

PacifiCorp Naughton Power Plant – SO₂ Modeling Assessment Report, Rev. 1

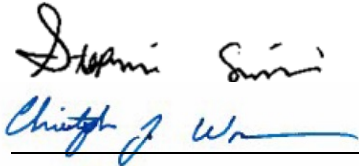
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1. Introduction

1.1 Overview of the SO₂ Data Requirements Rule

In August 2015, the U.S. Environmental Protection Agency (EPA) issued the SO₂ Data Requirements Rule¹ (DRR), which directs state and tribal air agencies in “an orderly process” to identify maximum ambient air 1-hour SO₂ concentrations in areas with large sources of SO₂ emissions.

The purpose of the DRR is to identify large SO₂-emitting sources, generally those with annual emissions greater than 2,000 tons for the most recent year for which emissions data are available and to characterize SO₂ concentrations in the vicinity of these sources. The affected sources are those that have not been previously captured as part of the initial non-attainment area designations for the 1-hour SO₂ National Ambient Air Quality Standard (NAAQS) in August 2013 or with the sources identified by the March 2015 Consent Decree between the EPA and the Sierra Club and National Resources Defense Council.

The Wyoming Department of Environmental Quality (WDEQ) is consulting with the owners or operators of the DRR-identified sources in Wyoming to identify the means for determining whether the area surrounding each identified source is in attainment with the SO₂ NAAQS for area designation purposes. One of these identified sources is the Naughton Power Plant located near Kemmerer, Wyoming. The Naughton facility is owned and operated by PacifiCorp.

According to the DRR, the method of characterizing the SO₂ concentrations around each source can be done by either:

- 1) installing and operating an ambient air monitoring network; or
- 2) performing an air dispersion modeling study to characterize the SO₂ concentration pattern in areas beyond the secured industrial boundary where monitors could be placed.

Alternatively, instead of a source characterization, each identified source can modify its air operating permit prior to January 13, 2017 such that the DRR-identified source either:

- 3) limits annual SO₂ emissions to less than 2,000 tons, or
- 4) limits short-term (1-hour) and/or longer-term (up to 30-day average) SO₂ emissions that, based on the results of an air dispersion modeling study, demonstrate that the area surrounding the source is in attainment with the SO₂ NAAQS, allowing the state air agency to provide a recommendation for a designation of attainment with the NAAQS.

The WDEQ and PacifiCorp have determined that the SO₂ characterization will be conducted with method 1 noted above, with the use of monitoring. However, due to nearby industrial areas where WDEQ indicates that monitoring is infeasible, WDEQ has asked for a modeling characterization in these non-industrial areas that are accessible to the general public for supplemental information. This document addresses the WDEQ request, and describes the air quality modeling procedures and results of an air dispersion modeling demonstration that was performed for the 1-hour NAAQS for SO₂.

In preparation for this modeling analysis, a draft dispersion modeling protocol for Naughton was submitted to WDEQ and EPA Region 8 dated February, 2016. WDEQ and EPA Region 8 provided written comments on the draft modeling protocol on June 28, 2016. Comments were addressed in a subsequent revised draft dispersion modeling protocol for Naughton submitted to WDEQ and EPA Region 8 on October 6, 2016.

The current version of the TAD references other EPA modeling guidance documents, including the following clarification memos (1) the August 23, 2010 “Applicability of Appendix W Modeling Guidance for the 1-hour SO₂ NAAQS” and (2) the March 1, 2011 “Additional Clarification Regarding Application W Modeling Guidance for the 1-hour NO₂ National Ambient Air Quality Standard” (hereafter referred to as the “additional clarification memo”). In the

¹ Docket ID No. EPA-HQ-OAR-2013-0711, August 10, 2015.
http://www.epa.gov/oagps001/sulfurdioxide/pdfs/so2_drr_final_081215.pdf.

March 1, 2011 clarification memo, EPA declares that the memo applies equally to the 1-hour SO₂ NAAQS even though it was prepared primarily for the 1-hour NO₂ NAAQS.

1.2 Report Organization

This report consists of five sections. **Section 1** provides this introductory discussion. **Section 2** provides a description of the PacifiCorp Naughton facility. That section also includes a topographic map centered at the source, and tables of emission points (and stack parameters). **Section 3** provides the general modeling approach and technical options used. **Section 4** discusses the model configuration, including model domain, nearby sources, receptors, ambient background, and meteorological data. **Section 5** discusses the procedures that were used to characterize SO₂ concentrations in the vicinity of the Naughton plant and the modeling results.

2. Description of PacifiCorp's Naughton Facility

PacifiCorp's Naughton Power Plant is located about 4 miles southwest of Kemmerer, Wyoming in Lincoln County. Naughton has three existing coal-fired boilers and based on the current stack configuration, Boilers 1 and 2 exhaust through a combined 476-foot stack. Boiler 3 exhausts through a dedicated 475-foot stack. For the combined flues, the modeling was conducted with a single merged stack, consistent with EPA precedent established with Model Clearinghouse Memo 91-II-01.²

The location of the plant is shown in **Figure 2-1**. A topographic map of the area surrounding Naughton is provided in **Figure 2-2**. As shown in **Figure 2-2**, there is "complex" terrain (with elevations above stack top) within 10 kilometers of the plant. In addition, as shown in **Figures 2-1** and **2-2**, the area in the immediate vicinity (i.e., within 3 km) of Naughton can be characterized as having a rural land use type.

The modeling was performed with the actual stack heights in accordance with recommendations in the DRR and TAD. **Table 2-1** shows the physical stack parameters that will be used in the modeling. The hourly exhaust flow rates, temperatures, and emission rates were based on the actual data available from the CEM systems. The emissions for modeling consist of actual hourly data for the most recent 36-months (December 2013 – November 2016).

The three coal-fired boilers are the major source of SO₂ emissions at Naughton. There are other small insignificant sources of SO₂ at Naughton; however, these sources are either emergency in nature and thus do not operate routinely or have very low actual SO₂ emissions. In either case, these small sources of SO₂ do not have an impact on the results of the 1-hour SO₂ modeling and are not included in the modeling consistent with guidance provided by EPA's March 1, 2011 Clarification Memo³. As such, the three coal-fired boilers are the only emission sources from the Naughton Power Plant that were included in the 1-hour SO₂ modeling.

Table 2-1: Naughton – Physical Stack Parameters⁽¹⁾

Unit	Description	Stack Base Elevation (feet msl)	Stack Height (feet)	Flue Diameter (feet)
Unit 1	Tangential Coal Fired Boiler	6932	476	24 (effective diameter of merged flues)
Unit 2	Tangential Coal Fired Boiler			
Unit 3	Tangential Coal Fired Boiler	6933	475	29

(1) Emission rates, exhaust temperature, and exhaust flow rate were based on hourly CEMs data.

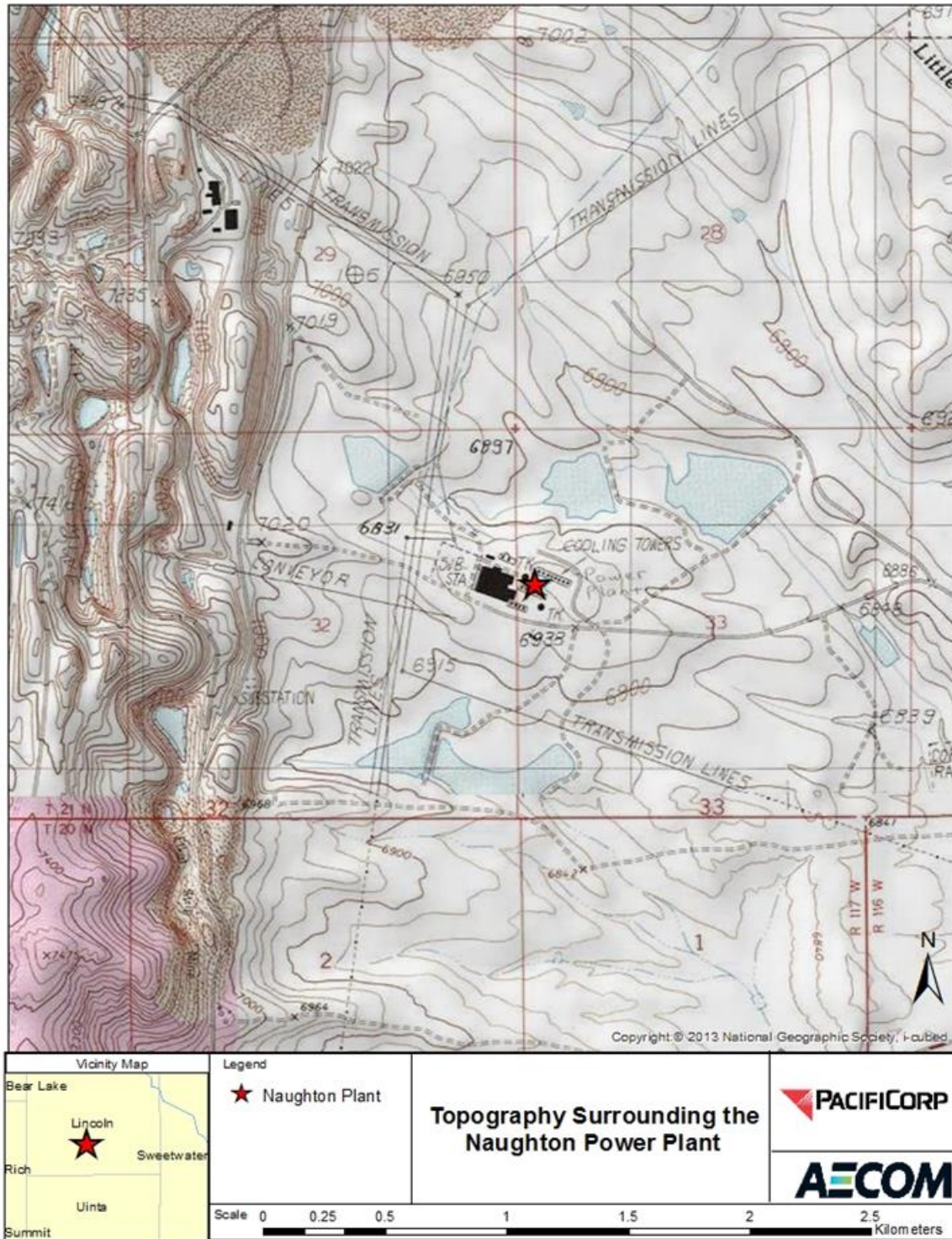
² Available at <http://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=91-II%20%20-01>.

