AECOM Environment

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1-Hour SO_2 NAAQS Compliance Modeling per the Data Requirements Rule for Montana-Dakota Utilities Co. R.M. Heskett Station

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1.0 Introduction

1.1 Overview of the SO_2 Data Requirements Rule

In August 2015, the U.S. Environmental Protection Agency (USEPA) issued the SO_2 Data Requirements Rule[1] (DRR), which directs state and tribal air agencies, in "an orderly process", to identify maximum ambient air 1-hour SO_2 concentrations in areas with sources of SO_2 emissions with annual emissions greater than 2,000 tons for the most recent year for which emissions data are available as necessary to characterize SO_2 concentrations in the vicinity of these sources. The affected sources are those that were not previously captured as part of USEPA's initial non-attainment area designations for the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS) in August 2013 and those that were not identified in the March 2015 Consent Decree entered in Sierra Club, et al. v. McCarthy, Case # 13-cv-03953-DI (N.D. Cal. March 2, 2015).

The North Dakota Department of Health (NDDH) consulted with the owners or operators of the DRR-identified sources in North Dakota to identify the means for determining whether the area surrounding each identified source is in attainment with the SO_2 NAAQS for area designation purposes. According to the DRR, the method of characterizing the SO_2 concentrations around each source can be done by either:

- installing and operating an ambient air monitoring network; or
- performing an air dispersion modeling study to characterize the SO_2 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:

- limits annual SO_2 emissions to less than 2,000 tons, or
- limits short-term (1-hour) and/or longer-term (up to 30-day average) SO_2 emissions that, based on the results of an air dispersion modeling study, demonstrate that the area surrounding the source is in attainment with the SO_2 NAAQS, allowing the state air agency to provide a recommendation for a designation of attainment with the NAAQS.

This document describes the air quality modeling procedures and results of an air dispersion modeling demonstration that was performed for the 1-hour NAAQS for SO_2. The modeling was performed to characterize SO_2 concentrations and provide information for establishing the attainment designation for the region surrounding the R.M. Heskett Station located in Mandan, North Dakota. The R.M. Heskett Station is owned and operated by Montana-Dakota Utilities Co. This modeling report is being prepared and submitted to the NDDH to provide a general overview of the modeling procedures and the results of the modeling analysis.

A draft dispersion modeling protocol for R.M. Heskett Station was submitted to NDDH and USEPA Region 8 on March 21, 2016. USEPA provided a written set of comments on the draft modeling

[1] Docket ID No. EPA–HQ–OAR–2013–0711, August 10, 2015. http://www.epa.gov/oaqps001/sulfurdioxide/pdfs/so2_drr__final_081215.pdf.

protocol on April 18, 2016. These comments were addressed in a subsequent revised draft dispersion modeling protocol for R.M. Heskett Station submitted to NDDH and USEPA Region 8 on June 17, 2016.

The NDDH issued its "Draft Protocol for Modeling Analyses Used to Address USEPA's Data Requirements Rule (DRR) for 1-hour SO_2 NAAQS Designations in North Dakota" in March 2016. USEPA Region 8 and owners and operators of the DRR-sources in North Dakota provided separate written sets of comments on NDDH's draft modeling protocol on May 10, 2016. The NDDH submitted an updated draft modeling protocol to USEPA Region 8 on October 17, 2016. USEPA Region 8 therein requested that NDDH supply a supplemental modeling protocol for each source-specific modeling analysis to be conducted under the DRR. Montana-Dakota Utilities Co. submitted a supplemental modeling protocol for R.M. Heskett Station to NDDH on December 5, 2016. NDDH issued their final modeling protocol to USEPA Region 8 on December 1, 2016, which the USEPA Region 8 accepted on December 5, 2016. As such, the modeling procedures follow the methodology outlined in the final NDDH modeling protocol and the MDU-prepared supplemental package. In addition, modeling procedures are consistent with applicable guidance, including the August 2016 "SO_2 NAAQS Designations Modeling Technical Assistance Document" (TAD)[2] issued by the USEPA. The modeling approach is also consistent with the final Data Requirements Rule (DRR) for the 2010 1-hour SO_2 primary NAAQS (80 FR 51052, August 21, 2015).

The current version of the TAD references other USEPA modeling guidance documents, including the following clarification memos (1) the August 23, 2010 "Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 NAAQS" and (2) the March 1, 2011 "Additional Clarification Regarding Application W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard" (hereafter referred to as the "additional clarification memo"). In the March 1, 2011 clarification memo, USEPA declares that the memo applies equally to the 1-hour SO_2 NAAQS even though it was prepared primarily for the 1-hour NO_2 NAAQS.

1.2 North Dakota Montana-Dakota Utilities Co. R.M. Heskett Station Affected by the DRR

This report addresses the Montana-Dakota Utilities Co. R.M. Heskett Station, located northwest of Bismarck, North Dakota, that the NDDH has identified for consideration under the DRR. SO_2 emission sources for this plant are discussed in this document, and modeling procedures are specified.

1.3 Contents of the Modeling Report

This report consists of five sections. **Section 1** provides an introductory presentation. **Section 2** provides a description of the R.M. Heskett Station. 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 SO_2 concentrations in the vicinity of R.M. Heskett Station and the modeling results.

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[2] https://www.epa.gov/sites/production/files/2016-06/documents/so2modelingtad.pdf

2.0 Description of Montana-Dakota Utilities R.M. Heskett Station

R.M. Heskett Station is located about 10 kilometers northwest of Bismarck, North Dakota in Morton County. R.M. Heskett Station has two existing coal-fired boilers (Unit 1 & Unit 2), each of which exhaust through their own, separate 91.08 meter (298.8-ft) tall stacks.

The location of the plant is shown in **Figure 2-1**. A topographic map of the area surrounding R.M. Heskett is provided in **Figure 2-2**. As shown in **Figure 2-2**, there is "complex" terrain (with elevations above stack top) within 4 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 R.M. Heskett Station 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 the TAD. **Table 2-1** shows the physical stack parameters that were used in the modeling. The hourly exhaust flow rates, temperatures, and emission rates are based on the actual data available from the continuous emission monitor (CEM) systems. The emissions for modeling consist of actual hourly data for the most recent three calendar years (2013-2015).

The two coal-fired boilers are the major SO_2 emission sources at the R.M. Heskett Station. While there are other small insignificant sources of SO_2 at R.M. Heskett Station, they are emergency in nature and thus do not operate routinely and/or have very low actual SO_2 emissions since they combust natural gas. It should be further noted that Unit 3 is a simple-cycle combustion turbine added to the site in 2014. This unit only combusts natural gas and is also considered an insignificant contributor of hourly SO_2 emissions at R.M. Heskett Station. These small sources of SO_2 are not expected to have an impact on the results of the 1-hour SO_2 modeling and were not included in the modeling, which is consistent with guidance provided in USEPA's March 1, 2011 Clarification Memo[3]. As such, the two coal-fired boilers are the only emission sources at the R.M. Heskett Station that were included in the 1-hour SO_2 modeling.

