapolate surface winds if calm	0	Y	
BIAS	Layer dependent biases weighting aloft measurements	NZ*0	Y	
RMIN2	Minimum vertical extrapolation distance	4	Y	
IPROG	Use gridded prognostic wind field model output fields as input to the diagnostic wind field model	14	N	Use winds from MM5.DAT file as initial guess field
ISTEPPG	MM5 output timestep	1	Y	
LVARY	Use varying radius of influence	F	Y	
RMAX1	Maximum radius of influence over land in sfc layer	50	n/a	WRAP BART Modeling Protocol Recommended Value
RMAX2	Maximum radius of influence over land aloft	100	n/a	
RMAX3	Maximum radius of influence over water	100	n/a	
RMIN	Minimum radius of influence used anywhere	0.1	Y	
TERRAD	Terrain feature radius of influence	10	n/a	
R1	Weighting of first guess surface field	100	n/a	
R2	Weighting of first guess aloft field	200	n/a	
RPROG	MM4 windfield weighting parameter	0	n/a	Not used since IPROG is not equal to 1.

CALMET Control File Inputs

Variable	Description	PNM Value	Agreement with Default	Comments
DIVLIM	Minimum divergence criterion	5.E-6	Y	
NITER	Number of divergences minimization iterations	50	Y	
NSMMTH	Number of passes through smoothing filter in each layer of CALMET	2,4,4,4,4, 4,4,4,4,4	Y	
NINTR2	Maximum number of stations use din each layer for the interpretation of data to a grid point	99	Y	
CRITFN	Critical Froude number	1.0	Y	
ALPHA	Kinematic effects parameter	0.1	Y	
FEXTR2	Scaling factor for extrapolating sfc winds aloft	NZ*0	Y	
NBAR	Number of terrain barriers	0	Y	
IDIOTP1	Surface temperature computation switch	0	Y	
ISURFT	Number of sfc met station to use for temp calcs	42	n/a	Surface Station KFMN 2002 = 43 2003 = 46
IDIOPT2	Domain average lapse rate switch	0	Y	
IUPT	Upper air station to use for lapse rate calculation	0	n/a	Upper Air Stations Not Used
ZUPT	Depth through wish lapse rate is calculated	200	Y	
IDIOPT3	Domain averaged wind components	0	Y	
IUPWIND	Number of aloft stations to use for wind calc	-1	Y	
ZUPWIND	Bottom and top of layer through which the domain scale winds are computed	1, 1000	Y	
IDIOPT4	Observed surface wind component switch	0	Y	
IDIOPT5	Observed aloft wind component switch	0	Y	
LLBREZE	Use lake breeze model	F	Y	
NBOX	Number of lake breeze regions	n/a	n/a	
NLB	Number of stations in the region	n/a	n/a	
METBXID (NLB)	Stations ID's in the region	n/a	n/a	
Input Group 6: Mixing Height, Temperature and Precipitation Parameters				
CONSTB	Neutral stability mixing height coefficient	1.41	Y	
CONSTE	Convective stability mixing height coefficient	0.15	Y	

CALMET Control File Inputs

Variable	Description	PNM Value	Agreement with Default	Comments
CONSTN	Stable stability maxing height coefficient	2400	Y	
CONSTW	Overwater mixing height coefficient	0.16	Y	
FCORIOL	Absolute vale of Coriolis parameter	1 E-4	Y	
IAVEZI	Conduct spatial averaging	1	Y	
MNMDAV	Maximum search radius in averaging process	1	Y	
HAFANG	Half angle of upwind looking cone for averaging	30	Y	
ILEVZI	Layers of wind use in upwind averaging	1	Y	
DPTMIN	Minimum potential temperature lapse rate in the stable layer above the current convective mixing height	0.001	Y	
DZZI	Depth of layer above current convective mixing height through which lapse rate is computed	200	Y	
ZIMIN	Minimum overland mixing height	50	Y	
ZIMAX	Maximum overland mixing height	4500	Y	WRAP BART Modeling Protocol Recommended Value
ZIMINW	Minimum overwater mixing height	50	Y	
ZIMAXW	Maximum overwater mixing height	4500	Y	WRAP BART Modeling Protocol Recommended Value
IRHPROG	3D relative humidity form observation or from MM5	0	Y	Use RH from SURF.DAT file
ITPROG	3D temperature from observations or from MM5	1	N	Use Surface stations and Use MM5/3D for Upper Air
IRAD	Type of interpolation	1	Y	
TRADKM	Temperature interpolation radius of influence	500	N	WRAP BART Modeling Protocol Recommended Value
NUMTS	Maximum number of station for temperature interpolation	5	Y	
IAVET	Spatially average temperatures	1	Y	
TGDEFB	Temperature gradient below mixing height over water	-0.0098	Y	
TGDEFA	Temperature gradient above mixing height over water	-0.0045	Y	
JWAT1	Beginning land use categories over water	55	n/a	WRAP BART Modeling Protocol Recommended Value
JWAT2	Ending land use categories for water	55	n/a	WRAP BART Modeling Protocol Recommended Value

CALMET Control File Inputs

Variable	Description	PNM Value	Agreement with Default	Comments
NFLAGP	Precipitation interpolation flag	2	Y	
SIGMAP	Radius of influence for precipitation interpolation	100	Y	
CUTP	Minimum precipitation rate cutoff (mm/hr)	0.01	Y	
INPUT GROUP: 7 Surface meteorological station parameters See Appendix A				
INPUT GROUP: 8 Upper air meteorological station parameters Upper Air Stations Not Used				
INPUT GROUP: 9 Precipitation station parameters See Appendix A				

Appendix C
CALPUFF Control File Inputs

CALPUFF Control File Inputs

Variable	Description	PNM Value	Default	Comments
INPUT GROUP 1: General run control parameters				
METRUN	Control parameter for running all periods in met. File (0=no; 1=yes)	0	Y	
IBYR	Starting year of the CALPUFF run	2001	n/a	2002 and 2003 are the other years modeled
IBMO	Starting month	1	n/a	
IBDY	Starting day	1	n/a	
IBHR	Starting hour	0	n/a	
XBTZ	Base time zone	7	n/a	Mountain Standard Time
IRLG	Length of the run (hours)	8736	n/a	
NSPEC	Total number of species modeled	11	5	
NSE	Number of species emitted	7	3	
METFM	Meteorological data format	1	Y	CALMET unformatted file
AVET	Averaging time (minutes)	60.0	Y	
PGTIME	Averaging time (minutes) for PG - σ_y	60.0	Y	
INPUT GROUP 2: Technical options				
MGAUSS	Control variable determining the vertical distribution used in the near field	1	Y	Gaussian
MCTADJ	Terrain adjustment method	3	Y	Partial plume path adjustment
MCTSG	CALPUFF sub-grid scale complex terrain module (CTSG) flag	0	Y	CTSG not modeled
MSLUG	Near-field puffs are modeled as elongated “slugs”?	0	Y	No
MTRANS	Transitional plume rise modeled?	1	Y	Transitional plume rise computed
MTIP	Stack tip downwash modeled?	1	Y	Yes
MBDW	Method used to simulate building downwash?	1	Y	ISC. However, building downwash not used.
MSHEAR	Vertical wind shear above stack top modeled in plume rise?	0	Y	No
MSPLIT	Puff splitting allowed?	0	Y	WRAP BART Modeling Protocol Recommended Value
MCHEM	Chemical mechanism flag	1	Y	Transformation rates computed internally (MESOPUFF II scheme)
MAQCHEM	Aqueous phase transformation flag	0	Y	Aqueous phase not modeled
MWET	Wet removal modeled?	1	Y	Yes
MDRY	Dry deposition modeled?	1	Y	Yes
MDISP	Method used to compute dispersion coefficients	3	Y	PG dispersion coefficients in RURAL & MP coefficients in urban areas
MTURBVW	Sigma-v/sigma-theta, sigma-w measurements used?	-	-	Not used since MDISP = 3.

CALPUFF Control File Inputs

Variable	Description	PNM Value	Default	Comments
MDISP2	Backup method used to compute dispersion when measured turbulence data are missing	-	-	Not used since MDISP = 3.
MROUGH	PG sigma-y,z adj. for roughness?	0	Y	No
MPARTL	Partial plume penetration of elevated inversion?	1	Y	Yes
MTINV	Strength of temperature inversion	0	Y	No
MPDF	PDF used for dispersion under convective conditions?	0	Y	No
MSGTIBL	Sub-Grid TIBL module used for shoreline?	0	Y	No
MBCON	Boundary conditions (concentration) modeled?	0	Y	No
MFOG	Configure for FOG model output	0	Y	No
MREG	TEST options specified to see if they conform to regulatory values?	1	Y	Checks made
INPUT GROUP 3: Species list				
CSPEC	Species modeled	SO2 SO4 NOX HNO3 NO3 PM8.00 PM4.25 PM1.88 PM1.25 PM0.813 PM0.625	n/a	**Modeled**: All **Emitted**: SO2, NOx, SO4, PM8P00, PM4P25, PM1P88, PM1P25, PM0P813, PM0P625 **Dry deposited**: SO2(gas), SO4(particle), NOx(gas), HNO3(gas), NO3(particle), PM8P00(particle), PM4P25(particle), PM1P88(particle), PM1P25(particle), PM0P813(particle), PM0P625 (particle) (all but NOx are wet deposited also) These particulate sizes are based on the NPS spreadsheet speciations
INPUT GROUP 4: Map projection and grid control parameters				
PMAP	Map projection	LCC	N	Lambert conformal conic
FEAST	False Easting	0.0	Y	
FNORT	False Northing	0.0	Y	
RLATO	Latitude	40.0 N	n/a	
RLONG	Longitude	97.0 W	n/a	
XLAT1 XLAT2	Matching parallel(s) of latitude for projection	33N 45 N	n/a n/a	
DATUM	Datum region for the coordinates	NWS-84	N	
NX NY	<u>Meteorological grid</u>: No. X grid cells in meteorological grid	216 216	n/a	