³ Available at http://www3.epa.gov/scram001/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf.

Figure 2-1: Location of the Naughton Power Plant



Figure 2-2: Topography in the Vicinity of Naughton Power Plant



3. Dispersion Modeling Selection and Options

The EPA Guideline on Air Quality Models (Appendix W⁴) prescribes a set of approved models for regulatory applications for a wide range of source types and dispersion environments. Based on a review of the factors discussed below, the latest version⁵ of AERMOD (15181) was used in this modeling assessment for the PacifiCorp Naughton facility.

In a proposed rulemaking published in the July 29, 2015 Federal Register (80 FR 45340), the EPA released a revised version of AERMOD (15181), which replaced the previous version of AERMOD dated 14134. Modeling for the Naughton facility was conducted using AERMOD 15181 with default options.

Based on EPA guidance provided in the modeling Technical Assistance Document (TAD), all stacks were modeled with their actual physical stack height. In addition, EPA's Building Profile Input Program (BPIP-Version 04274) version that is appropriate for use with PRIME algorithms in AERMOD was used to incorporate downwash effects in the model for all modeled point sources. The building dimensions of nearby building structures were input to the BPIP/PRM program to determine direction-specific building data for input to AERMOD, as shown in **Figure 3-1**. BPIP input and output files are provided in the modeling archive attached to this report.

Consistent with the updated modeling TAD guidance for characterizing SO₂ concentrations due to existing emissions, actual hourly emission rates (as well as hourly stack temperature and exit velocity) from a recent 36-month period (December 2013- November 2016) were used.

For the WDEQ-requested modeling analysis, the areas to consider for receptor placement are those areas that are outside of industrial facilities, within which WDEQ considers that monitoring is not feasible due to access limitations and interferences by industrial equipment and processes. Therefore, for this Naughton Power Plant SO₂ characterization modeling, receptors were included in all areas except for: a) inside the secured property of the power plant and over the adjacent Kemmerer mine property.

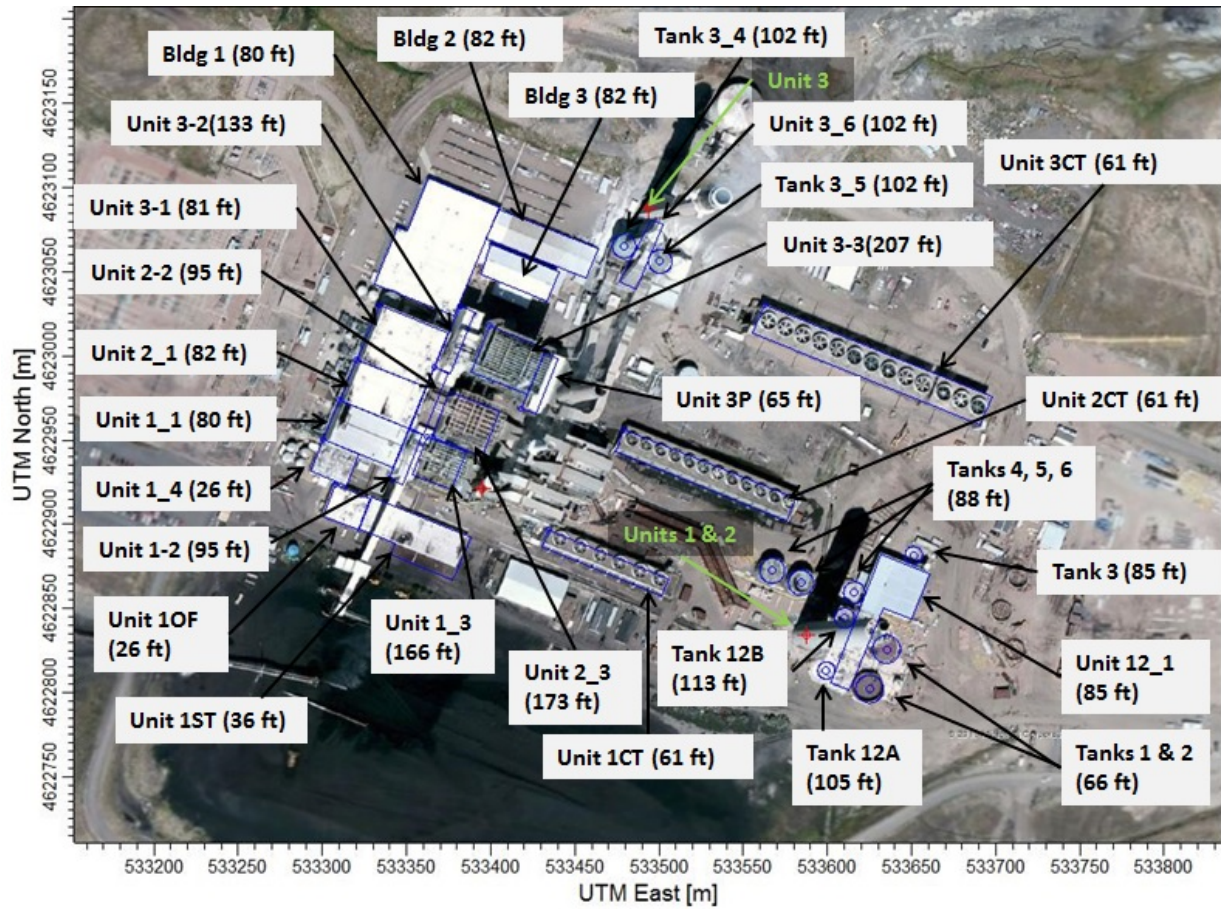
For this application, receptor spacing was consistent with WDEQ guidelines⁶ and features the most closely spaced receptors close to the Naughton facility.

⁴ Available at http://www3.epa.gov/ttn/scram/guidance/guide/appw_05.pdf.

⁵ As of December 20, 2016.

⁶ <http://deq.wyoming.gov/aqd/new-source-review/resources/guidance-documents/>.

Figure 3-1: Stacks and Buildings in the GEP Analysis for Naughton Power Plant



4. Modeling Configuration

4.1 Modeling Domain

The Naughton Power Plant is a relatively isolated facility with little to no industrial development nearby other than the Kemmerer Mine to the west of the facility. The modeling domain established was based on the area necessary to include all modeled sources (primary plus background) and all modeled receptor points. The modeling domain was set to 25 km, which is consistent with guidance from WDEQ⁷.

4.2 Receptor Grid

The modeling analysis was conducted using the following Cartesian receptor grid design.

- 5) 50-m receptor spacing along the ambient air boundary for the SO₂ characterization (includes boundaries of both Naughton facility and Kemmerer Mine).
- 6) 100-m receptor spacing extending out 1.8 kilometers from the grid center.
- 7) 250-m receptor spacing between 1.8 and 3.0 kilometers from the grid center.
- 8) 500-m receptor spacing between 3.0 and 10 kilometers from the grid center.
- 9) 1000-m receptor spacing beyond 10 kilometers (out to 25 km).

The receptor grid used in the modeling analysis can be seen in **Figures 4-1 and 4-2** for near-field and far-field views respectfully. It was based on Universal Transverse Mercator (UTM) coordinates referenced to NAD 83 datum and in zone 12. The receptor grid was centered at the approximate mid-point of the modeled facility based on WDEQ Guidance Document.

The latest version of AERMAP (version 15181), the AERMOD terrain preprocessor program, was used to calculate terrain elevations and critical hill heights for the modeled receptors at each of the project facilities using National Elevation Data (NED). The dataset was downloaded from the USGS website (<http://viewer.nationalmap.gov/viewer/>) and will consist of 1/3 arc second (~10 m resolution) NED. As per the AERMAP User's Guide, the domain was sufficient to ensure all significant nodes are included such that all terrain features exceeding a 10% elevation slope from any given receptor, are considered.

As discussed in Section 3 of the report, receptors were excluded from inside the secured property of the Naughton Power Plant and over the Kemmerer mine property, where active mining operations are occurring.

⁷ Wyoming Department of Environmental Quality/Air Quality Division Guidance for Submitting Major Source/PSD Modeling Analyses.