Table 2-1: R.M. Heskett – Physical Stack Parameters[(1)]

Unit	Description	UTM-14N [NAD-83] East (m)	UTM-14N [NAD-83] North (m)	Stack Base Elevation (meters msl)	Stack Height (m)	Flue Diameter (m)
Unit 1	Spreader Stoker	356414.5	5192141.5	505.206	91.084	2.21
Unit 2	Atm. Fluid Bed	356448.5	5192035.2	505.206	91.084	3.66

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

[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 R.M. Heskett Station

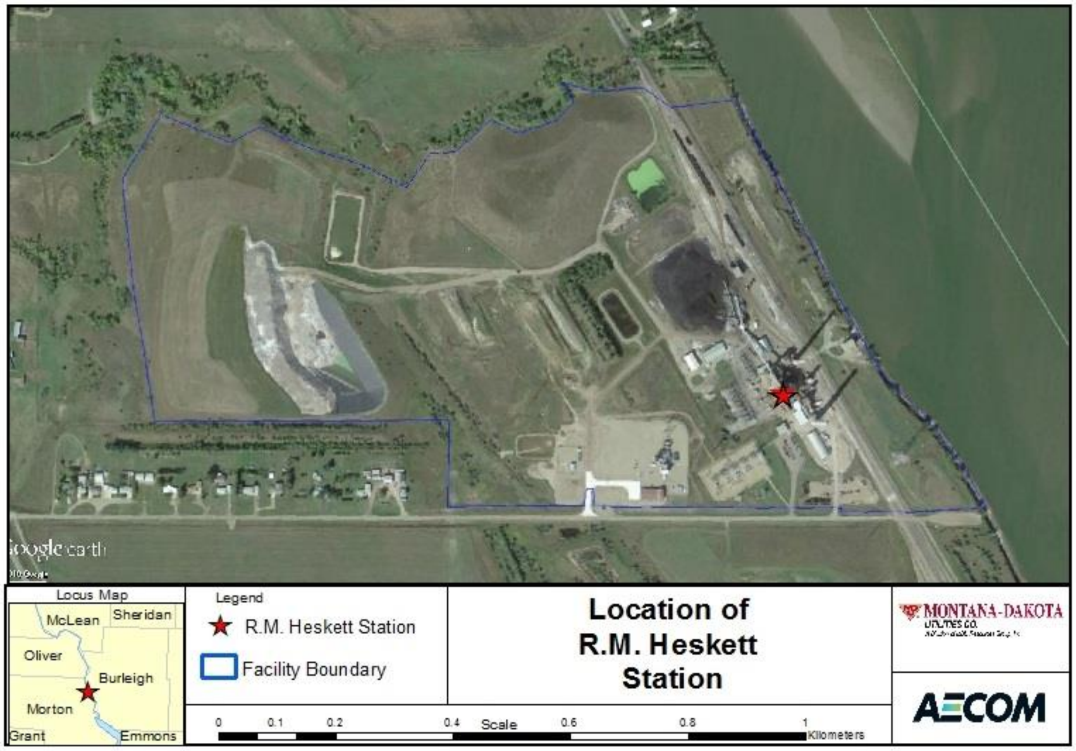
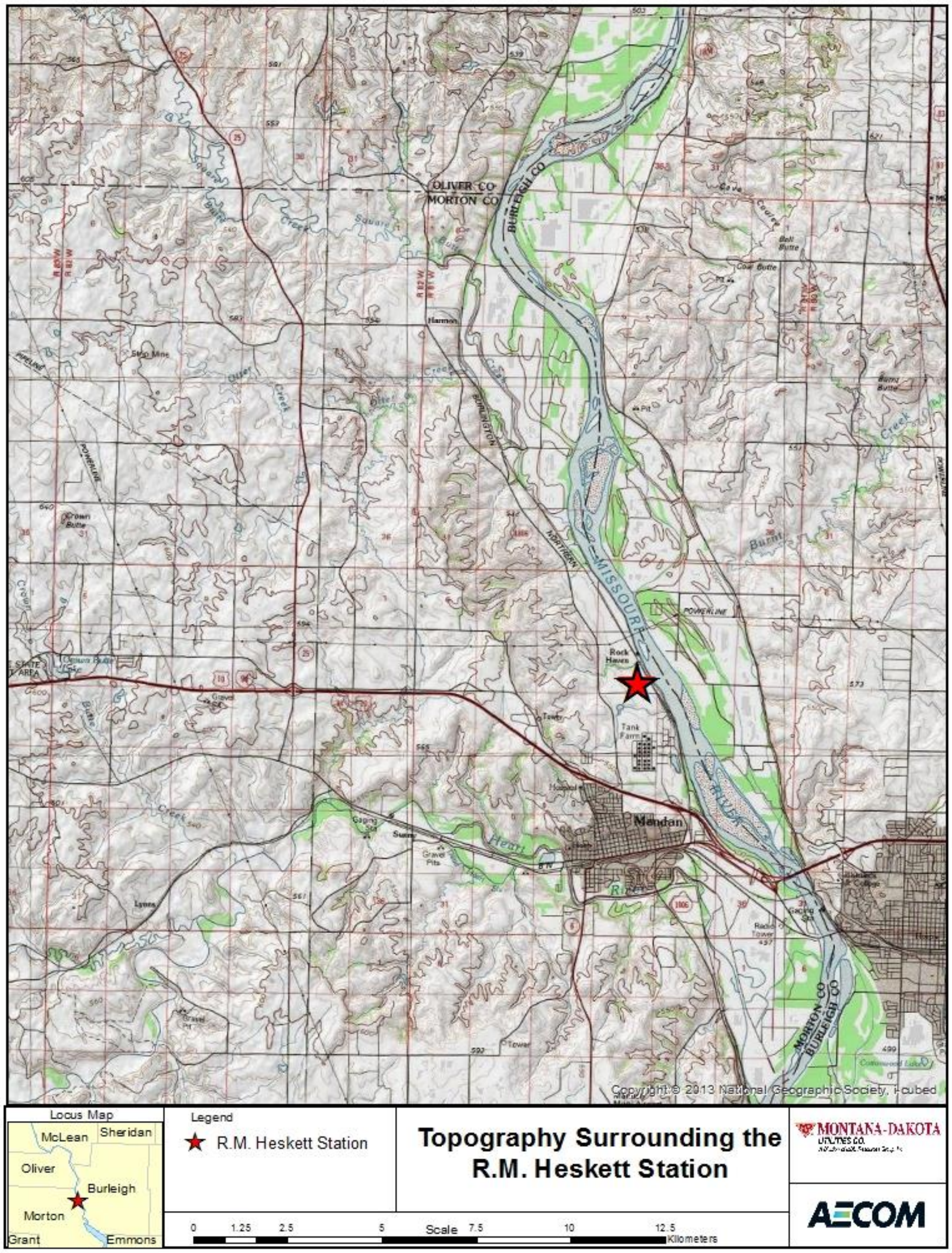


Figure 2-2: Topography in the Vicinity of R.M. Heskett Station



3.0 Dispersion Modeling Selection and Options

The USEPA Guideline on Air Quality Models (Appendix W[4]) 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 version of AERMOD (15181) was used in the DRR modeling for R.M. Heskett Station.