CALPUFF Control File Inputs

Variable	Description	PNM Value	Default	Comments
NZ	No. Y grid cells in meteorological grid No. vertical layers in meteorological grid	10		
DGRIDKM	Grid spacing (km)	4	n/a	
ZFACE	Cell face heights (m)	0,20, 100,200,350,500,750,1000, 2000, 3000,4000, 5000	n/a	
XORIGKM YORIGKM	Reference coordinates of SW corner of grid cell (1,1) (km)	-1368 -900	n/a	
 IBCOMP JBCOMP IECOMP JECOMP	<u>Computational grid:</u> X index of LL corner Y index of LL corner X index of UR corner Y index of UR corner	 1 75 192 216	n/a	
LSAMP IBSAMP JBSAMP IESAMP JESAMP MESHDN	Logical flag indicating if gridded receptors are used X index of LL corner Y index of LL corner X index of UR corner Y index of UR corner Nesting factor of the sampling grid	F 1	- Y	Receptors are only in the Class I areas assessed
INPUT GROUP 5: Output options				
SPECIES	Species (or group) list for output options	1	n/a	Concentrations saved for SO2, SO4, NOx, HNO3, NO3, PM8.00 PM4.25, PM1.88, PM1.25, PM0.813, PM0.625
INPUT GROUP 6: Subgrid scale complex terrain (CTSG) inputs				
NHILL	Number of terrain features	0	Y	
NCTREC	Number of special complex terrain receptors	0	Y	
MHILL	Terrain and CTSG receptor data for CTSG hills input in CTDM format?	0	n/a	None input.
XHILL2M	Factor to convert horizontal dimensions to meters	1	Y	
ZHILL2M	Factor to convert vertical dimensions to meters	1	Y	
XCTDMKM	X-origin of CTDM system relative to CALPUFF coordinate system, in Km	0	n/a	
YCTDMKM	Y-origin of CTDM system relative to CALPUFF coordinate system, in Km	0	n/a	

CALPUFF Control File Inputs

Variable	Description	PNM Value	Default	Comments
INPUT GROUP 7: Chemical parameters for dry deposition of gases				
SPECIES DIFFUSVTY ALPHA STR REACTVTY MESO RES HENRYS C	Chemical parameters for dry deposition of gases	-	Y Y Y Y Y Y	SO2; NOx; HNO3 0.1509 0.1656 0.1628 1000 1 1 8 8 18 0 5 0 0.04 3.5 8.0*E-8
INPUT GROUP 8: Size parameters for dry deposition of particles				
SPECIES GEO. MASS MEAN DIA. GEO.STAND DEV.	Single species: mean and standard deviation used to compute deposition velocity for NINT size-ranges; averaged to obtain mean deposition velocity. Grouped species: size distribution specified, standard deviation as "0". Model uses deposition velocity for stated mean diameter.	-	n/a	Species Diameter Std Dev. SO4 0.48 2 NO3 0.48 2 PM8.00 8.00 0 PM4.25 4.25 0 PM1.88 1.88 0 PM1.25 1.25 0 PM0.813 0.813 0 PM0.625 0.625 0 When modeling known diameters, used a standard deviation of zero.
INPUT GROUP 9: Miscellaneous dry deposition parameters				
RCUTR	Reference cuticle resistance	30	Y	
RGR	Reference ground resistance	10	Y	
REACTR	Reference pollutant reactivity	8	Y	
NINT	Number of particle-size intervals to evaluate effective particle deposition velocity	9	Y	
IVEG	Vegetation state in unirrigated areas	1	Y	
INPUT GROUP 10: Wet deposition parameters				
POLL LIQ PRECIP FRZ PRECIP	Scavenging coefficients	-	Y Y Y	Poll Liq Frz SO2 3E-5 0 SO4 1E-4 3E-5 NOx 0 0 HNO3 6E-5 0 NO3 1E-4 3E-5 PM8.00 1E-4 3E-5 PM4.25 1E-4 3E-5 PM1.88 1E-4 3E-5 PM1.25 1E-4 3E-5 PM0.813 1E-4 3E-5 PM0.625 1E-4 3E-5
INPUT GROUP 11: Chemistry parameters				
MOZ	Ozone data input option	1	N	Read hourly ozone conc. From the OZONE.DAT data file
BCKO3	Monthly ozone concentrations	12*80	N	WRAP BART Modeling Protocol Recommended Value

CALPUFF Control File Inputs

Variable	Description	PNM Value	Default	Comments
BCKNH3	Monthly ammonia concentrations	12*1	N	WRAP BART Modeling Protocol Recommended Value
RNITE1	Nighttime SO2 loss rate	0.2	Y	
RNITE2	Nighttime NOx loss rate	2.0	Y	
RNITE3	Nighttime HNO3 formation rate	2.0	Y	
MH2O2	H2O2 data input option	-	-	MQACHEM = 0; not used
BCKH2O2	Monthly H2O2 concentrations	-	-	MQACHEM = 0; not used
BCKPMF OFRAC VCNX	Secondary Organic Aerosol options	-	-	MCHEM = 1; thus, not used
INPUT GROUP 12: Misc. Dispersion and computational parameters				
SYTDEP	Horizontal size of puff beyond which time-dependent dispersion equations (Heffter) are used.	550	Y	
MHFTSZ	Switch for using Heffter equation for sigma z as above	0	Y	
JSUP	Stability class used to determine plume growth rates for puffs above boundary layer	5	Y	
CONK1	Vertical dispersion constant for stable conditions	0.01	Y	
CONK2	Vertical dispersion constant for neutral/unstable conditions	0.1	Y	
TBD	Factor determining transition-point from Schulman-Scire to Huber-Snyder building downwash scheme	0.5	Y	No building downwash used
IURB1 IURB2	Range of land use categories for which urban dispersion is assumed	10 19	Y Y	METFM=1; not used
ILANDUIN	Land use category for modeling domain	-	-	METFM=1; not used
ZOIN	Roughness length (m) for modeling domain	-	-	METFM=1; not used
XLAIIN	Leaf area index for modeling domain	-	-	METFM=1; not used
ELEVIN	Elevation above sea level	-	-	METFM=1; not used
XLATIN	Latitude (degrees) for met location	-	-	METFM=1; not used
XLONIN	Longitude (degrees) for met location	-	-	METFM=1; not used
ANEMHT	Anemometer height (m)	-	-	METFM=1; not used
ISIGMAV	Form of lateral turbulence data in PROFILE.DAT	1	Y	Read sigma-v
IMIXCTDM	Choice of mixing heights	-	-	METFM=1; not used
XMXLEN	Maximum length of a slug	1	Y	
XSAMLEN	Maximum travel distance of a puff/slug during one sampling step	1	Y	

CALPUFF Control File Inputs

Variable	Description	PNM Value	Default	Comments
MXNEW	Maximum number of slugs/puffs released from one source during one time step	99	Y	
MXSAM	Maximum number of sampling steps for one puff/slug during one time step	99	Y	
NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2	Y	
SYMIN	Minimum sigma y for a new puff/slug	1	Y	
SZMIN	Minimum sigma z for a new puff/slug	1	Y	
SVMIN SWMIN	Default minimum turbulence velocities sigma-v and sigma-w for each stability class	-	Y	A B C D E F .5 .5 .5 .5 .5 .5 .2 .12 .08 .06 .03 .016
CDIV	Divergence criterion for dw/dz across puff used to initiate adjustment for horizontal convergence	0, 0	Y	
WSCALM	Minimum wind speed allowed for non-calm conditions. Used as minimum speed returned when using power-law extrapolation toward surface	0.5	Y	
XMAXZI	Maximum mixing height (m)	4500	N	Top interface in CALMET simulation
XMINZI	Minimum mixing height (m)	50	Y	
WSCAT	Default wind speed classes	-	Y	1 2 3 4 5 1.54 3.09 5.14 8.23 10.80
PLXO	Default wind speed profile power-law exponents for stabilities 1-6	-	Y ISC RURAL	A B C D E F .07 .07 .10 .15 .35 .55
PTGO	Default potential temperature gradient for stable classes E, F (deg K/m)	-	Y	0.020; 0.035
PPC	Default plume path coefficients for each stability class	-	Y	A B C D E F .5 .5 .5 .5 .35 .35
SL2PF	Slug-to-puff transitions criterion factor equal to sigma-y/length of slug	10	Y	Puff Splitting not enabled
NSPLIT	Number of puffs that result every time a puff is split	3	Y	Puff Splitting not enabled
IRESPLIT	Time of day when split puffs are eligible to be split once again; this is typically set once per day, around sunset before nocturnal shear develops	-	N	Hour 17 = 1 Puff Splitting not enabled
ZISPLIT	Split is allowed only if last hour's mixing height (m)	100	Y	Puff Splitting not enabled