Figure 4-1: Near-Field Receptor Grid for Naughton Power Plant

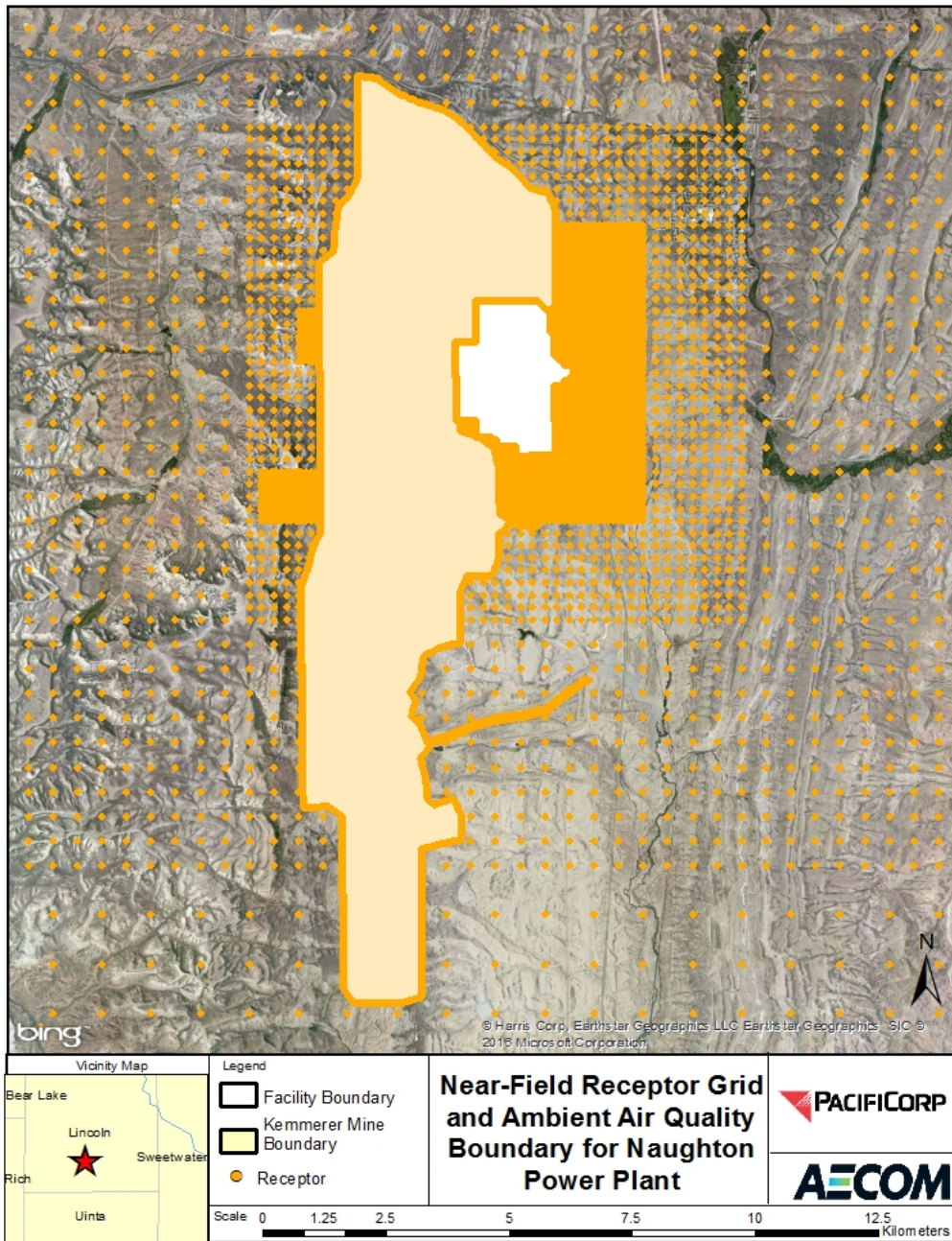
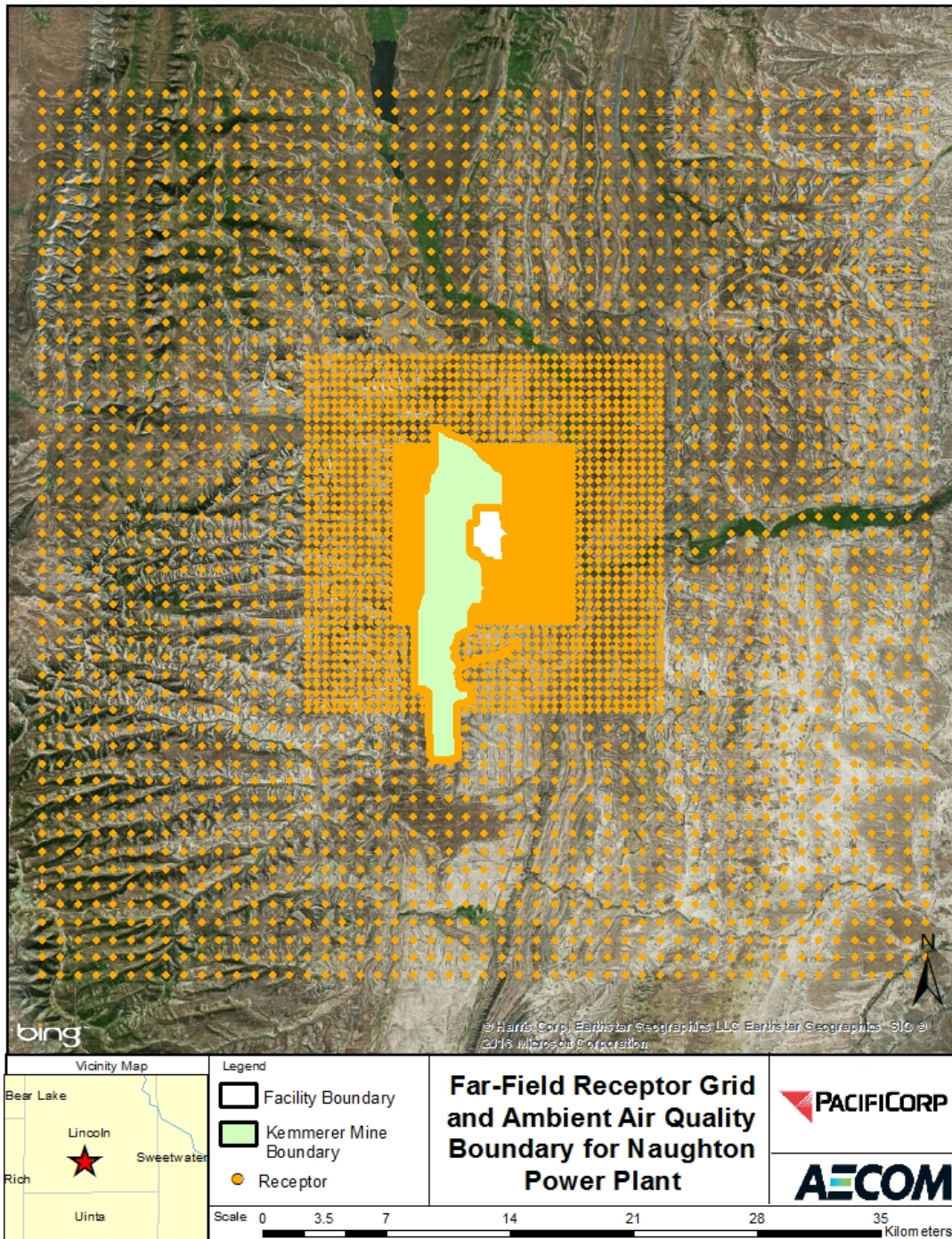


Figure 4-2: Far-Field Receptor Grid for Naughton Power Plant



4.3 Meteorological Data for Modeling

Meteorological data required for AERMOD include hourly values of wind speed, wind direction, and ambient temperature. Since the AERMOD dispersion algorithms are based on atmospheric boundary layer dispersion theory, additional boundary layer variables are derived by parameterization formulas, which are computed by the AERMOD meteorological preprocessor, AERMET. These parameters include sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient, convective and mechanical mixing heights, Monin-Obukhov length, surface roughness length, Bowen ratio, and albedo.

Onsite hourly meteorological data was available at Naughton for the 3-year period that was modeled. Concurrent upper-air data was obtained from the closest or most representative National Weather Service site, which was determined to be Salt Lake City, UT. Additional details are provided in the following sections.

4.3.1 Available Onsite Meteorological Data and Upper-Air Data

Due to the complex terrain in the vicinity of Naughton Power Station, use of on-site meteorological data is preferred when performing for air quality dispersion modeling studies. Three years of PSD-quality meteorological data was available from a 50-meter height instrumented tower located approximately 1.5 km east of Naughton (UTM 535081.2E, 4622993.9N, Zone 12) at a base elevation of 2,103 meters. Meteorological data were collected at 2-m, 10-m, and 50-m levels on the tower. Measurements were obtained for the three-year period from December 1, 2013 to November 30, 2016. Variables measured at the 10-m and 50-m levels on the tower used in the modeling included scalar wind speed (WS), wind direction (WD), the standard deviation of the wind direction ($\sigma_{\theta} = \sigma_{\theta}$), and the standard deviation of the vertical wind speed ($\sigma_w = \sigma_w$). The ambient temperature was measured at all three levels (2, 10, and 50 m). In addition, solar radiation sensors (total and net), relative humidity, and sea level pressure were reported at the tower site.

The hourly on-site meteorological data for Naughton was processed with the latest version of AERMET (Version 15181), the meteorological preprocessor for AERMOD. Specifically, AERMET was run utilizing three concurrent years (December 2013- November 2016) of hourly surface observations from the onsite meteorological tower along with concurrent upper air data from Salt Lake City, UT. Per guidance from WDEQ, the Bulk Richardson scheme was used to estimate heat fluxes within AERMET under stable conditions using the on-site data available at Naughton. **Figure 4-3** shows the location of the precipitation site (discussed later in Section 4.3.2.2) and upper-air station in relationship to Naughton. **Figure 4-4** shows the 50-m level wind rose for the Naughton on-site meteorology data from December 2013 – November 2016.

The upper air data input to AERMET was downloaded from the NOAA/ESRL/GSD - RAOB database (<http://esrl.noaa.gov/raobs/>).

Table 4-1 provides the site location and information for these data sets for the modeling of emissions from the Naughton Plant. **Table 4-2** provides the meteorological data capture percentages for Naughton. All quarters for the modeled period (December 2013- November 2016) had data capture statistics that were generally well above 90%.

Table 4-1: Meteorological Data for Use in AERMET for Naughton Plant

Met Site	Latitude	Longitude	Base Elevation (m)	Data Source	Data Format
Naughton Onsite Tower	41.758	-110.578	2103	On-site	MS Excel
Salt Lake City, UT	40.770	-111.970	1288	FSL	FSL

Table 4-2: Meteorological Data Capture Percentages Per Quarter for Onsite Met Data (December 2013 – November 2016)¹

Year	Q1	Q2	Q3	Q4
2013				98.1%
2014	99.3%	99.4%	99.2%	99.8%
2015	98.8%	98.0%	94.9%	99.8%
2016	99.6%	98.7%	97.7%	99.9%

¹ The percentage of hours available for modeling, as determined by AERMOD V. 15181. Note that Quarter 4 for 2013 consists of only December, and the Quarter 4 for 2016 consists of October and November.