In a proposed rulemaking published in the July 29, 2015 Federal Register (80 FR 45340), the USEPA released a revised version of AERMOD (15181), which replaces the previous version of AERMOD dated 14134. The rulemaking included proposed refinements to USEPA's preferred short-range model, AERMOD, involving low wind conditions. These refinements involve an adjustment to the computation of the friction velocity ("ADJ_U*") in the AERMET meteorological pre-processor. At present, ADJ_U* remains a non-guideline beta option, the use of which requires USEPA concurrence. Recent examples of such concurrence are found in USEPA's February 10, 2016 and April 29, 2016 release of the Model Clearinghouse Review of the Use of ADJ_U* Beta Option,[5, 6] each of which supports the use of this non-guideline beta option.

On June 29, 2016, USEPA Region 8 submitted a request for concurrence memorandum[7] to USEPA's Model Clearinghouse for use of the ADJ_U* non-regulatory option in AERMET to more appropriately characterize SO_2 emissions from R.M. Heskett Station for the SO_2 DRR. In response to the Region 8 request, the USEPA Office of Air Quality Planning and Standards, Air Quality Modeling Group issued a Model Clearinghouse Memo on August 1, 2016[8] that supports the use of the ADJ_U* non-regulatory beta option for R.M. Heskett Station. The modeling for the required DRR modeling demonstration for R.M. Heskett Station includes the ADJ_U* refinement.

Based on USEPA guidance in the TAD, all stacks were modeled with their actual physical stack height. In addition, USEPA'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 BPIPPRM program to determine direction-specific building data for input to AERMOD, as shown in **Figures 3-1** and **3-2**.

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

[5] Available at http://www3.epa.gov/ttn/scram/guidance/mch/new_mch/16-X-01_MCResponse_Region10_Donlin-02102016.pdf

[6] Available at https://www3.epa.gov/ttn/scram/guidance/mch/new_mch/16-I-01_MCResponse_Region1_Schiller-04292016.pdf

[7] Available at https://www3.epa.gov/ttn/scram/guidance/mch/new_mch/16-VIII-01_MCRequest_Region8_Heskett-06292016.pdf

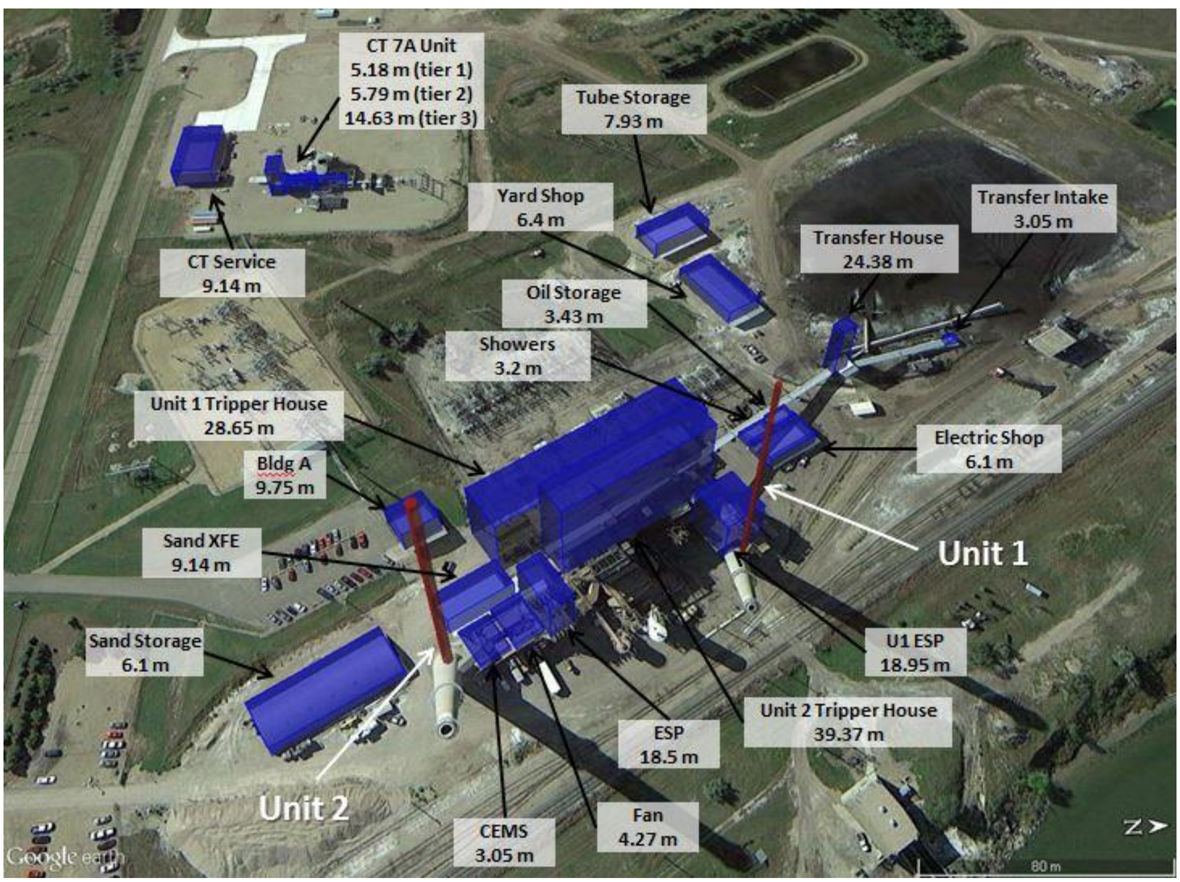
[8] Available at https://www3.epa.gov/ttn/scram/guidance/mch/new_mch/16-VIII-01_MCResponse_Region8_Heskett-08012016.pdf

Consistent with the modeling TAD guidance for characterizing SO_2 concentrations due to existing emissions, actual hourly emission rates (as well as hourly stack temperature and exit velocity) from the most recent three years that are available (2013-2015) were used. Consistent with the TAD guidance, receptors used in the modeling may be excluded from the following areas that are not considered ambient air, or where a monitor could not be placed:

- over water (rivers, lakes, ponds, and swamps) and
- on the secured property of Montana Dakota Utilities Co. R.M. Heskett Station.