CALPUFF Control File Inputs

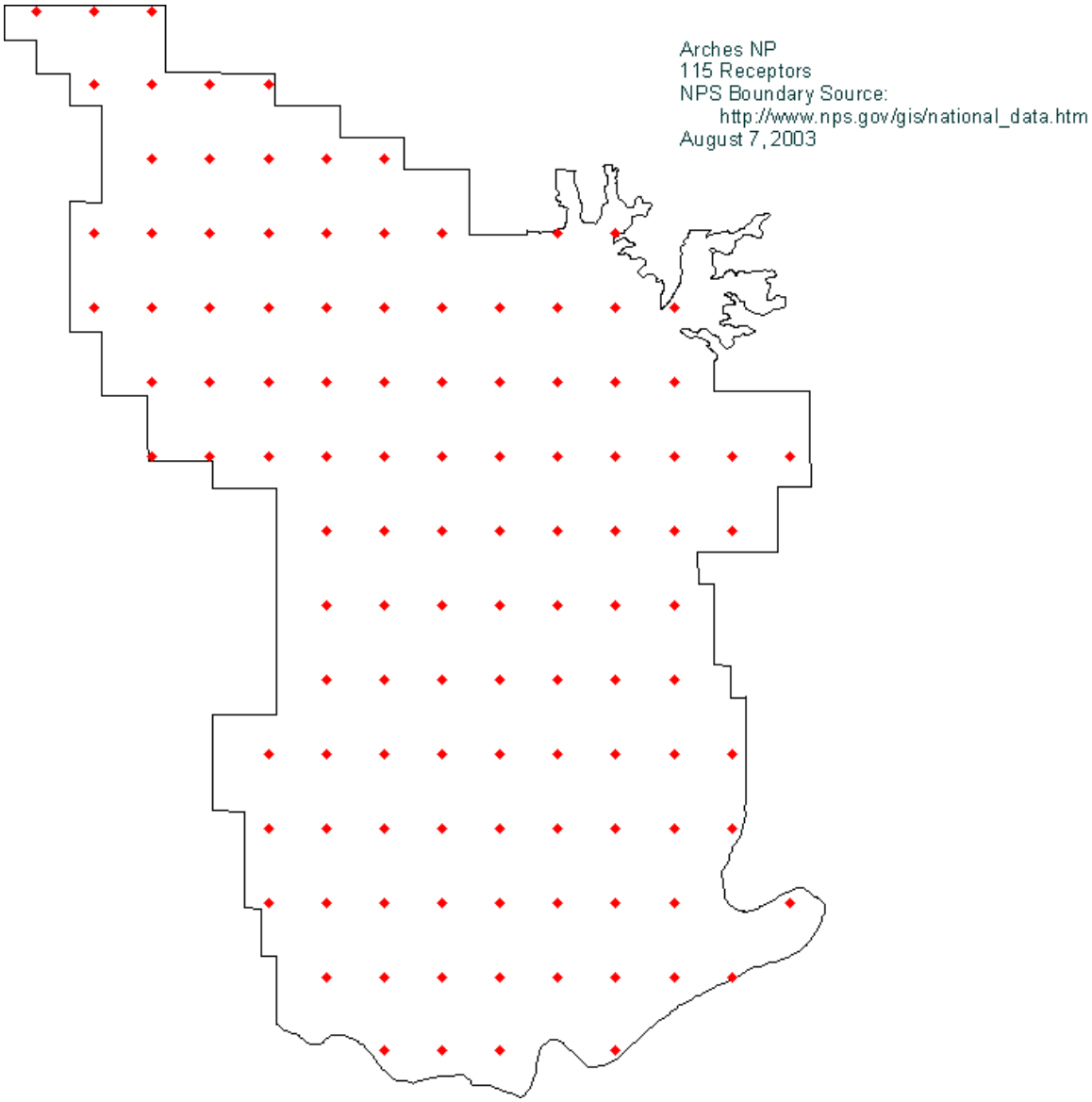
Variable	Description	PNM Value	Default	Comments
	exceeds a minimum value			
ROLDMAX	Split is allowed only if ratio of last hour's mixing ht to the maximum mixing ht experienced by the puff is less than a maximum value	0.25	Y	Puff Splitting not enabled
NSPLITH	Number of puffs that result every time a puff is split	5	Y	Puff Splitting not enabled
SYSPLITH	Minimum sigma-y of puff before it may be split	1	Y	Puff Splitting not enabled
SHSPLITH	Minimum puff elongation rate due to wind shear, before it may be split	2	Y	Puff Splitting not enabled
CNSPLITH	Minimum concentration of each species in puff before it may be split	1E-7	Y	Puff Splitting not enabled
EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	1E-4	Y	
EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-6	Y	
DSRISE	Trajectory step-length (m) used for numerical rise integration	1	Y	
HTMINBC	Minimum height (m) to which BC puffs are mixed as they are emitted. Actual height is reset to the current mixing height at the release point if greater than this minimum	500	Y	
RSAMPBC	Search radius (in BC segment lengths) about a receptor for sampling nearest BC puff. BC puffs are emitted with a spacing of one segment length, so the search radius should be greater than 1	10	Y	
MDEPBC	Near-surface depletion adjustment to concentration profile used when sampling BC puffs?	1	Y	Adjust concentration for depletion
INPUT GROUP 13: Point source parameters				
NPT1	Number of point sources with parameters	-	n/a	See Table 2-2
IPTU	Units used for point source emissions	1	N	Grams/second
NSPT1	Number of source-species combinations with variable emissions scaling factors	0	Y	
NPT2	Number of point sources with	0	n/a	

CALPUFF Control File Inputs

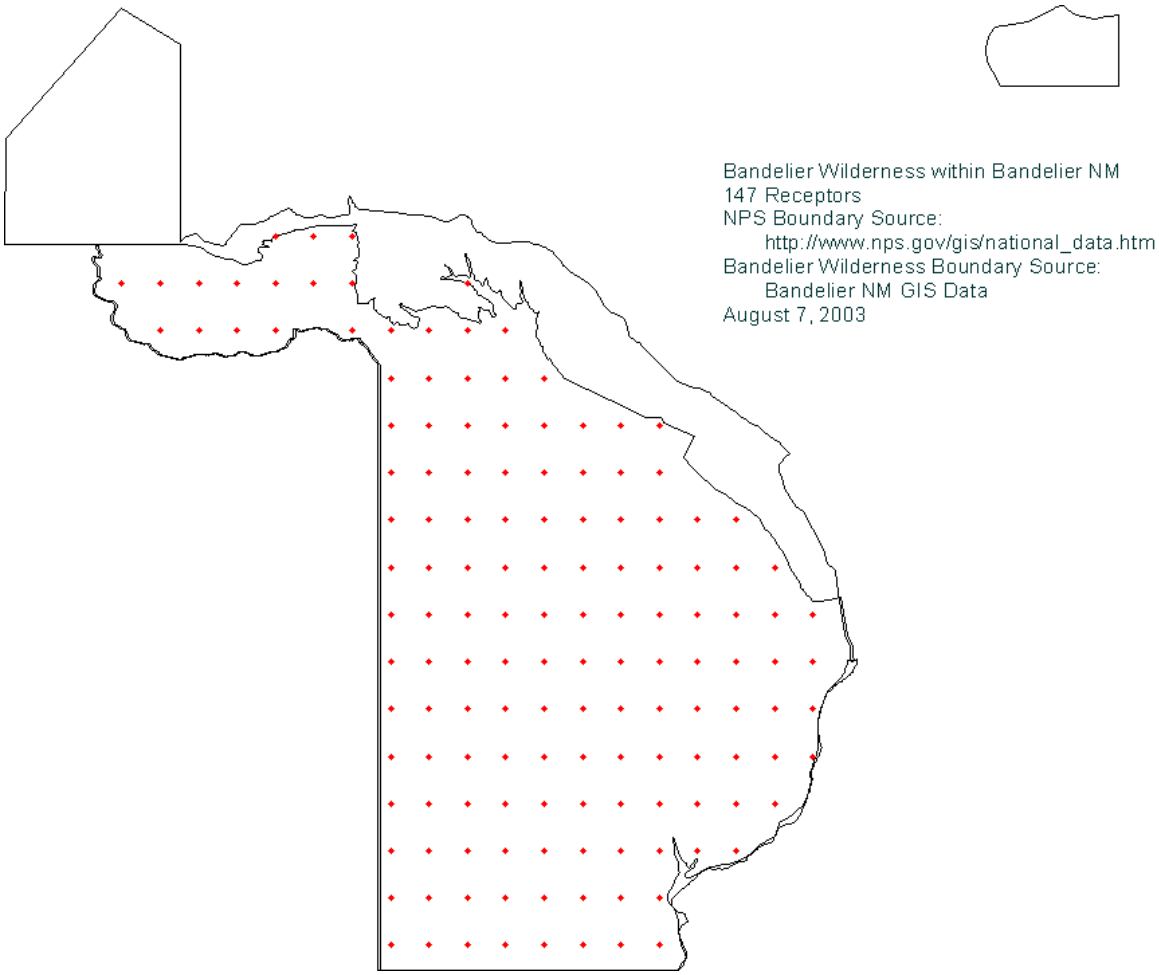
Variable	Description	PNM Value	Default	Comments
	variable emission parameters provided in external file			
INPUT GROUP 14: Area source parameters – Not used				
INPUT GROUP 15: Line source parameters – Not used				
INPUT GROUP 16: Volume source parameters – Not used				
INPUT GROUP 17: Non-gridded (discrete) receptor information				
NREC	Number of non-gridded receptors	4,358	n/a	Arches 115 Bandelier 147 Black Canyon of the Gunnison 94 Canyonlands 506 Capitol Reef 363 Grand Canyon 351 Great Sand Dunes 195 La Garita 187 Maroon Bells Snowmass 262 Mesa Verde 312 Pecos 321 Petrified Forest 144 San Pedro Parks 247 West Elk 261 Weminuche 744 Wheeler Peak 109