Figure 4-3: Location of Meteorological Stations Relative to Naughton Plant

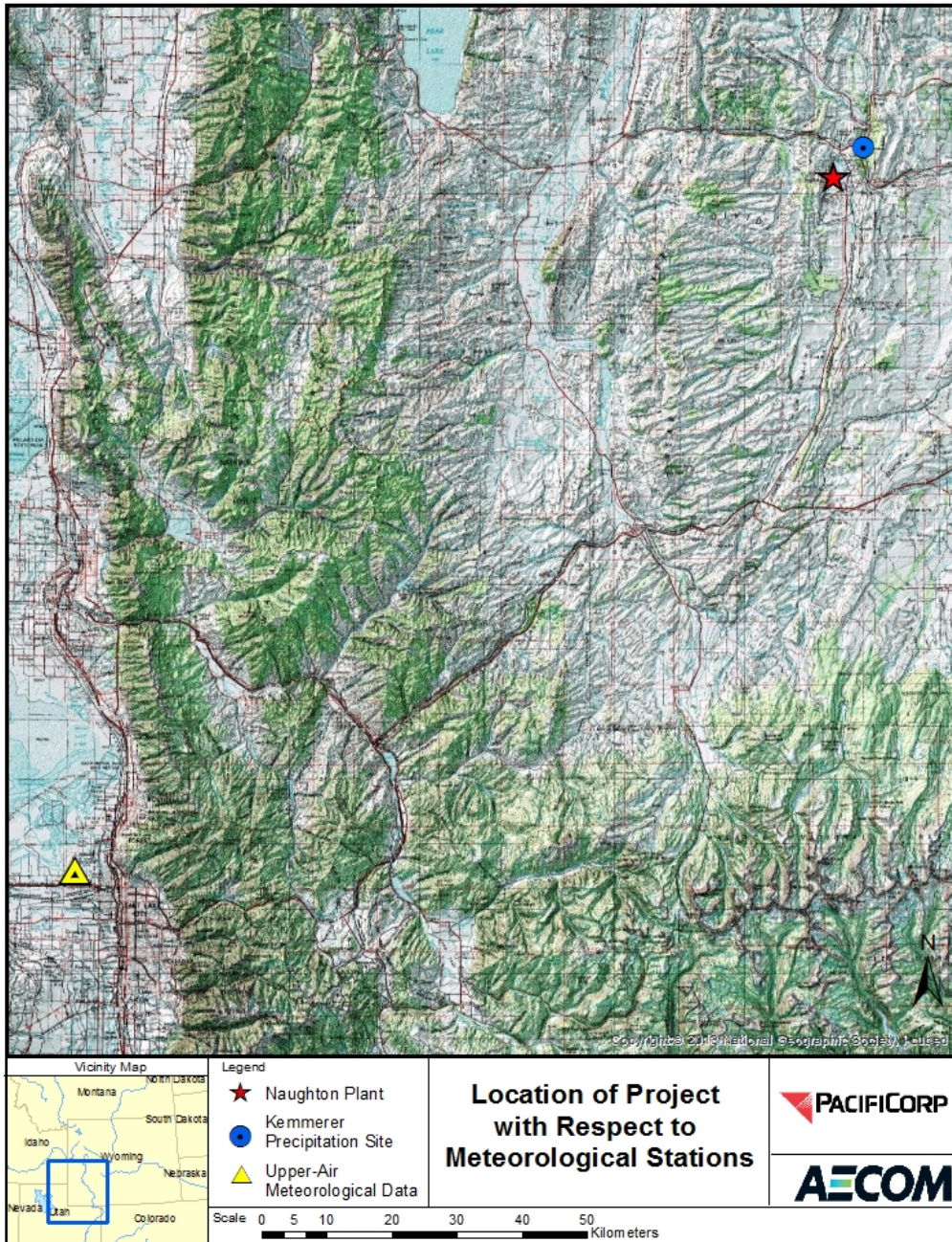
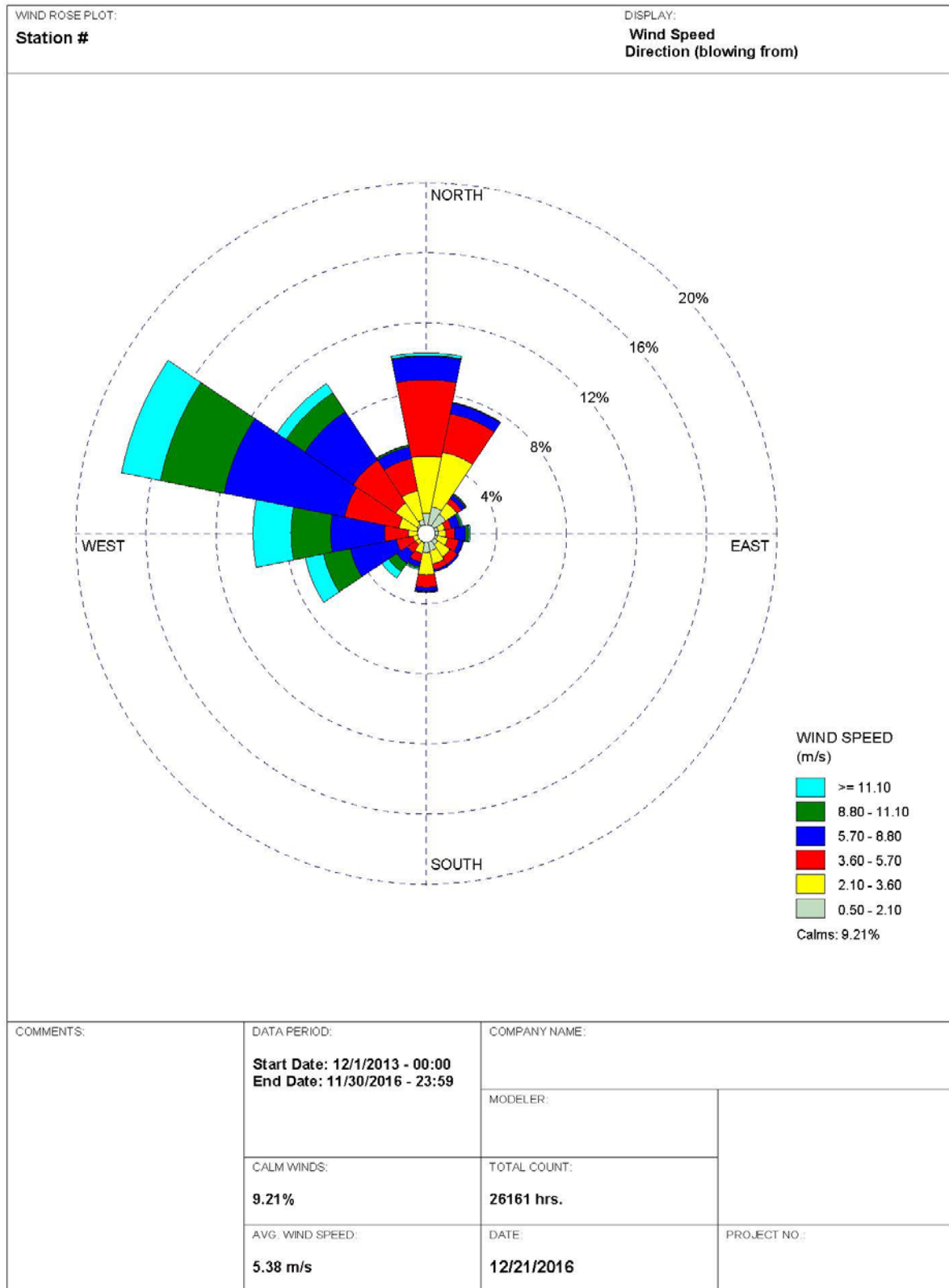


Figure 4-4: Wind Rose from Naughton On-site Meteorological Tower (Dec 2013 – Nov 2016) at the 50-m Level



WRPLOT View - Lakes Environmental Software

4.3.2 AERSURFACE Analysis – Meteorological Site Land Use Characteristics

AERMET requires specification of site characteristics including surface roughness (z_o), albedo (r), and Bowen ratio (B_o). These parameters were developed according to the guidance provided by EPA in the recently revised AERMOD Implementation Guide (AIG)⁸.

The revised AIG provides the following recommendations for determining the site characteristics:

1. The determination of the surface roughness length should be based on an inverse distance weighted geometric mean for a default upwind distance of 1 kilometer relative to the measurement site. Surface roughness length may be varied by sector to account for variations in land cover near the measurement site; however, the sector widths should be no smaller than 30 degrees.
2. The determination of the Bowen ratio should be based on a simple un-weighted geometric mean (i.e., no direction or distance dependency) for a representative domain, with a default domain defined by a 10-km by 10-km region centered on the measurement site.
3. The determination of the albedo should be based on a simple un-weighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for Bowen ratio, with a default domain defined by a 10-km by 10-km region centered on the measurement site.

The AIG recommends that the surface characteristics be determined based on digitized land cover data. The EPA has developed a tool called AERSURFACE⁹ that can be used to determine the site characteristics based on digitized land cover data in accordance with the recommendations from the AIG discussed above. AERSURFACE incorporates look-up tables of representative surface characteristic values by land cover category and seasonal category. The latest version of AERSURFACE (13016) version was applied with the instructions provided in the AERSURFACE User's Guide.

The current version of AERSURFACE supports the use of land cover data from the USGS National Land Cover Data 1992 archives¹⁰ (NLCD92). The NLCD92 archive provides data at a spatial resolution of 30 meters based upon a 21-category classification scheme applied over the continental U.S. The AIG recommends that the surface characteristics be determined based on the land use surrounding the site where the surface meteorological data were collected.

As recommended in the AIG for surface roughness, the 1-km radius circular area centered at the meteorological station site can be divided into sectors for the analysis; each chosen sector has a mix of land uses that is different from that of other selected sectors. Sectors used to define the meteorological surface characteristics for the onsite meteorological tower are shown in **Figure 4-5**.

4.3.2.1 Seasonal Classification

In AERSURFACE, the various land cover categories are linked to a set of seasonal surface characteristics. As such, AERSURFACE requires specification of the seasonal category for each month of the year. Each month was assigned to its default season unless evidence of snow cover changes the default season to winter with snow. The following five seasonal categories, as offered by AERSURFACE, include:

- Midsummer with lush vegetation;
- Autumn with un-harvested cropland;
- Late autumn after frost and harvest, or winter with no snow;
- Winter with continuous snow on ground; and
- Transitional spring with partial green coverage or short annuals.

The following seasonal classifications were used:

⁸ Available at http://www3.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_3August2015.pdf.

⁹ Available at http://www3.epa.gov/ttn/scram/dispersion_related.htm#aersurface.

¹⁰ Available at <http://edcftp.cr.usgs.gov/pub/data/landcover/states/>.

June, July, August = Midsummer with lush vegetation;

September, October = Autumn with un-harvested cropland;

April, May = Transitional spring with partial green coverage or short annuals;

November, December, January, February, March = Late autumn after frost and harvest, or winter with no snow; and

November, December, January, February, March = Winter with continuous snow on ground.

For the months of November, December, January, February, and March, locally-representative snow cover data records were reviewed for sites near the plant. For each month, if the month had more than 50% of the days with a measurable snow depth, then the month was considered "Winter with continuous snow on ground". Otherwise, the month was considered "Late autumn after frost and harvest, or winter with no snow".