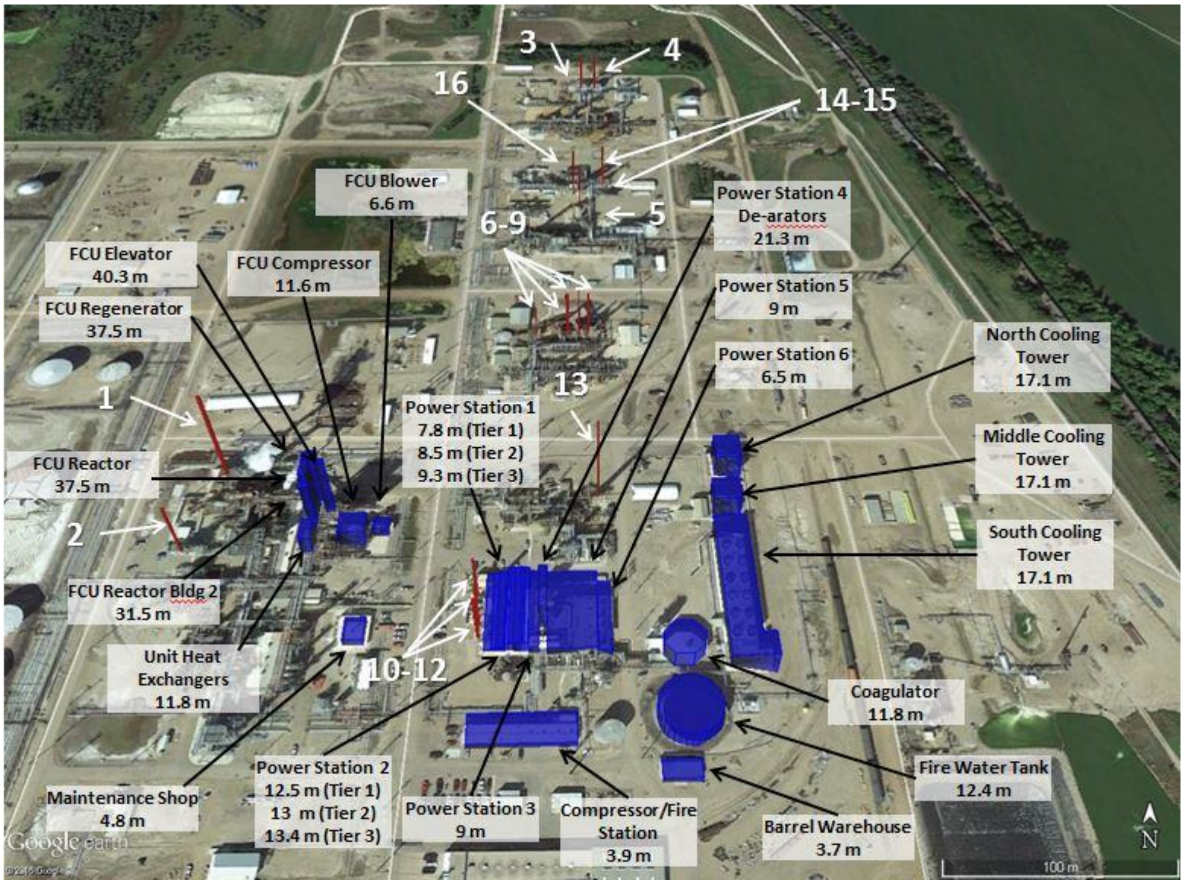
For this application, no receptors were excluded from water bodies, but receptors were excluded from the secured property within R.M. Heskett Station. Receptor spacing used in the modeling is consistent with NDDH guidelines[9] and features the most closely spaced receptors close to the R.M. Heskett Station.

Figure 3-1: Stacks and Buildings in the GEP Analysis for R.M. Heskett Station



[9] Available at http://www.ndhealth.gov/AQ/Policy/ND%20Air%20Dispersion%20Modeling%20Guide.pdf.

Figure 3-2: Stacks and Buildings in the GEP Analysis for Tesoro Mandan Refinery



4.0 Modeling Configuration

4.1 Modeling Domain

R.M. Heskett Station is located near the Tesoro Mandan Refinery. The modeling domain was established based on the area necessary to include all modeled sources (primary plus background) and all modeled receptor points. The modeling domain was set to 20 km, which is consistent with the NDDH modeling protocol.

4.2 Receptor Grid

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

- 25-m receptor spacing along the R.M. Heskett Station boundary for the SO_2 characterization.
- 50-m receptor spacing extending out 1.7 kilometers from the grid center (located near the Heskett stacks at 356431.50 meters Easting, 5192088.3 meters Northing). This distance brings the 50-m grid spaced receptors to at least 500 m from the Heskett fenceline, in accordance with the NDDH modeling protocol.
- 100-m receptor spacing between 1.7 and 5 kilometers from the grid center.
- 250-m receptor spacing between 5 and 10 kilometers from the grid center.
- 500-m receptor spacing beyond 10 kilometers (out to 20 km).

The receptor grid used in the modeling analysis was based on Universal Transverse Mercator (UTM) coordinates referenced to NAD 83 datum and in zone 14. In consultation with the agency reviewers, receptors were only excluded for the secured area of R.M. Heskett Station. **Figures 4-1** and **4-2** show the model receptor grids for near-field and far-field views respectfully.

The latest version of AERMAP (version 11103), 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 consists of 1 arc second (~30 m resolution) NED. As per the AERMAP User's Guide, the domain was sufficient to ensure all significant nodes were included such that all terrain features exceeding a 10% elevation slope from any given receptor, are considered.