Appendix D
National Park Service Receptors

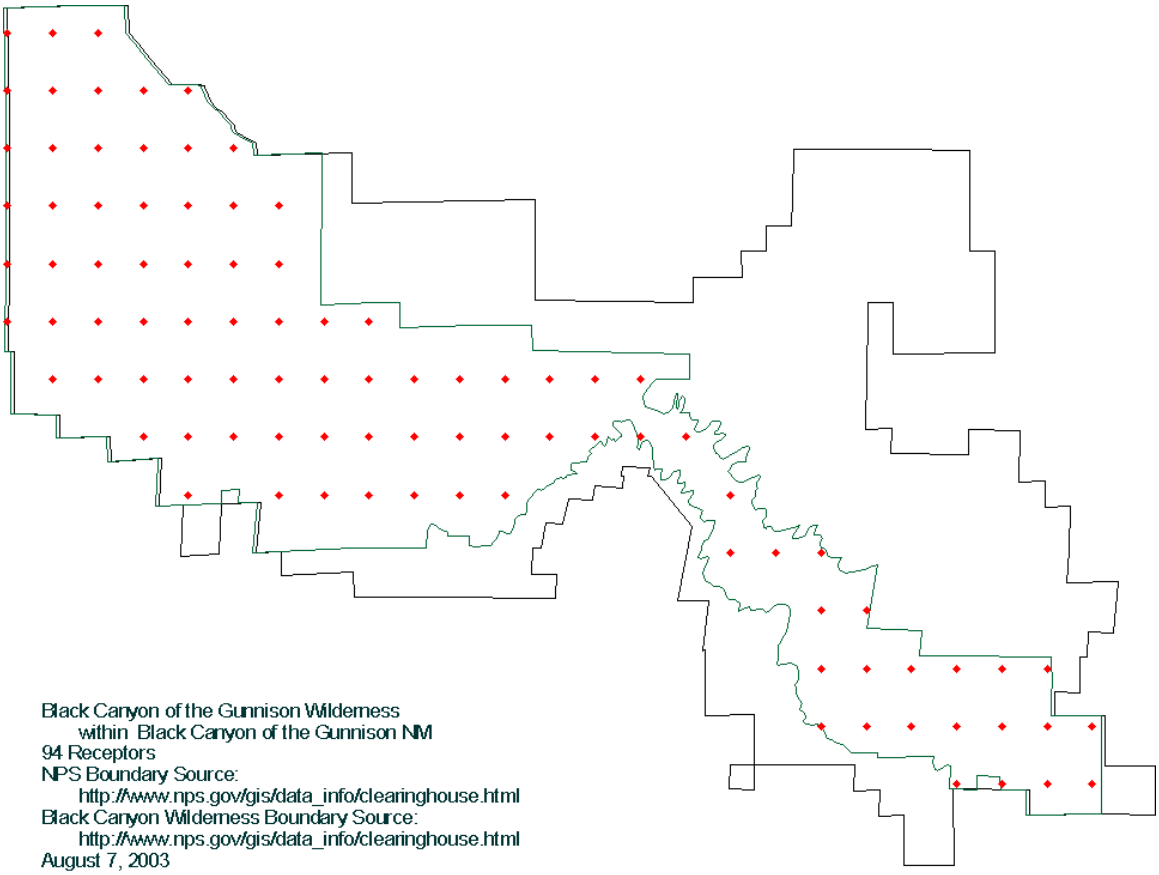
National Park Service Receptors



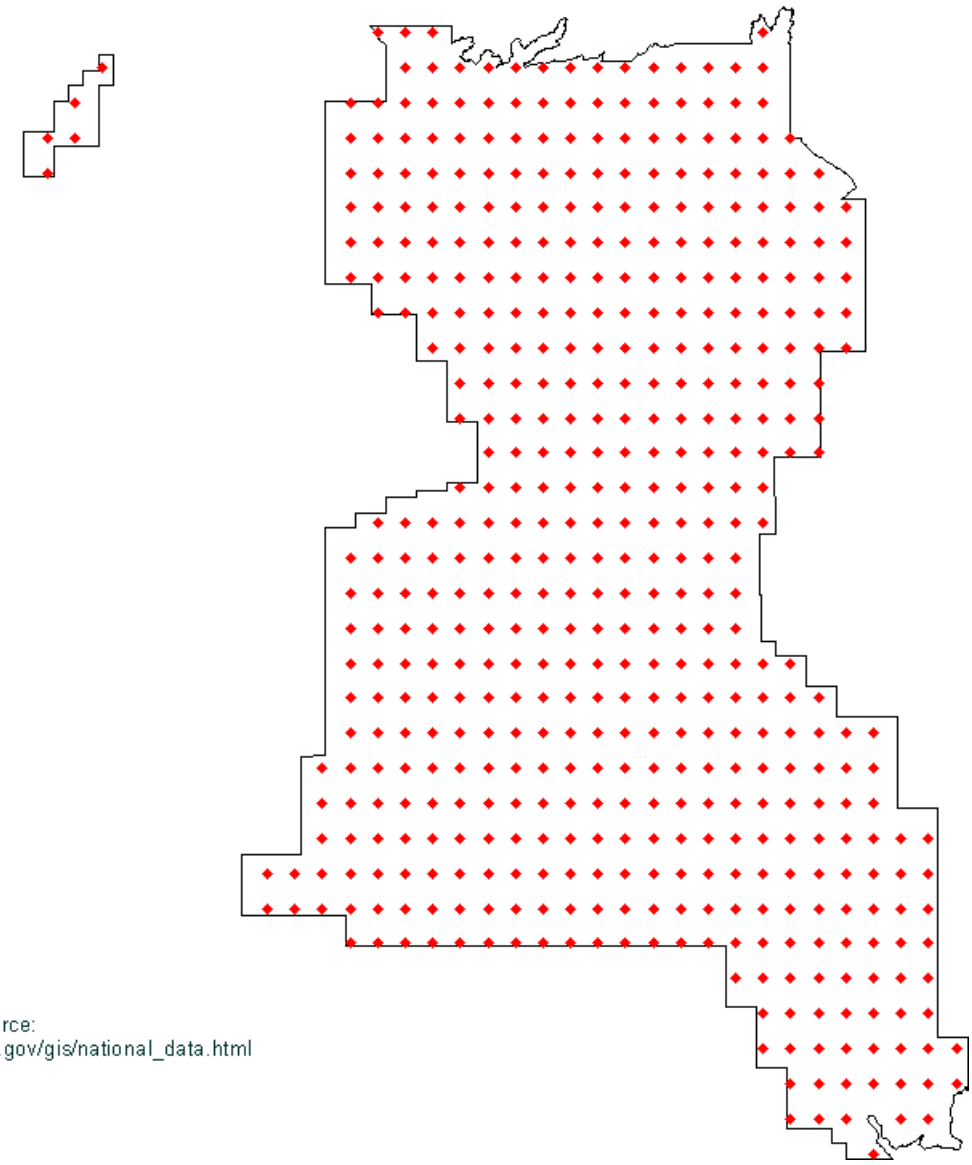
National Park Service Receptors



National Park Service Receptors

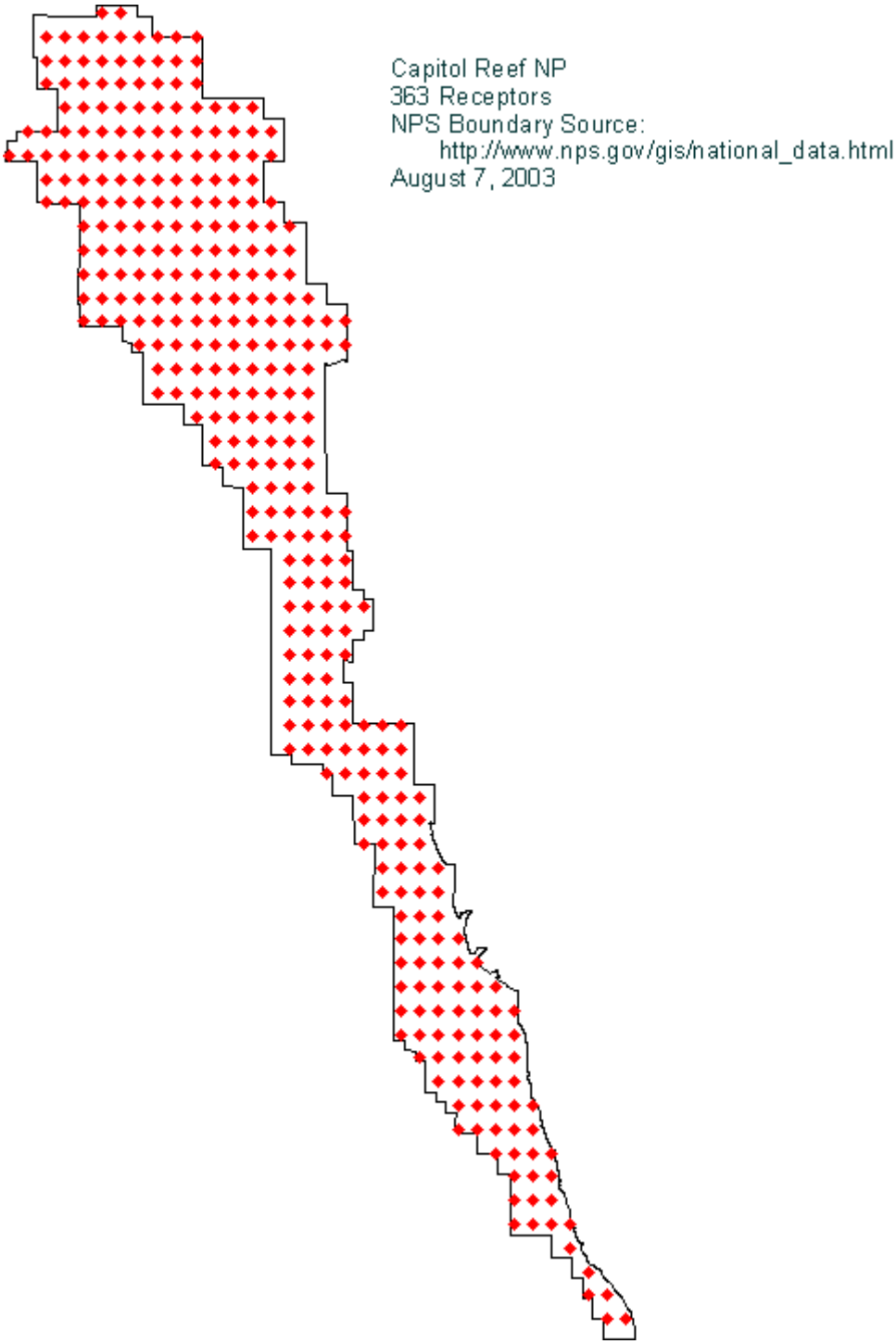


National Park Service Receptors



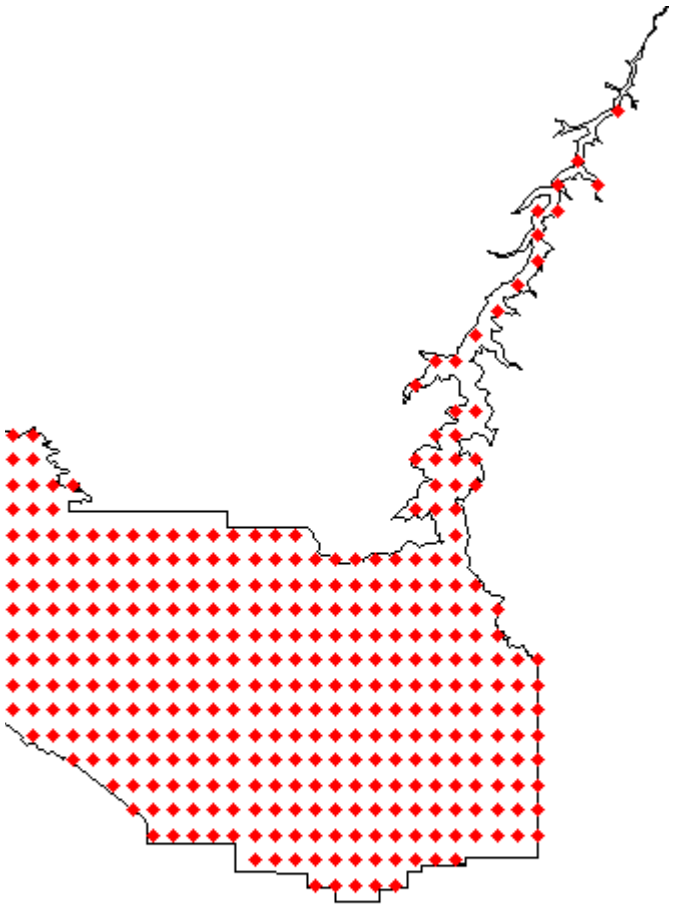
Canyonlands NP