4.3.2.2 Surface Moisture Determination

For Bowen ratio, the land use values are linked to three categories of surface moisture corresponding to average, wet and dry conditions. The surface moisture condition for the site may vary depending on the meteorological data period for which the surface characteristics will be applied. AERSURFACE applies the surface moisture condition for the entire data period. Therefore, if the surface moisture condition varies significantly across the data period, then AERSURFACE can be applied multiple times to account for those variations. As recommended in AERSURFACE User's Guide, the surface moisture condition for each month was determined by comparing precipitation for the period of data to be processed to the 30-year climatological record, selecting "wet" conditions if precipitation is in the upper 30th-percentile, "dry" conditions if precipitation is in the lower 30th-percentile, and "average" conditions if precipitation is in the middle 40th-percentile. The 30-year precipitation data set used in this modeling was taken from Kemmerer, WY, per guidance from WDEQ.

As part of the AERSURFACE processing, the user is required to provide whether the site is in an arid region. WDEQ has historically used a long-term average of approximately nine inches or less of annual precipitation to be an arid region. In 2013, the annual precipitation met this threshold. As a result the input to AERSURFACE was set as being arid for 2013. If the location experiences continuous snow cover for at least one month during the year, according to the AERSURFACE User's Guide the program does not offer the arid or non-arid prompt. Since only the month of December for 2013 is included and it was determined to have continuous snow cover, the arid option in AERSURFACE was not applicable.

4.3.3 AERMET Data Processing

AERMET (Version 15181) was used to process data required for input to AERMOD using default options. Boundary layer parameters used by AERMOD, which also are required as input to the AERMET processor, include albedo, Bowen ratio, and surface roughness. The land classifications and associated boundary layer parameters were determined following procedures outlined above. AERMET was applied to create two meteorological data files required for input to AERMOD:

SURFACE: A file with boundary layer parameters such as sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient in the 500-meter layer above the planetary boundary layer, and convective and mechanical mixing heights. Also provided are values of Monin-Obukhov length, surface roughness, albedo, Bowen ratio, wind speed, wind direction, temperature, and heights at which measurements were taken.

PROFILE: A file containing multi-level meteorological data with wind speed, wind direction, temperature, sigma-theta (σ_θ) and sigma-w (σ_w) when such data are available. The PROFILE file contains data at 2, 10, and 50 meter heights from the on-site tower.

Figure 4-5: Sectors Used for Surface Characteristics at Naughton Onsite Tower



4.4 Nearby Sources and Ambient Background Concentrations

4.4.1 Nearby Sources to be Modeled

Wyoming DEQ provided modeling input data for nearby background sources that the agency determined appropriate for inclusion in the modeling. WDEQ identified a number of background sources from three facilities, the Pioneer Gas Plant, Carter Creek Gas Plant and Shute Creek Treating Facility. SO₂ emissions from these nearby background sources (Pioneer Gas Plant, Carter Creek Gas Plant, and Shute Creek Treating Facility) were explicitly modeled at current allowable emission rates as part of the cumulative modeling with Naughton Power Plant. A summary of these background sources, provided by WDEQ are listed in **Table 4-3**.

WDEQ confirmed there were no significant SO₂ emission sources at the Kemmerer Mine. According to the 2011 National Emissions Inventory (2011 NEI)¹¹, the Kemmerer Mine produced only 1.2 tons of annual SO₂ emissions. This emission rate is significantly lower than Naughton and should be captured in ambient background data, which is included in the cumulative modeling.

Table 4-3: Summary of SO₂ Background Sources

Facility Name	Source Description	UTM Easting (Zone 12)	UTM Northing (Zone 12)	Base Elevation (ft)	Stack Height (ft)	Temperature (F)	Exit Velocity (ft/sec)	Stack Diameter (ft)	Short-term Limit (lbs/hr)
Pioneer Cryogenic Gas Plant	V1-Honeywell 303-1 Thermal Oxidizer	555173	4627767	6676.0	40.0	1500.0	29.0	4.0	5.60
Carter Creek Gas Plant	06/P4/Low Pressure Flare (F4402)	507556	4602474	8059.0	300.0	1299.0	103.0	2.0	56.90
Carter Creek Gas Plant	01/F1/Boiler A F4201A	507209	4602174	8121.0	90.0	293.0	52.0	5.0	0.50
Carter Creek Gas Plant	03/F3/Boiler C F4201C	507209	4602174	8121.0	90.0	293.0	52.0	5.0	0.50
Carter Creek Gas Plant	02/F2/Boiler B F4201B	507209	4602174	8121.0	90.0	293.0	52.0	5.0	0.50
Shute Creek Treating Facility	Tail Gas Incinerator - SRC41864	575642.9	4637469	6480.0	199.0	523.7	63.7	6.9	254.61
Shute Creek Treating Facility	Turbine 1 - SRC41882	575446.1	4637050	6480.3	100.0	362.0	48.0	10.5	51.03
Shute Creek Treating Facility	Turbine 2 - SRC41883	575394.1	4637050	6479.3	100.0	362.0	48.0	10.5	51.03
Shute Creek Treating Facility	Turbine 3 - SRC41884	575341.1	4637050	6478.7	100.0	362.0	48.0	10.5	51.03
Shute Creek Treating Facility	Syngas Furnace - SRC41898	575542.1	4637094	6479.0	100.0	300.0	45.0	4.3	0.05

4.4.2 Regional Background Concentrations

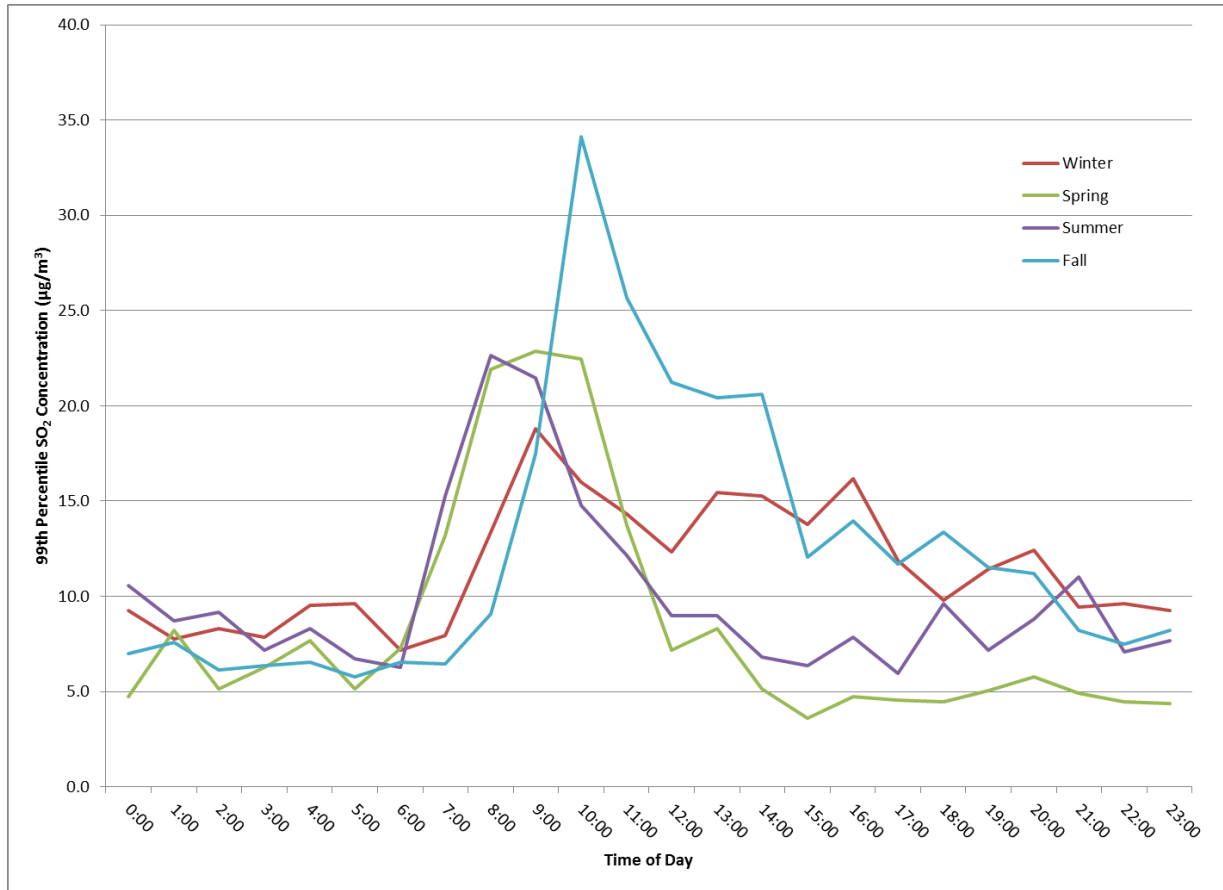
Ambient air quality data were used to represent the contribution of non-modeled sources to the total ambient air pollutant concentrations. In order to characterize SO₂ concentrations in the vicinity of each plant, the modeled design concentration must be added to a measured ambient background concentration to estimate the total design concentration. This total design concentration is then used to compare against the 1-hour SO₂ NAAQS.

Use of seasonal and hour-of-day varying background concentrations consistent with EPA guidance in their March 1, 2011 clarification memo¹² were used. The MOXA monitoring station concentrations observed during the 2012-2014 three-year period are displayed in **Figure 4-6**.

¹¹ <https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data>

¹² http://www.epa.gov/ttn/scram/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

Figure 4-6: 2012-2014 Average 99th Percentile Concentration at MOXA SO₂ Monitor



5. SO₂ Characterization Assessment

The 1-hour SO₂ characterization modeling for the SO₂ emissions from the Naughton Power Plant adheres to the following guidance documents (where applicable): (1) the August 2016 “SO₂ NAAQS Designations Modeling Technical Assistance Document” (TAD) issued in draft form by the USEPA, (2) the final DDR for the 2010 1-hour SO₂ primary NAAQS, (3) the PacifiCorp modeling protocol (October 6, 2016), and (4) direction received from the WDEQ Modeling Staff. A recent 3-year period was included in the modeling (December 2013 – November 2016). This modeling assessment excludes receptors from the power plant as well as the Kemmerer mine (an industrial area outside the power plant), which are both areas where the general public does not have access.

The 1-hour SO₂ characterization modeling was conducted using AERMET and AERMOD (version 15181) with default model options, the meteorological data described in **Section 4.3**, and the emission rates discussed in **Section 2** and **Section 4.4.1** for Naughton and nearby sources respectfully. Modeled concentrations were predicted over the receptor grid described in **Section 4.2**. Due to time constraints for requesting approval, the modeling did not use a previously proposed option, AERMOIST that more accurately predicts the plume rise of moist plumes, which would better characterize Naughton units 1-3 plume rise. Accordingly, the modeling results reported here are conservatively high.