Figure 4-1: Near-Field View of Receptor Grid for R.M. Heskett Station

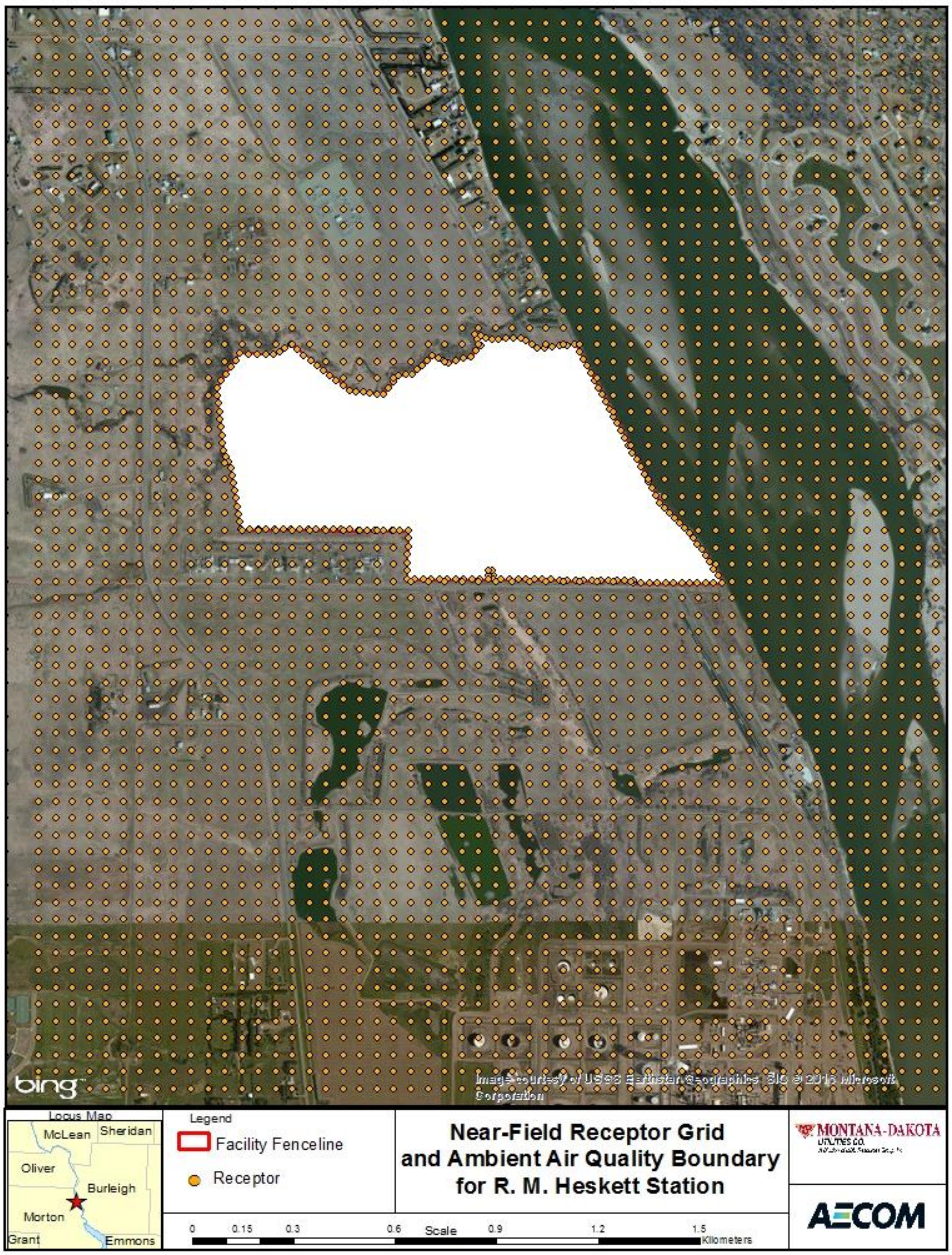
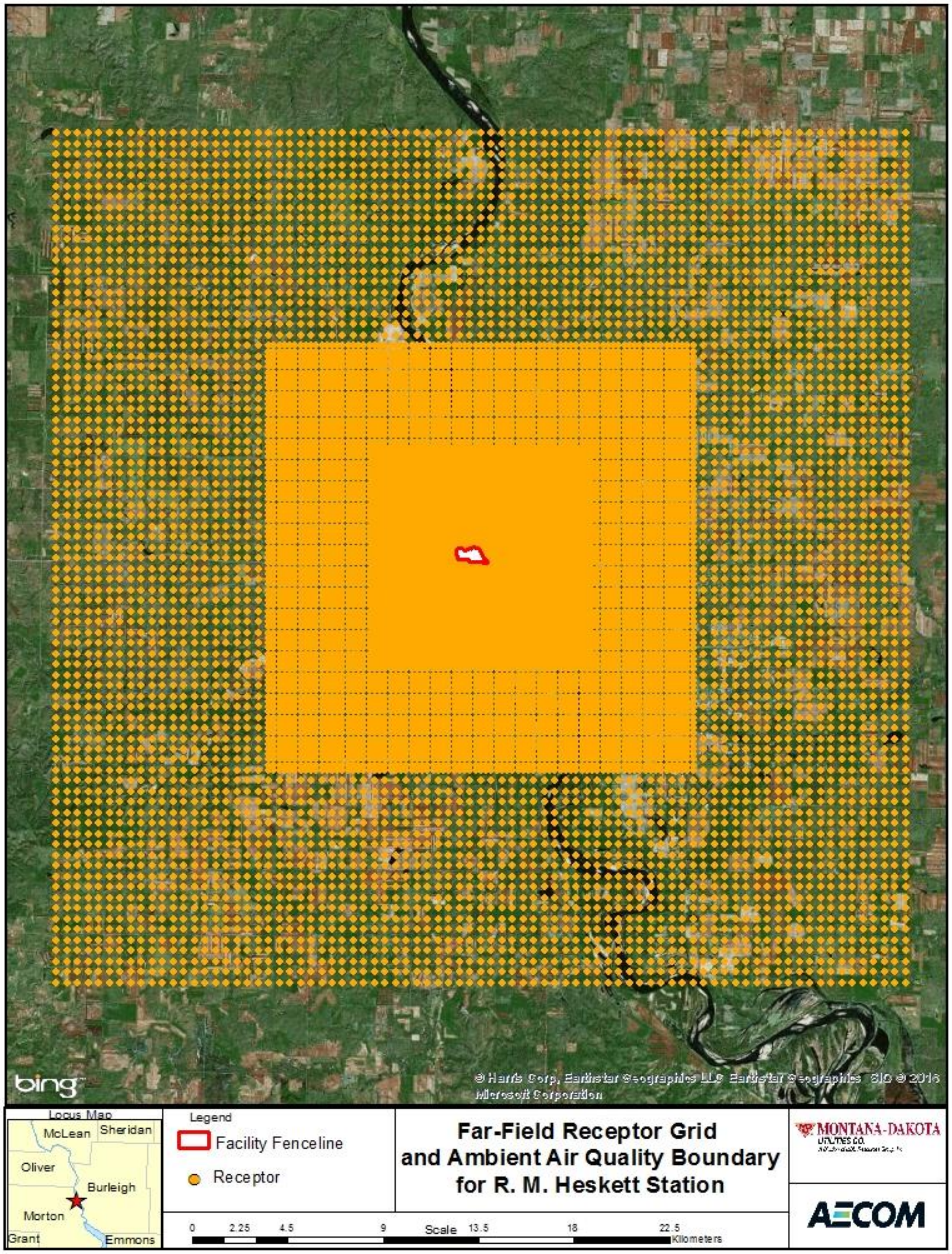


Figure 4-2: Far-Field View of Receptor Grid for R.M. Heskett Station



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.

Hourly surface observations (including 1-minute and 5-minute ASOS) were processed from Bismarck Municipal Airport (Bismarck, ND). Concurrent upper air data were obtained from the closest or most representative National Weather Service site, which was determined to be Bismarck, ND. Additional details are provided in the following sections.

4.3.1 Available Offsite Meteorological Data and NWS Upper Air Data

The hourly meteorological data for R.M. Heskett Station was processed with the latest version of AERMET (Version 15181). AERMET was run utilizing three concurrent years (2013-2015) of hourly surface observations from the Bismarck Municipal Airport in Bismarck, ND along with concurrent upper air data from Bismarck, ND. The hourly surface observations at Bismarck Municipal Airport routinely have at least 90% data capture, as shown in **Table 4-1**. Missing upper air data from Bismarck, ND were substituted with data from Glasgow, MT[10]. **Figure 4-3** shows the location of meteorological stations in relationship to the R.M. Heskett Station.

The AERMET inputs were based on surface meteorological data from the National Climatic Data Center's (NCDC) Integrated Surface Hourly (ISH) database along with both 1-minute and concurrent 5-minute Automated Surface Observing System (ASOS) data. The latest version of AERMINUTE (version 15272) was used to process this data. The upper air data input to AERMET were downloaded from the NOAA/ESRL/GSD - RAOB database (http://esrl.noaa.gov/raobs/). A wind rose for Bismarck Municipal Airport for the years 2013-2015 is shown in **Figure 4-4**.

Table 4-2 gives the site location and information on the meteorological datasets. The surface wind data are measured 10 meters above ground level. The temperature and relative humidity are measured 2 meters above ground level.

Table 4-1: Data Capture (%) by Meteorological Parameter and Level

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average	USEPA Threshold
2013	100.00%	100.00%	99.73%	100.00%	99.93%	90.00%
2014	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%
2015	99.58%	100.00%	99.00%	100.00%	99.65%	90.00%

[10] A total of 19 days over the 3 years to be modeled were substituted.