506 Receptors
NPS Boundary Source:
http://www.nps.gov/gis/national_data.html
August 7 , 2003

National Park Service Receptors

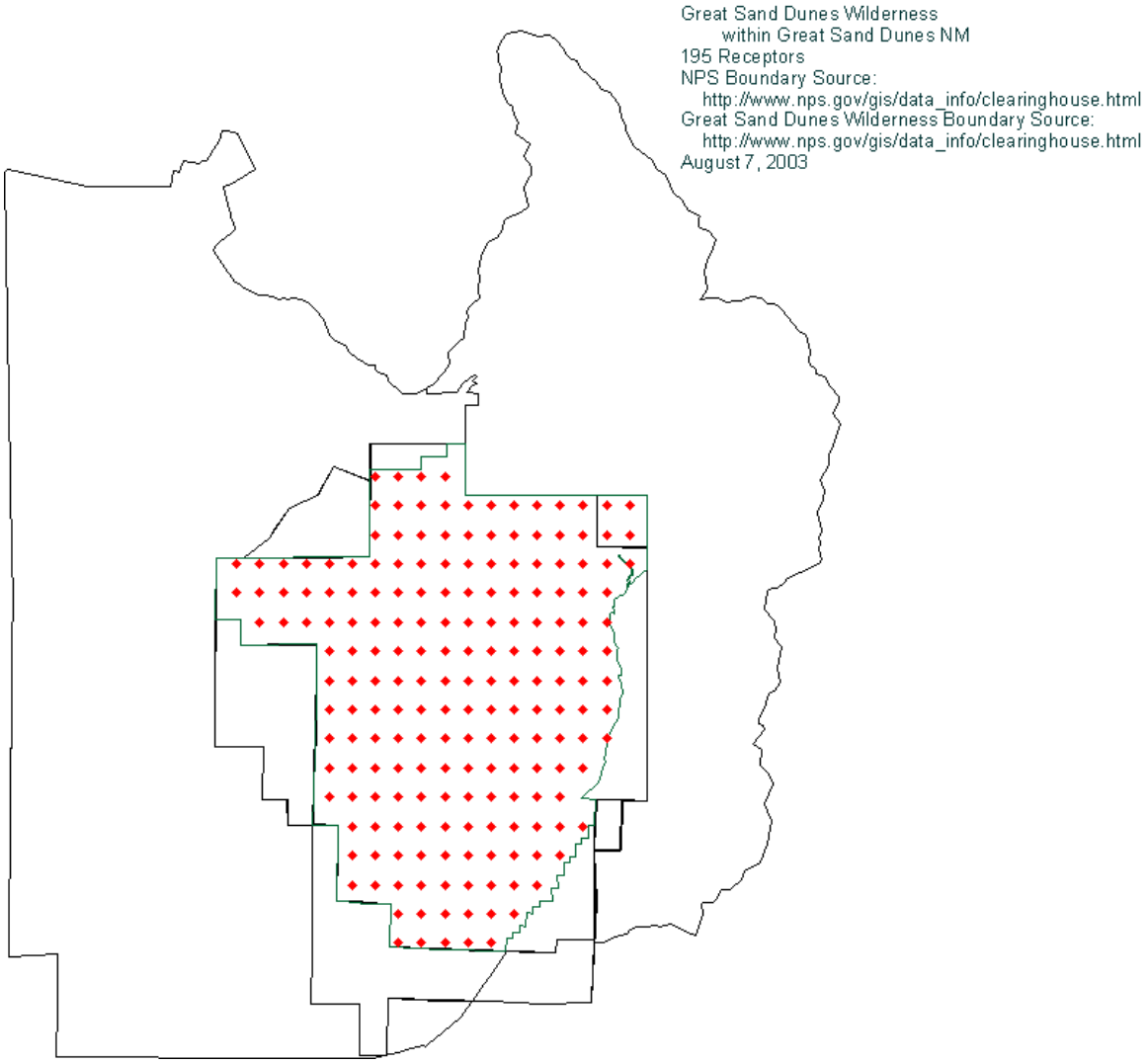


National Park Service Receptors

Grand Canyon NP
351 Receptors
NPS Boundary Source:
http://www.nps.gov/gis/national_data.html
August 7, 2003 Editted based on date from WRAP RMC