The modeled concentrations from AERMOD were calculated based on the form of the 1-hour SO₂ NAAQS and include ambient background concentrations from the MOXA monitoring station as described in **Section 4.4.2**. The total design concentration was then compared to the 1-hour SO₂ primary NAAQS.

Two model scenarios are presented per requests from WDEQ. Scenario 1 involves modeling all Naughton units (1-3) using December 2013 – November 2016 actual hourly-varying emission rates, stack temperatures and exit velocities. The second scenario (Scenario 2) uses a future allowable emission rate for Unit 3 based on plans to convert it to natural gas firing, while keeping Units 1 and 2 at December 2013 – November 2016 actual rates. The emission rate used for Unit 3 for this modeling run was 2.22 lb/hr, which is consistent with the assumption of a peak heat input rate at all times and a permit limit for pipeline natural gas SO₂ content (0.0006 lb/MMBtu). This emission rate is the same rate that was used for PacifiCorp’s March 2013 Naughton Unit 3 Gas Conversion Modeling Analysis submitted to WDEQ.

The modeled concentrations from AERMOD were calculated based on the form of the 1-hour SO₂ NAAQS and include ambient background concentrations from the MOXA monitoring station. A summary of the 1-hour SO₂ modeling results is presented in **Table 5-1**. As shown in **Table 5-1**, the modeled concentrations of 1-hour SO₂ within a receptor network with 100-m spacing are less than 76% of the NAAQS for the current emissions, and only about 30% of the NAAQS with the future operation of Unit 3 with natural gas firing. The modeling results indicate that all areas outside these industrial areas are well below the SO₂ NAAQS.

5.1.1.1 Concentration Maps for Scenario 1

Figure 5-2 illustrates the overall pattern of the total SO₂ concentrations along with the location of the total maximum design concentrations for Scenario 1. The maximum total design concentration on the 20-kilometer receptor grid occurs approximately 3.7 kilometers to the west-northwest of the Naughton plant.

Areas with 100-meter spaced receptors were included in the maximum impact area, located in the vicinity of an elevated terrain feature to the west of the power plant. The area of elevated terrain has peak elevations rising above the stack tops of Naughton. **Figure 5-3** illustrates the location and magnitude of the final concentration on the 100-meter spaced receptor grid. The coordinates of the receptor showing the maximum impact was located at 529911.09 Easting and 4623847.96 Northing, as shown in **Figure 5-4**.

5.1.1.2 Concentration Maps for Scenario 2

Figure 5-5 illustrates the overall pattern of the total SO₂ concentrations along with the location of the total maximum design concentrations for Scenario 2 (Unit 3 set at a future allowable emission rate operating with natural gas). The

maximum total design concentration on the 20-kilometer receptor grid occurs approximately 3.7 kilometers to the west-northwest of the main plant .

Additional 100-meter spaced receptors were placed at around the maximum impact area, located in the vicinity of an elevated terrain feature. The area of elevated terrain has peak elevations rising above the stack tops of Naughton. **Figure 5-6** illustrates the location and magnitude of the final concentration on the 100-meter spaced receptor grid. The coordinates of the receptor showing the maximum impact was located at 52911.76 Easting and 4623757.05 Northing, which places it on high terrain, as shown in **Figure 5-7**.

Table 5-1: Summary of 1-hour SO₂ Modeling Analysis

Pollutant	Averaging Period	Total Predicted Concentration ^{1, 2} (µg/m ³)	NAAQS (µg/m ³)	Percent of NAAQS (%)
SO ₂ (Scenario 1)	1-Hour	147.48	196	75.2%
SO ₂ (Scenario 2)	1-Hour	60.59	196	30.9%

¹ Model predictions include monitored background concentrations.

² Peak design concentration impacts occur within 100-m spaced receptor grid.

**Figure 5-1: Full Receptor Grid 1-hour SO₂ Model Concentrations – Actual Emissions for December 2013-
November 2016**

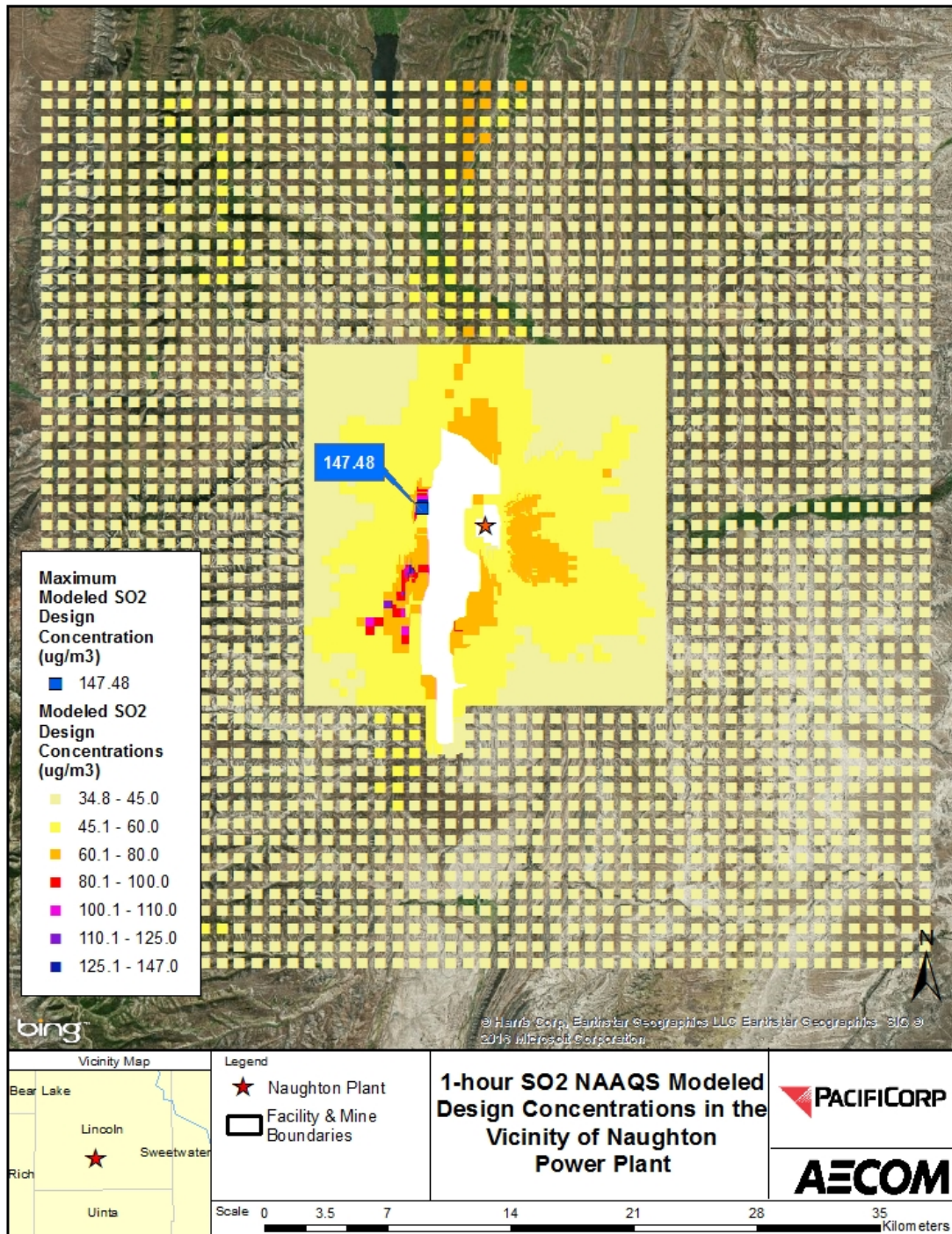


Figure 5-2: Maximum Impact of 1-hour SO₂ Model Concentrations within 100-m Spaced Receptor Grid – Actual Emissions for December 2013-November 2016

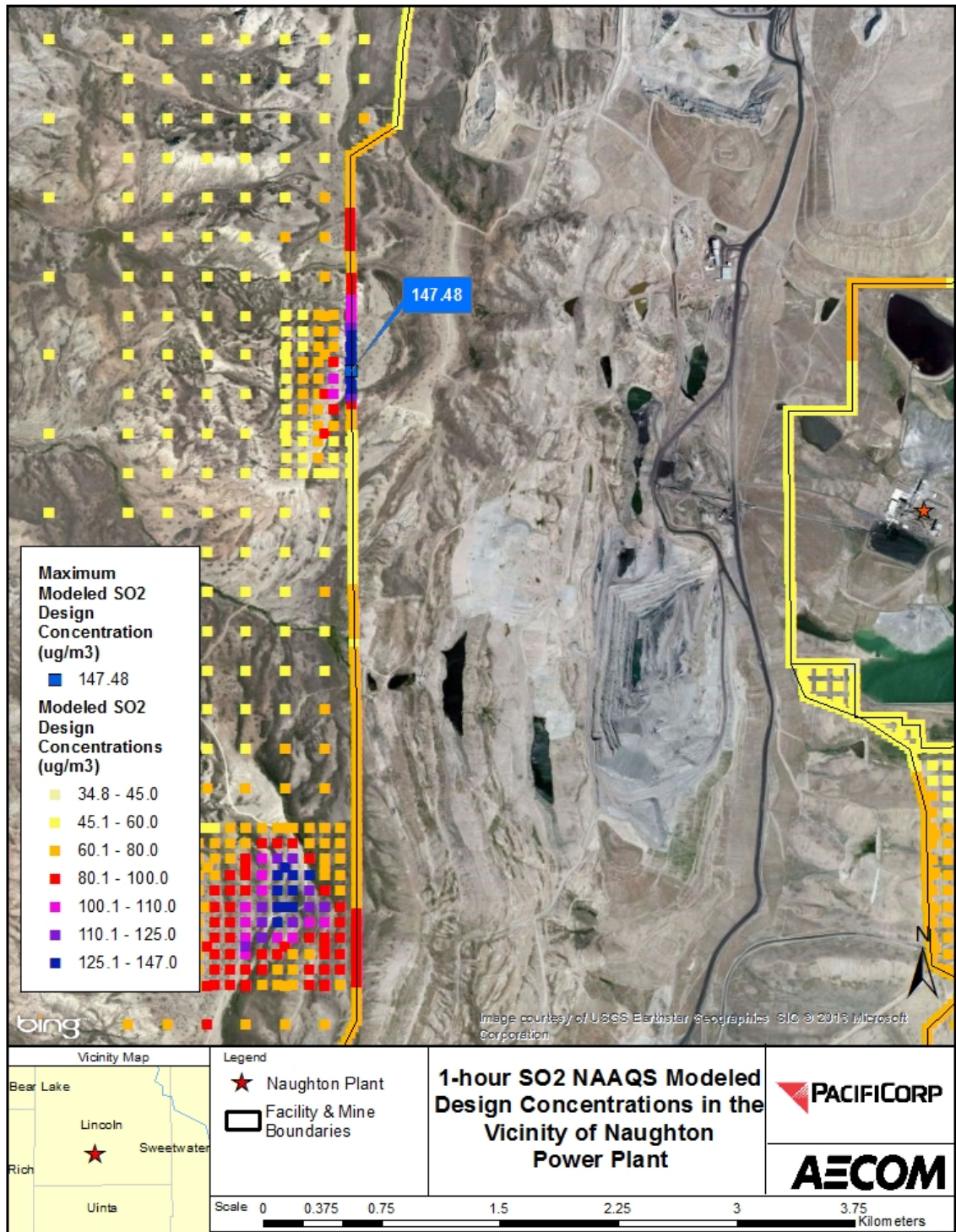


Figure 5-3: Maximum Modeled Impact Receptor Location Relative to Nearby Terrain – Actual Emissions for December 2013-November 2016