Table 4-2: Meteorological Data Used in AERMET for R.M. Heskett Station

Met Site	Latitude	Longitude	Base Elevation (m)	Data Source	Data Format
Bismarck Airport – Bismarck, ND	46.774	-100.748	506	NCDC	ISHD, 1-min, 5-min ASOS
Bismarck, ND	46.774	-100.748	506	FSL	FSL
Glasgow, MT	48.200	-106.620	693	FSL	FSL

Figure 4-3: Location of Meteorological Stations Relative to R.M. Heskett Station

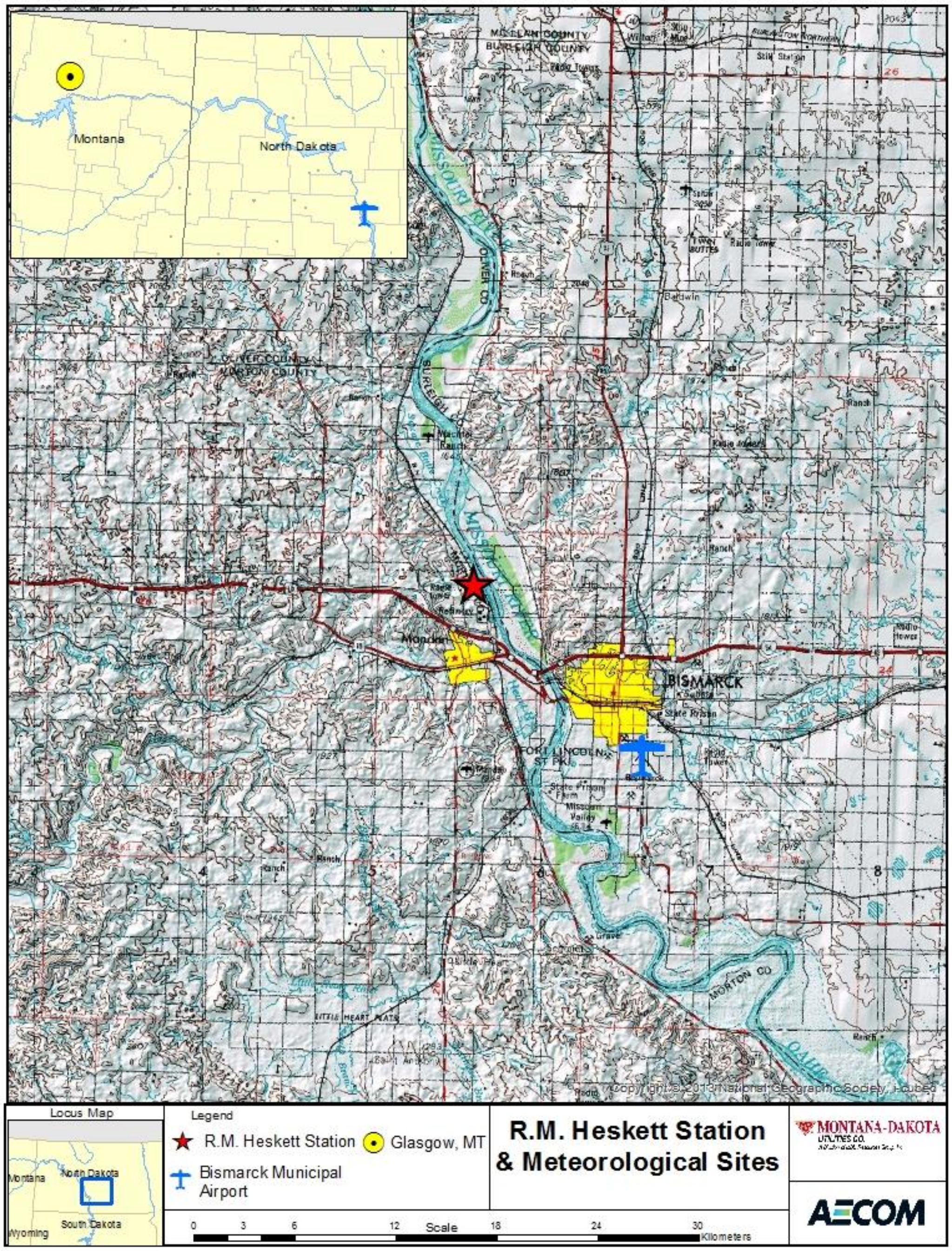
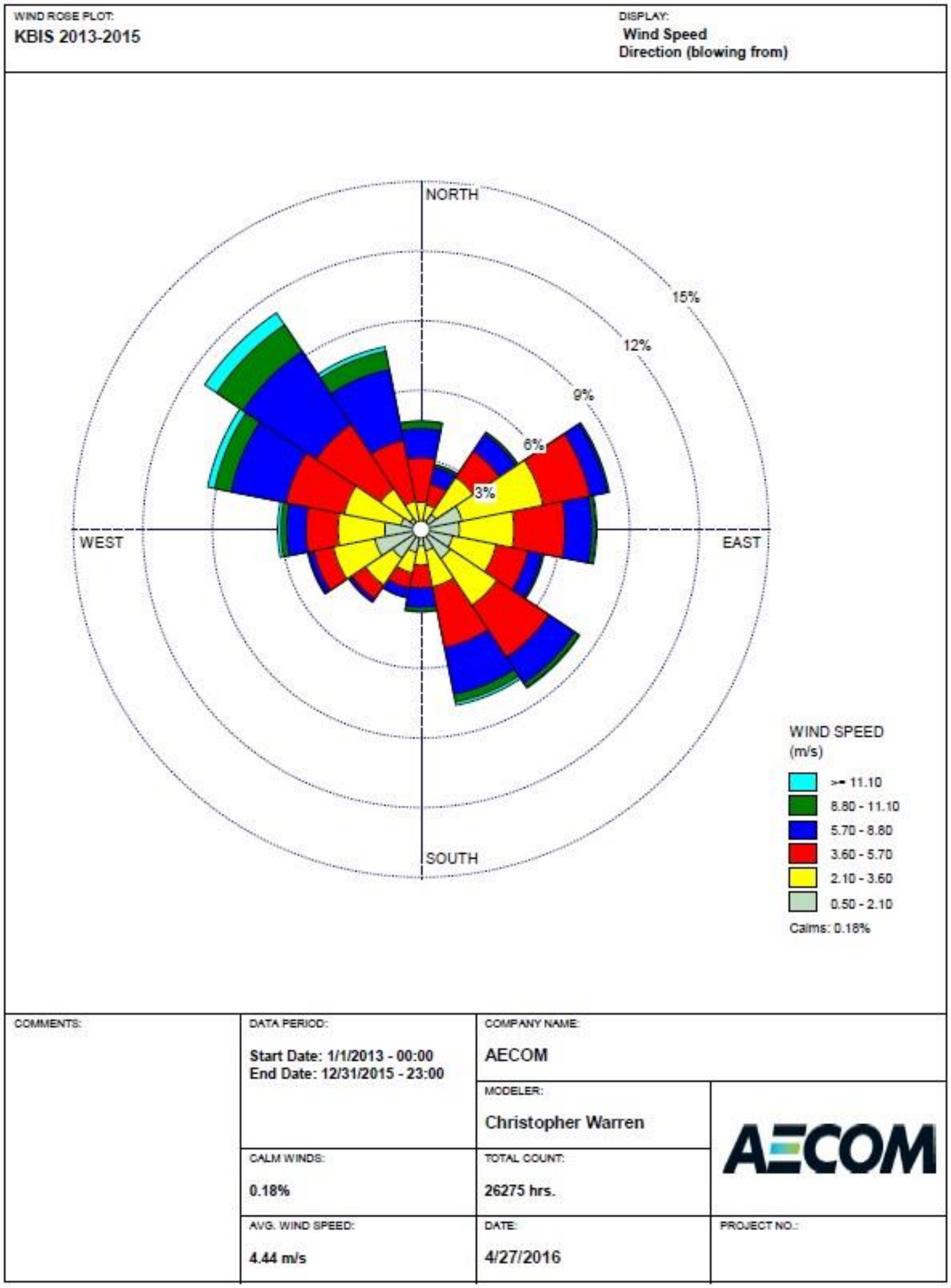


Figure 4-4: Wind Rose for Bismarck Municipal Airport, Bismarck, ND (KBIS)



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 USEPA in the recently revised AERMOD Implementation Guide (AIG)[11].