National Park Service Receptors

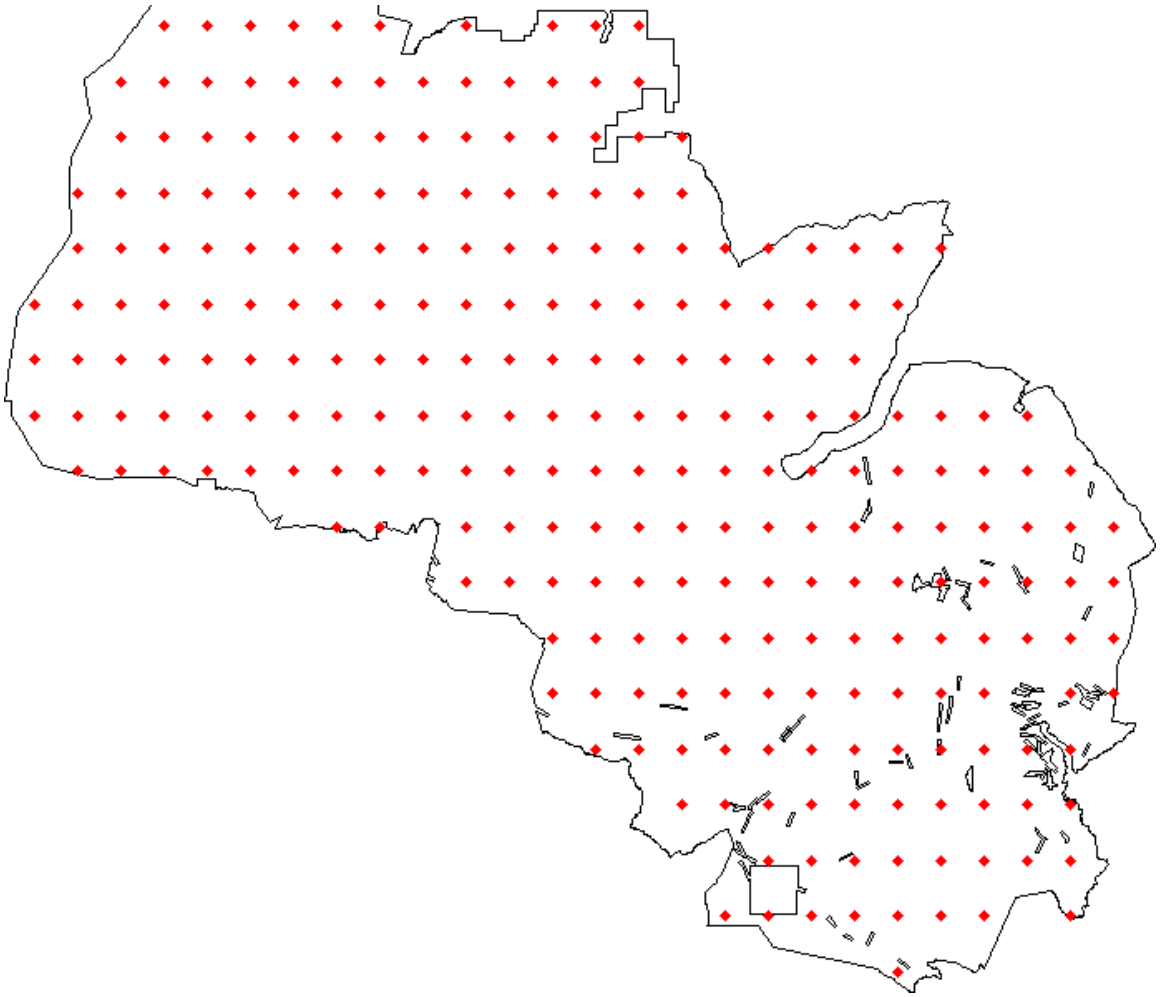


National Park Service Receptors

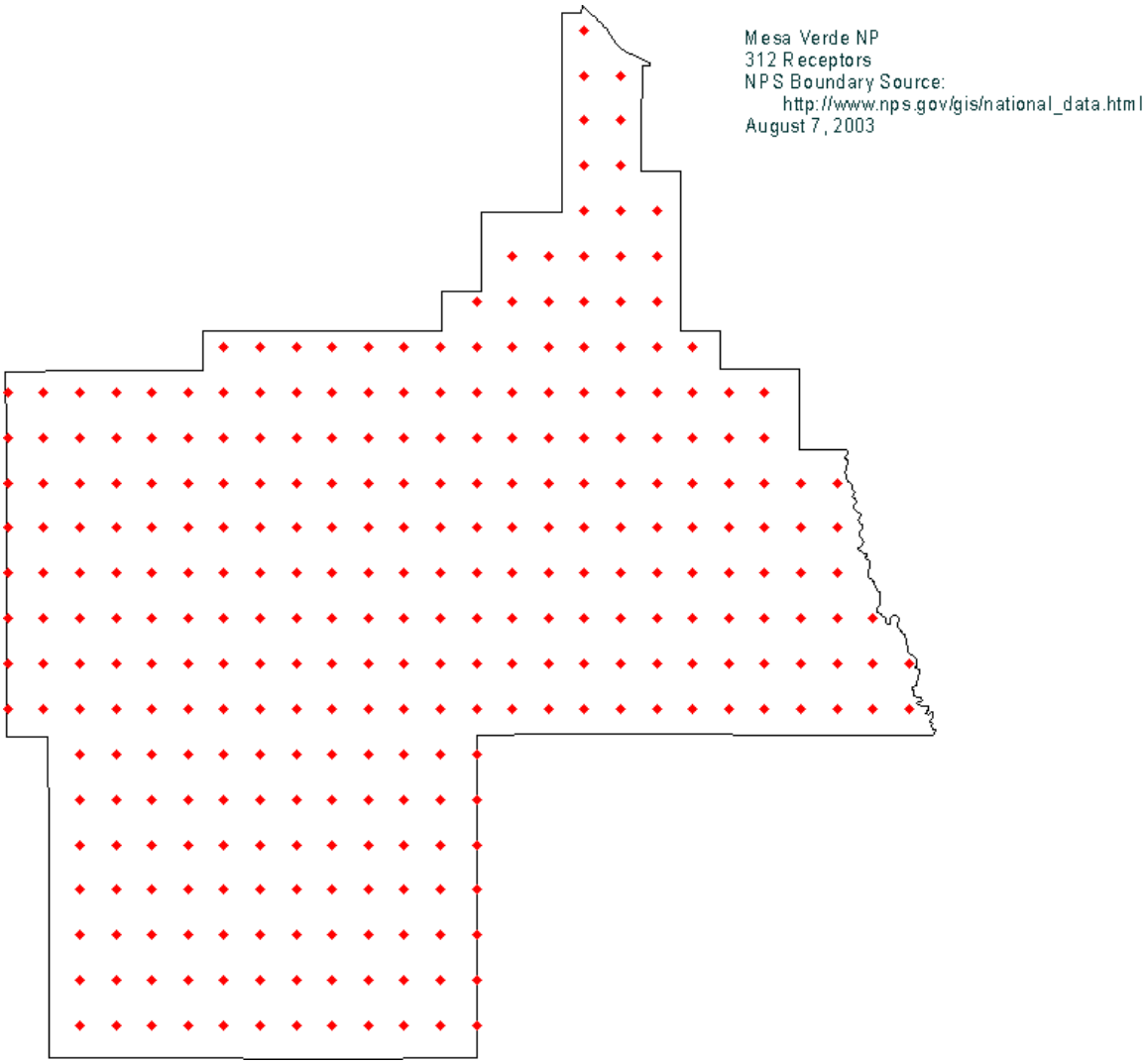
National Park Service Receptors

Maroon Bells-Snowmass Wilderness
262 Receptors
USFS Boundary Source:
FS National Coverage file:
NRIS - ALP group
Corvallis, OR
August 20, 2003