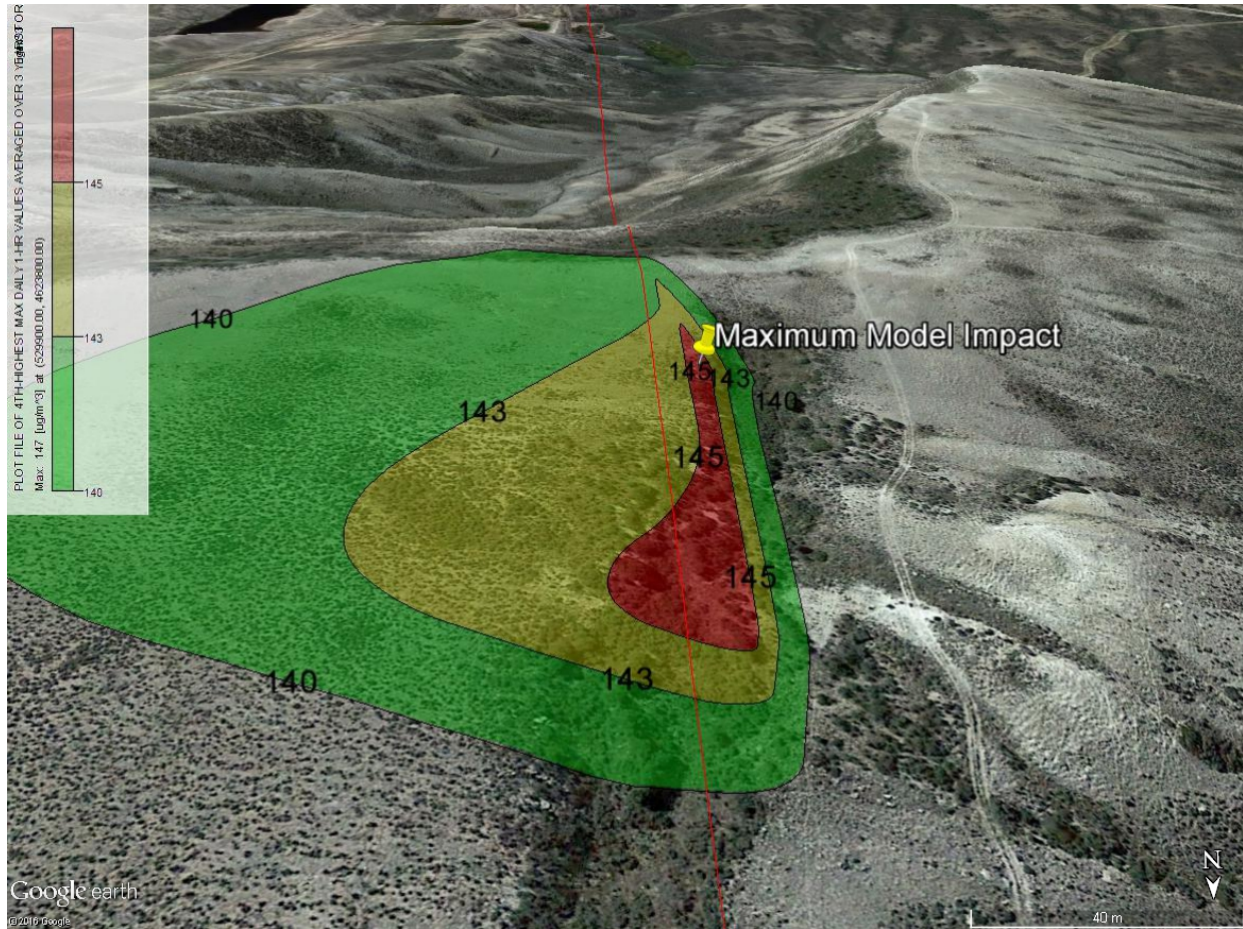


Figure 5-4: Full Receptor Grid 1-hour SO₂ Model Concentrations – Units 1-2 (Actual Emissions) and Unit 3 Natural Gas Future Emission Rate

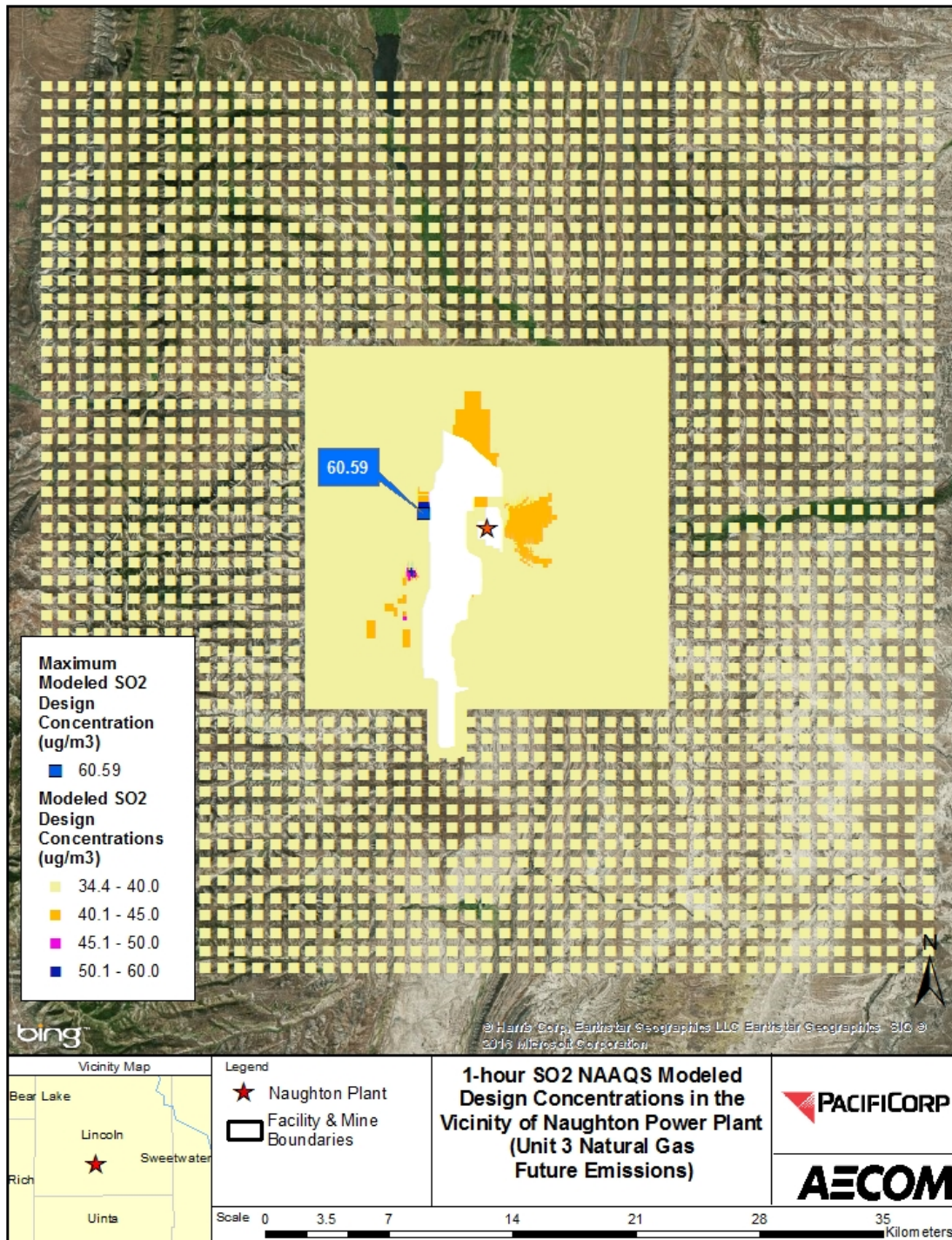


Figure 5-5: Maximum Impact 1-hour SO₂ Model Concentrations within 100-m Spaced Receptor Grid – Units 1-2 (Actual Emissions) and Unit 3 (Natural Gas Future Emission Rate)