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. USEPA has developed a tool called AERSURFACE[12] 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 archives[13] (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.

Recommended AERSURFACE inputs[14] are provided by NDDH. This includes using a 1-km radius circular area, which is to be divided into twelve sectors for surface roughness. The AIG recommends this circular area be centered at the meteorological station site. Since the meteorological site is at the Bismarck Municipal Airport, the AERSURFACE input was marked as an airport.

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

[12] Available at http://www3.epa.gov/ttn/scram/dispersion_related.htm#aersurface.

[13] Available at http://edcftp.cr.usgs.gov/pub/data/landcover/states/.

[14] Available at https://www.ndhealth.gov/AQ/Policy/AERSURFACE%20Inputs.pdf.

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. NDDH provides guidance[15] on how to assign the seasonal category for each month of the year based upon the location of the modeling in the state. Based on this guidance, the "South Central" region seasonal classification was used:

> October, November, December, March = Late autumn after frost and harvest, or winter with no snow;
>
> January, February = Winter with continuous snow on ground;
>
> April, May = Transitional spring with partial green coverage or short annuals;
>
> June, July, August = Midsummer with lush vegetation; and
>
> September = Autumn with un-harvested cropland.

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 were 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 Bismarck Municipal Airport. **Appendix A** contains the 30-years of monthly precipitation data used in the modeling. The 30-year period of record used to establish the 30-year average monthly precipitation totals include 1986 through 2015.

The monthly designations of surface moisture input to AERSURFACE are summarized in **Table 4-3**.

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[15] Available at https://www.ndhealth.gov/AQ/Policy/AERSURFACE%20Inputs.pdf.

Table 4-3: AERSURFACE Bowen Ratio Condition Designations

Month	2013	2014	2015
January	Dry	Average	Wet
February	Average	Dry	Average
March	Average	Average	Dry
April	Wet	Wet	Dry
May	Wet	Dry	Wet
June	Average	Average	Wet
July	Dry	Dry	Dry
August	Average	Wet	Average
September	Wet	Dry	Dry
October	Wet	Dry	Average
November	Dry	Average	Average
December	Wet	Dry	Wet

4.3.3 AERMET Data Processing

AERMET (Version 15181) and AERMINUTE (Version 15272) was used to process data required for input to AERMOD. 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 was determined following procedures outlined below. In running AERMET, the observed airport hourly wind direction (if used to substitute for missing AERMINUTE data) were randomized based on guidance from USEPA's March 8, 2013 Use of ASOS Meteorological Data in AERMOD Dispersion Modeling memo[16] using the "WIND_DIR RANDOM" keyword in AERMET. The randomization method addresses the lack of precision in the NWS wind direction observations, which are reported to the nearest 10 degrees. If the randomization method is not used, the potential exists for overly conservative model impacts to occur. Due to the improved model performance for the low wind options as documented in USEPA's August 1, 2016 Clearinghouse Memo, the ADJ_U* option was used in the AERMET processing.

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. For R.M. Heskett Station, the profile file contains a single level of wind data (10 meters) and the temperature data only, corresponding to the Bismarck Municipal Airport observation.

4.4 Dispersion Environment

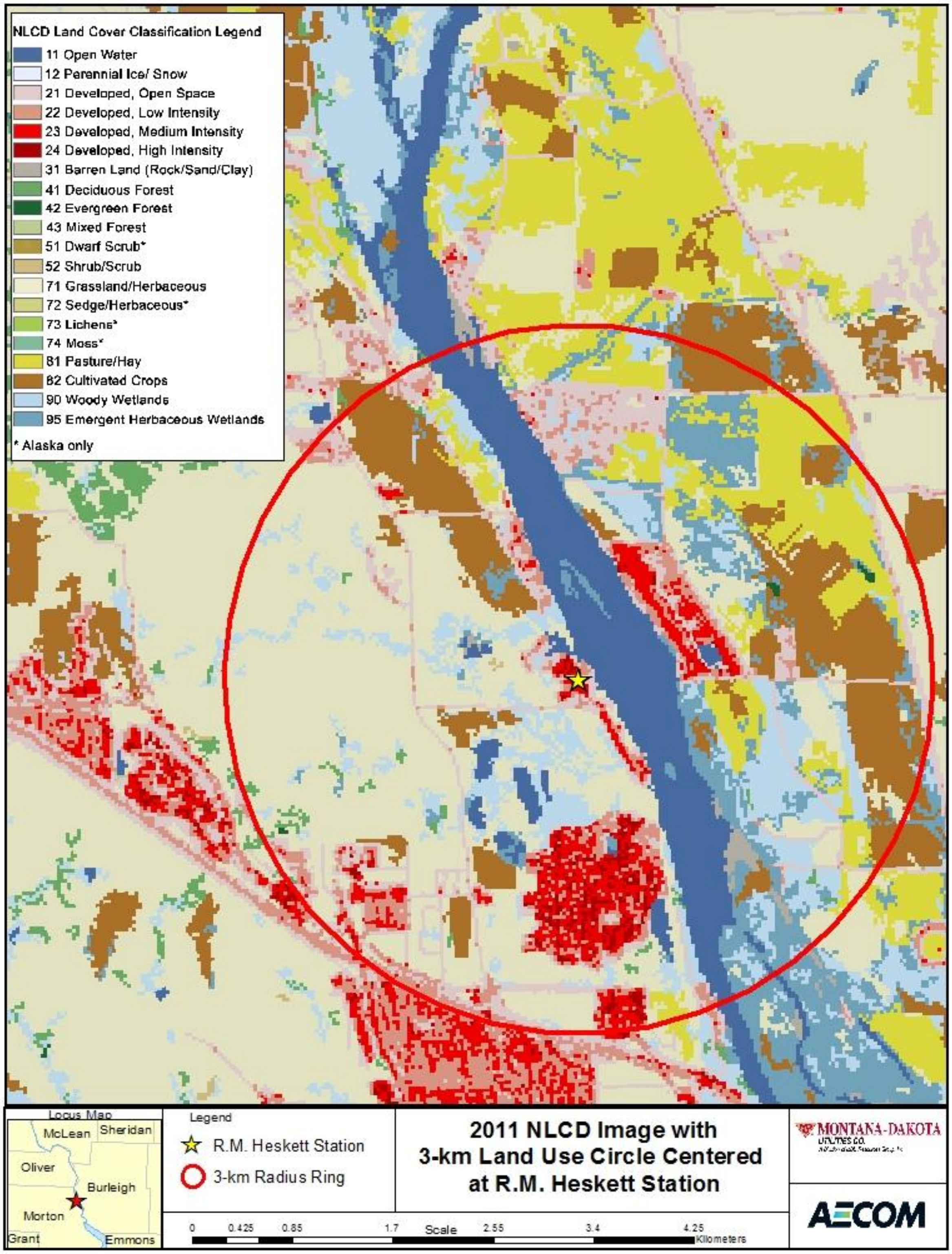
The application of AERMOD requires characterization of the local (within 3 kilometers) dispersion environment as either urban or rural, based on an USEPA-recommended procedure that characterizes an area by prevalent land use. This land use approach classifies an area according to 12 land use types. In this scheme, areas of industrial, commercial, and compact residential land use are designated urban. According to USEPA modeling guidelines, if more than 50% of an area within a 3-km radius of the facility is classified as rural, then rural dispersion coefficients