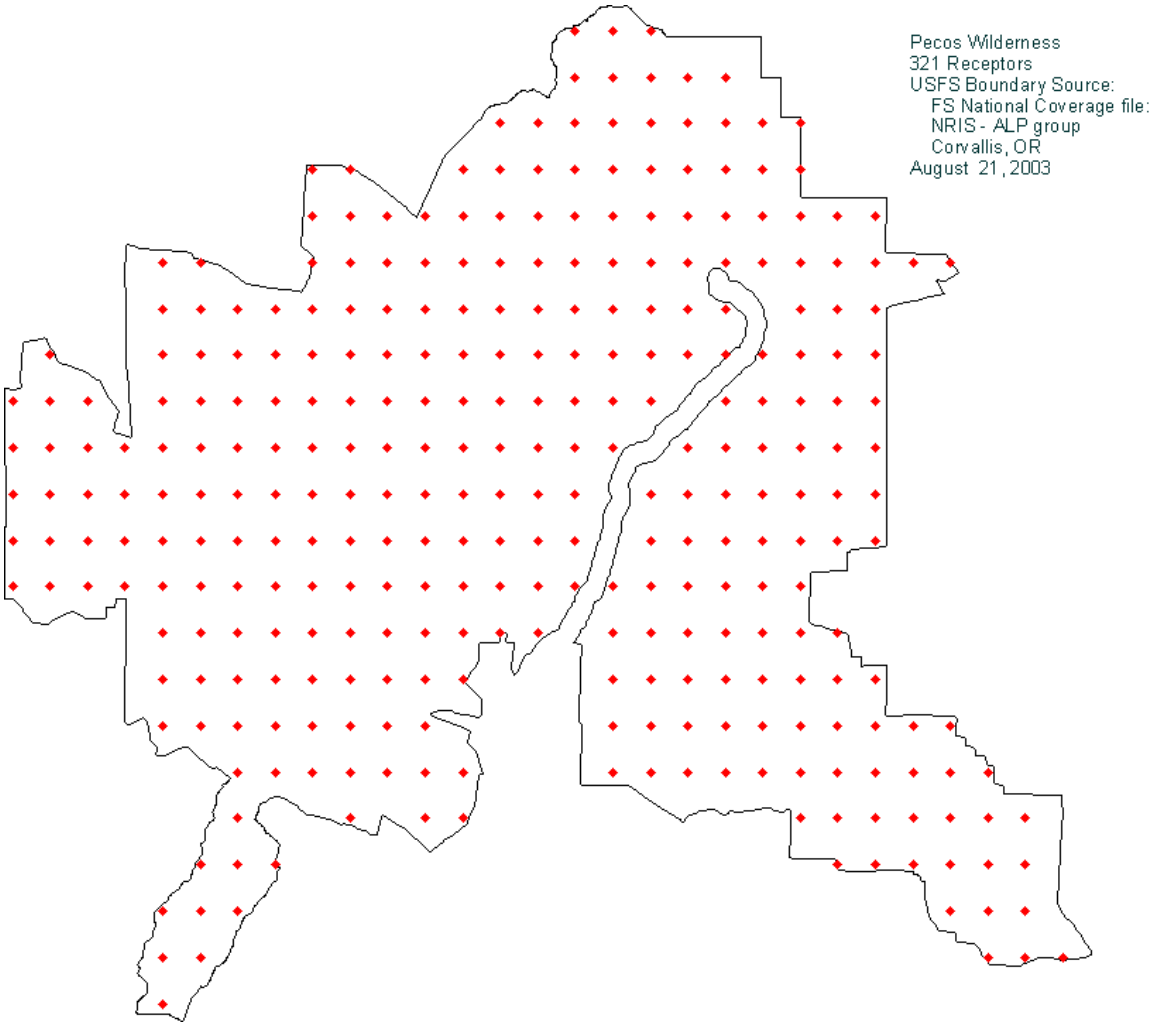
Editted based on data from WRAP RMC



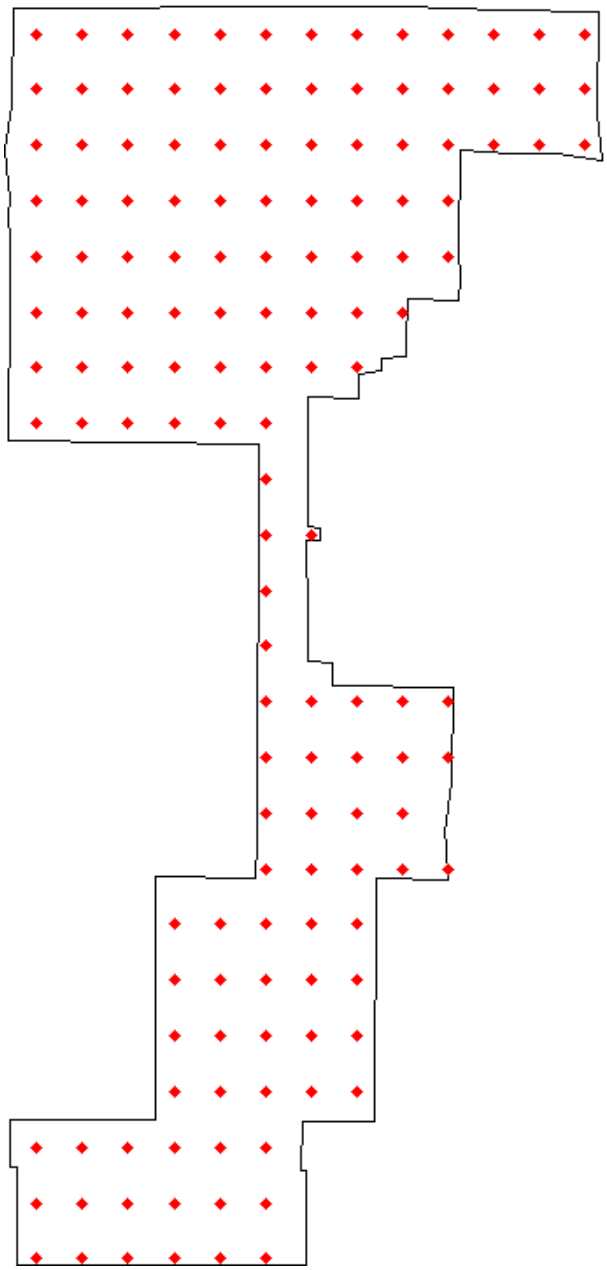
National Park Service Receptors



National Park Service Receptors

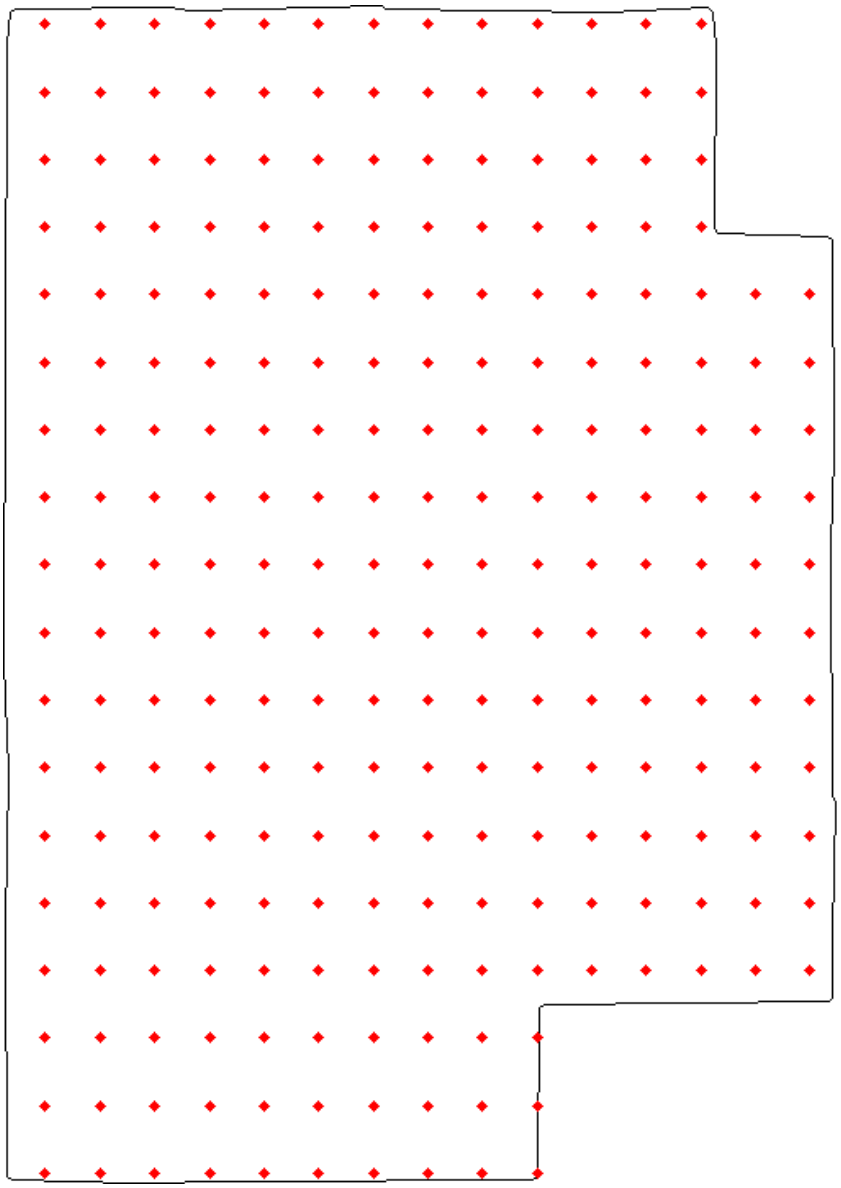


National Park Service Receptors



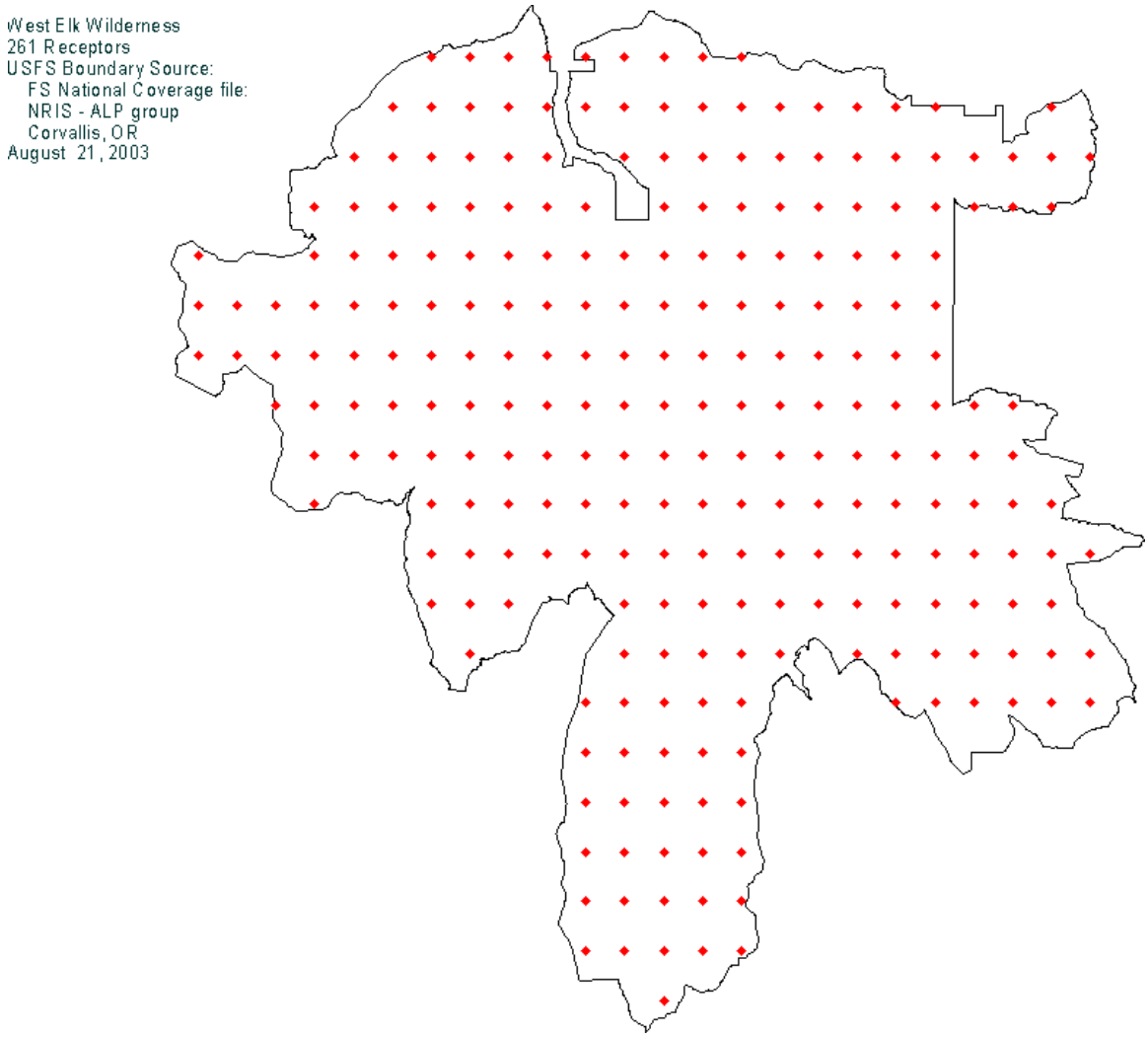
Petrified Forest NP
144 Receptors
NPS Boundary Source:
http://www.nps.gov/gis/national_data.html
August 7, 2003