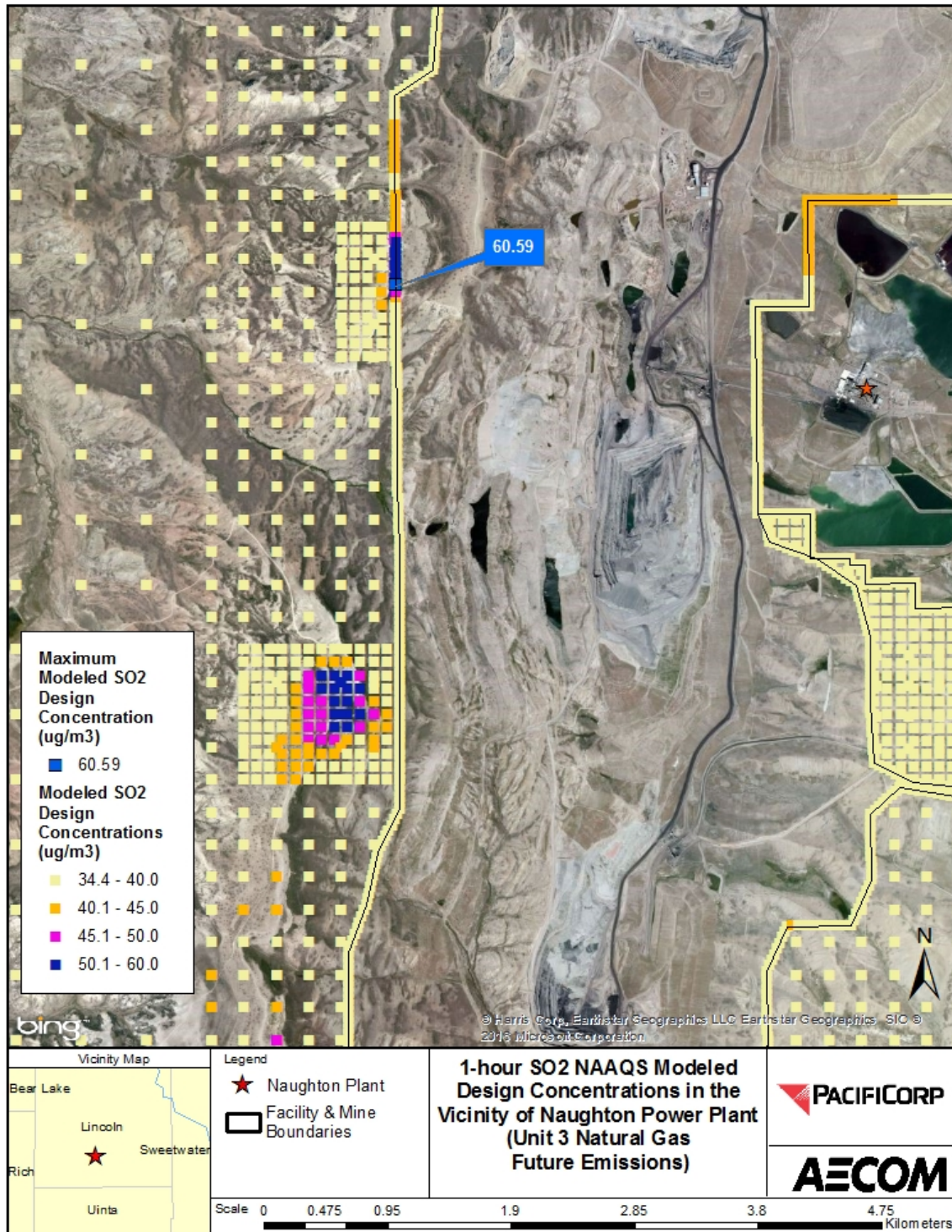
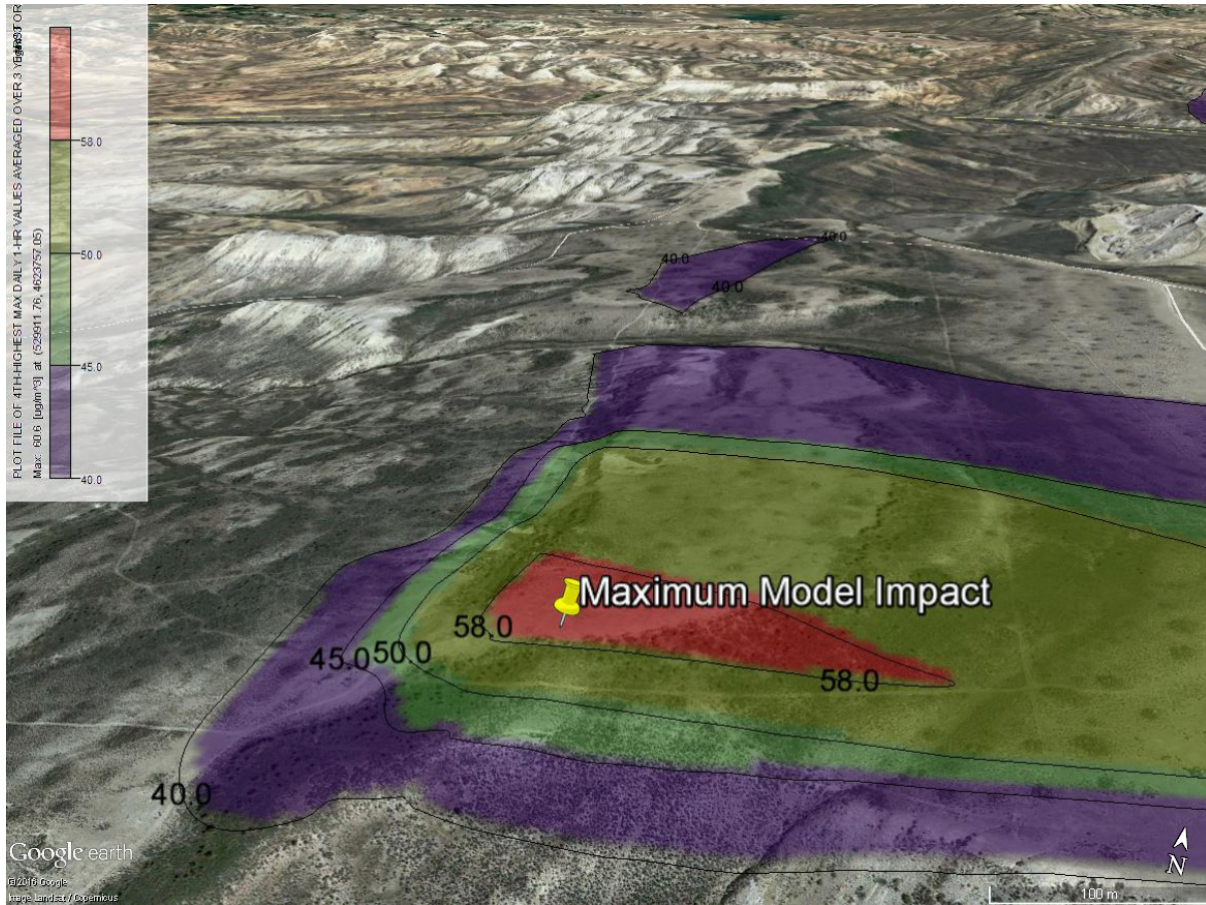


Figure 5-6: Maximum Modeled Impact Receptor Location Relative to Nearby Terrain – Units 1-2 (Actual Emissions) and Unit 3 Natural Gas Future Emission Rate



Appendix A

30-year Listing of Monthly Precipitation Data

Precipitation Data For Kemmerer, WY														
Year #	YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1	1985	0.46	0.46	0.95	0.65	1.62	0.75	0.54	0.15	1.45	0.81	2.24	1.51	11.614
2	1986	0.73	3.09	0.82	2.40	1.39	0.59	1.22	1.42	1.46	1.43	0.74	0.12	15.425
3	1987	1.15	0.59	1.80	0.08	2.76	0.31	1.47	1.72	0.23	1.05	0.87	0.76	12.783
4	1988	1.15	0.43	0.85	1.47	0.48	1.16	0.81	0.27	0.73	0.14	2.01	0.44	9.953
5	1989	0.39	1.58	1.75	1.13	0.81	0.67	0.44	0.89	2.06	0.26	0.64	0.33	10.941
6	1990	0.99	0.48	1.67	1.44	1.41	0.76	0.64	0.94	0.89	0.50	1.05	0.43	11.205
7	1991	0.48	0.01	0.96	1.06	1.43	1.43	0.36	1.06	1.34	0.80	1.26	0.11	10.295
8	1992	0.43	0.30	0.12	0.70	1.39	0.87	0.87	0.33	1.38	1.09	0.57	0.68	8.744
9	1993	0.63	0.80	0.52	0.46	1.29	1.45	1.08	1.89	0.24	1.33	0.84	0.32	10.835
10	1994	1.09	0.69	0.61	0.69	0.30	0.43	0.36	0.66	0.21	1.67	0.94	0.22	7.866
11	1995	0.75	0.90	1.04	1.48	1.73	1.77	0.31	2.39	0.96	0.50	1.68	1.29	14.811
12	1996	1.19	0.24	0.78	0.30	1.05	0.45	1.00	0.11	0.31		1.76	2.42	9.614
13	1997	1.14	0.25	0.28		1.00	2.29	0.75	1.63	2.40	0.33	0.25	0.25	10.555
14	1998	1.36	0.30	0.00	0.00	1.42	4.52	0.86		1.01	0.71	0.39	0.57	11.130
15	2001	0.00	0.16	0.00	0.40	0.89	0.30	0.97	0.25	0.69	0.40	0.40	0.60	5.067
16	2002	0.79	0.00	0.37		0.42	0.01	0.21	0.04	0.38	1.12	0.32	0.03	3.693
17	2003	0.00	0.53		0.10	0.81		0.03	0.35	0.16	0.59	0.23	0.23	3.039
18	2004	0.20	0.31	0.00	1.09	0.96	0.81	0.05	0.34	0.00	1.10	0.77	0.22	5.850
19	2005	1.39		0.67	1.29	0.97	0.22	0.36	0.39	0.00	0.00	0.50	1.00	6.791
20	2006	0.87	0.45	0.00	0.00	0.37	0.65	0.17	0.45	0.76	1.46	0.85	0.71	6.748
21	2007	0.13	0.46	0.77	0.15	0.57		0.01	1.48	0.47	0.60	0.00	0.91	5.551
22	2008	0.96	1.13	0.30	0.15	0.71	0.10	0.34	1.50	0.33	0.70	0.15	0.44	6.811
23	2009	0.51	0.32	0.59	1.15	1.46	1.72	0.41	0.55	0.77	0.83	0.35		8.673
24	2010	0.17	0.39	0.17	1.24	1.39	2.41	0.18	1.14	0.05	1.28	0.82	1.97	11.220
25	2011	0.90	1.28	0.57	0.75	3.70	0.52	0.67	0.53	0.57	0.74	0.92	0.19	11.335
26	2012	0.85	0.25	0.00	0.00	0.18	0.00	1.06	0.08	0.78	1.42	0.22	0.67	5.508
27	2013	0.17	0.36	0.38	0.71	1.18	0.00	0.73	0.68	1.59	1.39	0.17	1.01	8.370
28	2014	0.28	1.67	0.89	0.45	0.94	1.33	1.21	3.64	3.38	0.27	0.00	0.54	14.602
29	2015	0.08	0.47	0.40	0.81	4.18	0.12	1.06	0.55	0.87	1.11	0.73	0.78	11.157
30	2016	0.81	0.3	1.01	1.26	4.41	0.4	0.01	1.22	1.05	1.7	0.36		12.530