National Park Service Receptors

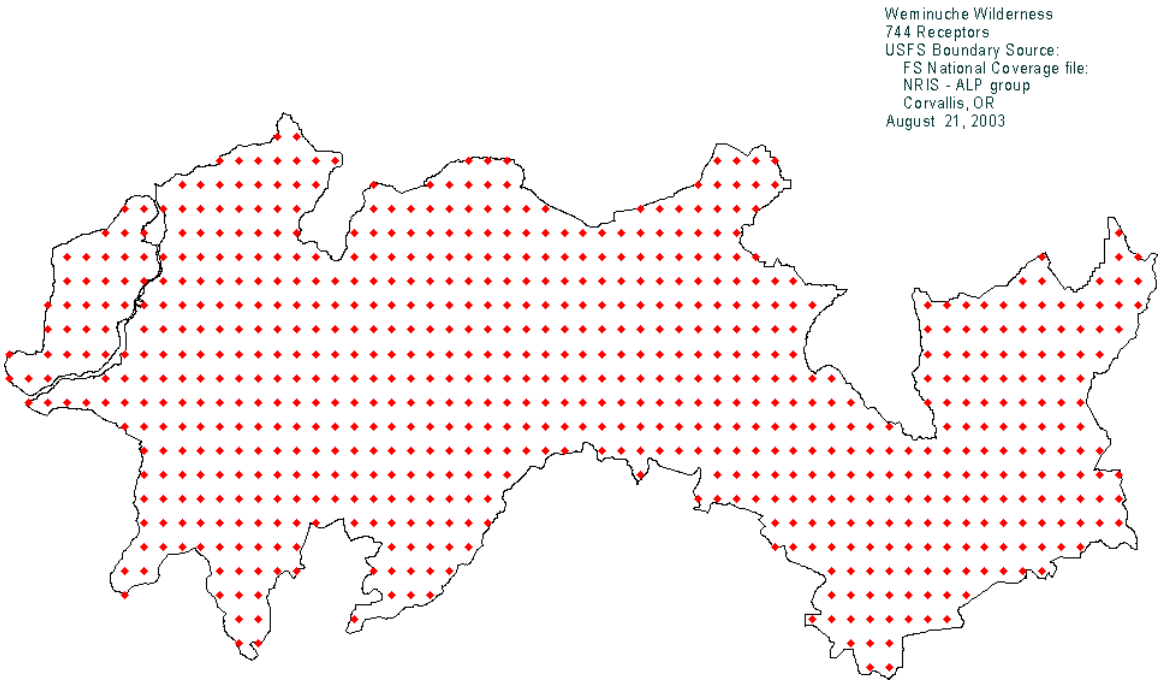


San Pedro Parks Wilderness
247 Receptors
USFS Boundary Source:
FS National Coverage file:
NRIS - ALP group
Corvallis, OR
August 21, 2003

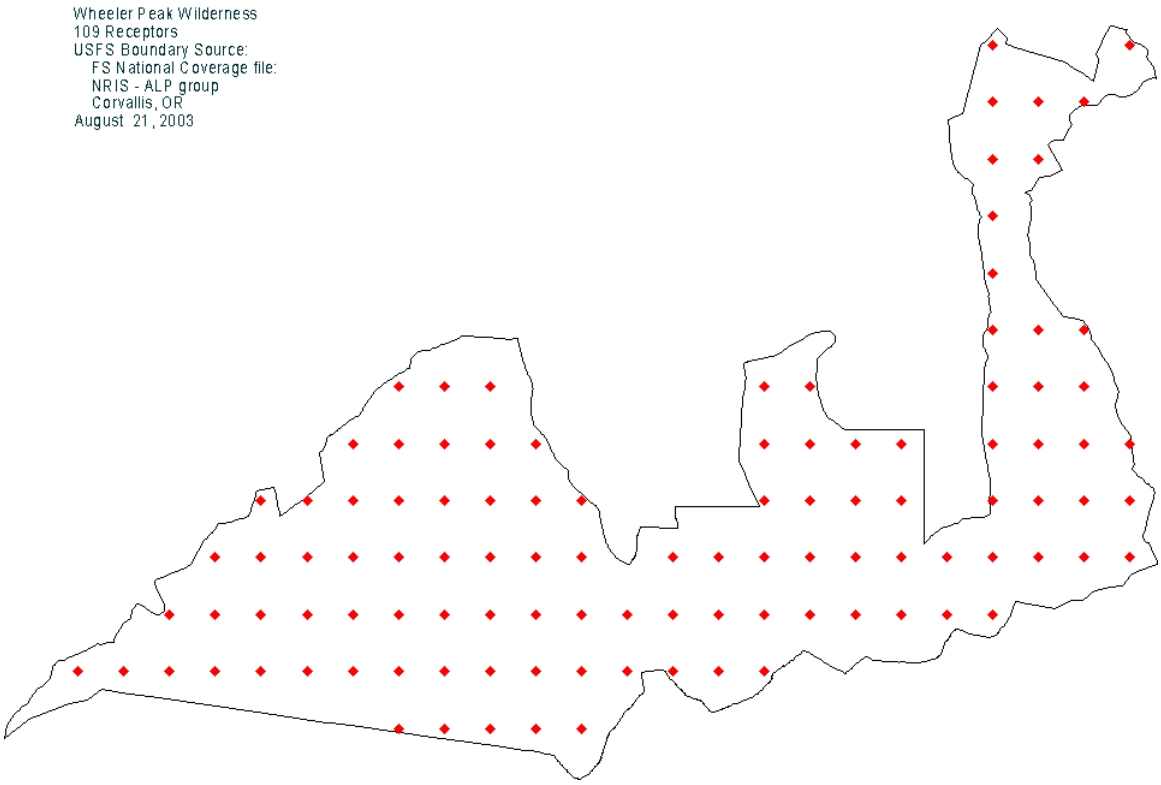
National Park Service Receptors



National Park Service Receptors



National Park Service Receptors



Appendix E
POSTUTIL Control File Inputs

POSTUTIL Control File Inputs

Variable	Description	Value	Default	Comments
INPUT GROUP 1: General run control parameters				
ISYR	Starting Year	2001	n/a	2002 and 2003 also modeled
ISMO	Starting month	1	n/a	
IDY	Starting day	1	n/a	
ISHR	Starting hour	1	n/a	
NPER	Number of periods to process	8736	n/a	2002=8736 hrs 2003=8736hrs
NSPECINP	Number of species to process from CALPUFF runs	11	n/a	See list below
NSPECOUT	Number of species to write to output file	9	n/a	See list below
NSPECCMP	Number of species to compute from those modeled	4	n/a	
MDUPLCT	Stop run if duplicate species names found?	0	Y	
NSCALED	Number of CALPUFF data files that will be scaled	0	Y	
MNITRATE	Re-compute the HNO3/NO3 partition for concentrations?	0	N	Not Used
BCKNH3	Default ammonia concentrations used for HNO3/NO3 partition	-	N	12*1
INPUT GROUP 2: Species processing information				
ASPECI	NSPECINP species will be processed	-	n/a	SO2 SO4 NOX HNO3 NO3 PM8.00 PM4.25 PM1.88 PM1.25 PM0.813 PM0.625
ASPECO	NSPECOUT species will be written	-	n/a	SO2 SO4 NOX HNO3 NO3 PMC PMF (or SOIL) EC SOA

Appendix F
CALPOST Control File Inputs

CALPOST Control File Inputs

Variable	Description	Value	Default	Comments
INPUT GROUP 1: General run control parameters				
METRUN	Option to run all periods found in met files	1	Y	Run all periods in CALPUFF data file
ISYR	Starting Year	2001	n/a	2002 and 2003 also modeled
ISMO	Starting month	0	n/a	METRUN= 1; not used
IDY	Starting day	0	n/a	METRUN= 1; not used
ISHR	Starting hour	0	n/a	METRUN= 1; not used
NHRS	Number of hours to process	0	n/a	METRUN= 1; not used
NREP	Process every hour of data?	1	Y	Every hour processed
ASPEC	Species to process	VISIB	n/a	Visibility processing
ILAYER	Layer/deposition code	1	Y	CALPUFF concentrations
A, B	Scaling factors X(new) = X(old) *A + B	0, 0	Y	
LBACK	Add hourly background concentrations/fluxes?	F	Y	
LG LD	Gridded receptors processed? Discrete receptors processed?	F T	Y N	Discrete receptors located only in the Class I areas assessed and are from NPS.
LCT	CTSG Complex terrain receptors processed?	F	Y	
LDRING	Report results by DISCRETE receptor RING?	F	Y	
NDRECP	Flag for all receptors after the last one assigned is set to “0”	-1	Y	As appropriate for Class I area being analyzed
IBGRID JBGRID IEGRID JEGRID	Range of gridded receptors	-1 -1 -1 -1	Y	When LG = T Entire grid processed if all =-1
NGONOFF	Number of gridded receptor rows provided to identify specific gridded receptors to process	0	Y	
RHMAX	Maximum relative humidity (%) used in particle growth curve	-	N	Not used for Method 6.
LVSO4 LVNO3 LVOC LVPMC LVPMF LVEC	Modeled species to be included in computing light extinction	T T T T T T	Y Y N Y Y N	
LVBK	Include BACKGROUND when ranking for TOP-N, TOP-50, and exceedence tables?	T	Y	
SPECPMC SPECPMF	Species name used for particulates in MODEL.DAT file	PMC SOIL	Y Y	SPECPMC = PMC SPECPMF = SOIL
EEPMC EEPMF	Modeled particulate species	0.6 1.0	Y Y	
EEPMCBK	Background particulate species	0.6	Y	
EESO4 EENO3	Other species	3.0 3.0	Y Y	

CALPOST Control File Inputs

Variable	Description	Value	Default	Comments
EEOC EESOIL EEEC		4.0 1.0 10	Y Y Y	
LAVER	Background extinction computation	F	Y	
MVISBK	Method used for background light extinction	6	N	WRAP BART Modeling Protocol Recommended Value. Compute extinction from speciated PM measurements. FLAG RH adjustment factor applied to observed and modeled sulfate and nitrate
RHFAC	Extinction coefficients for hygroscopic species (modeled and background). Monthly RH adjustment factors	-	n/a	See Table 4-1 in this document
BKSO4 BKNO3 BKPMC BKOC BKSOIL BKEC	Monthly concentrations of ammonium sulfate, ammonium nitrate, coarse particulates, organic carbon, soil and elemental carbon to compute background extinction coefficients	-	n/a	See Table 4-2 in this document
BEXTRAY	Extinction due to Rayleigh scattering (1/Mm)	10	Y	
IPRTU	Units for all output	1	Y	grams/cubic meter
L24HR	Averaging time reported	T	n/a	
LTOPN	Visibility: Top "N" table for each averaging time selected.	T	Y	
NTOP	Number of 'Top-N' values at each receptor selected (NTOP must be <=4)	4	Y	