[16] Available at https://www3.epa.gov/scram001/guidance/clarification/20130308_Met_Data_Clarification.pdf

are to be used in the dispersion modeling analysis. Conversely, if more than 50% of the area is urban, urban dispersion coefficients are used. **Figure 4-5** shows aerial image with 3-km radius centered on R.M. Heskett Station showing less than 50% compact residential and industrial development. For this application, Montana-Dakota Utilities Co. and AECOM ran AERMOD with rural dispersion as less than 10% of the area within 3 kilometers of R.M. Heskett is classified as developed (low, medium, and high intensity) (pink/red) as shown in the USGS National Land Cover Database (NLCD) (2011) imagery in **Figure 4-6**. Therefore, rural dispersion characterization was used for this modeling effort.

Figure 4-5: 3-km Land Use Circle Centered at R.M. Heskett Station with Aerial Imagery

Figure 4-6: 3-km Land Use Circle Centered at R.M. Heskett Station with 2011 NLCD Image



4.5 Nearby Sources and Ambient Background Concentrations

4.5.1 Nearby Sources to be Modeled

NDDH identified one nearby source to be explicitly modeled, the Tesoro Mandan Refinery. Therefore, the Tesoro Mandan Refinery was explicitly modeled as part of the modeling for R.M. Heskett Station. Actual hourly emissions from 2013-2015 for the refinery were included in the modeling.

4.5.2 Regional Background Concentrations

Ambient air quality data are used to represent the contribution of non-modeled sources to the total ambient air pollutant concentrations. In order to characterize SO_2 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 characterize the area as attainment or non-attainment for the 1-hour SO_2 NAAQS.

Use of seasonal and hour-of-day varying background concentrations consistent with USEPA guidance in their March 1, 2011 clarification memo[17] are used. The Bismarck Residential monitoring station (located at 1810 N 16th Street) concentrations observed during the 2013-2015 three-year period are listed in **Table 4-4** and **Table 4-5**.

[17] Available at http://www.epa.gov/ttn/scram/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

Table 4-4: Bismarck Residential Station 99th Percentile Hour of the Day and by Season Concentrations (µg/m^3), Hours 0-11

AVG	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Winter	19.21	13.36	14.93	16.07	14.24	16.33	21.22	23.84	11.79	14.15	20.61	27.07
Spring	9.87	9.08	9.00	7.69	7.16	8.30	7.77	9.61	18.60	12.58	15.46	9.43
Summer	4.63	4.80	5.24	5.41	4.28	2.97	11.62	10.22	10.74	12.49	14.76	11.53
Fall	7.34	6.64	7.07	5.50	8.03	8.30	10.22	11.88	13.27	12.66	11.79	18.60

Table 4-5: Bismarck Residential 99th Percentile Hour of the Day and by Season Concentrations (µg/m^3), Hours 12-23

AVG	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Winter	21.66	27.16	24.98	18.60	20.26	18.17	14.76	17.47	23.41	20.26	18.95	19.13
Spring	10.04	12.49	11.18	11.35	8.47	10.22	7.77	9.96	7.60	7.51	8.73	7.16
Summer	8.91	7.34	5.59	6.72	7.07	6.03	5.85	5.59	4.37	4.10	4.02	4.37
Fall	15.55	12.49	11.62	13.45	14.41	10.13	12.31	8.21	14.06	7.34	6.29	6.38

5.0 SO_2 Characterization Assessment

The 1-hour SO_2 characterization modeling for the R.M. Heskett Station adheres to the following guidance documents (where applicable): (1) the August 2016 “SO_2 NAAQS Designations Modeling Technical Assistance Document” (TAD) issued in draft form by the USEPA, (2) the final DDR for the 2010 1-hour SO_2 primary NAAQS, (3) the final NDDH modeling protocol (December 1, 2016), (4) USEPA Office of Air Quality Planning and Standards Air Quality Group August 1, 2016 Modeling Clearinghouse Memo supporting the use of the ADJ_U* non-regulatory beta option, and (5) direction received from the NDDH Modeling Staff.

The 1-hour SO_2 characterization modeling was conducted using AERMET (version 15181) beta ADJ_U* option 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 4.5.1** for R.M. Heskett Station and the Tesoro Mandan Refinery respectfully. Modeled concentrations were predicted over the receptor grids described in **Section 4.2**.

The modeled concentrations from AERMOD were calculated based on the form of the 1-hour SO_2 NAAQS and include ambient background concentrations from the Bismarck Residential monitor as described in **Section 4.5.2**. The total design concentration was then compared to the 1-hour SO_2 primary NAAQS to determine if the area surrounding R.M. Heskett Station should be designated as attainment or non-attainment.

A summary of the 1-hour SO_2 modeling results is presented in **Table 5-1**, which shows the modeled concentrations of 1-hour SO_2 are less than the NAAQS. The most refined receptor spacing produced an impact that is 63.9 percent of the NAAQS. The modeling results indicate that all areas surrounding the facility are in compliance with the applicable NAAQS standard and should be designated as attainment.

Figure 5-1 illustrates the overall pattern of the total SO_2 concentrations along with the location of the total maximum design concentrations. The maximum total design concentration on the 20-kilometer receptor grid occurs approximately 1,130 meters to the northwest of the main plant area just beyond the ambient air boundary within the 50-meter receptor spacing tier. A close-up of the maximum impact is shown in **Figure 5-2**.

Additional 100-meter spaced receptors were placed at a secondary maximum impact, located in the vicinity of an elevated terrain feature. The area of elevated terrain is known as Crown Butte, with peak elevations rising above the stack tops of R.M. Heskett Station. **Figure 5-3** illustrates the location and magnitude of the final concentration on the 100-meter spaced receptor grid.

Table 5-1: Summary of 1-hour SO_2 Modeling Analysis

Pollutant	Averaging Period	Total Predicted Concentration* ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS (%)
SO_2 *20-km Receptor Grid*	1-Hour	124.57	196	63.6%
SO_2 *100-m Refined Receptor Grid*	1-Hour	125.15	196	63.9%

** Model predictions include monitored background concentrations.*

Figure 5-1: Full Receptor Grid 1-hour SO_2 Model Concentrations

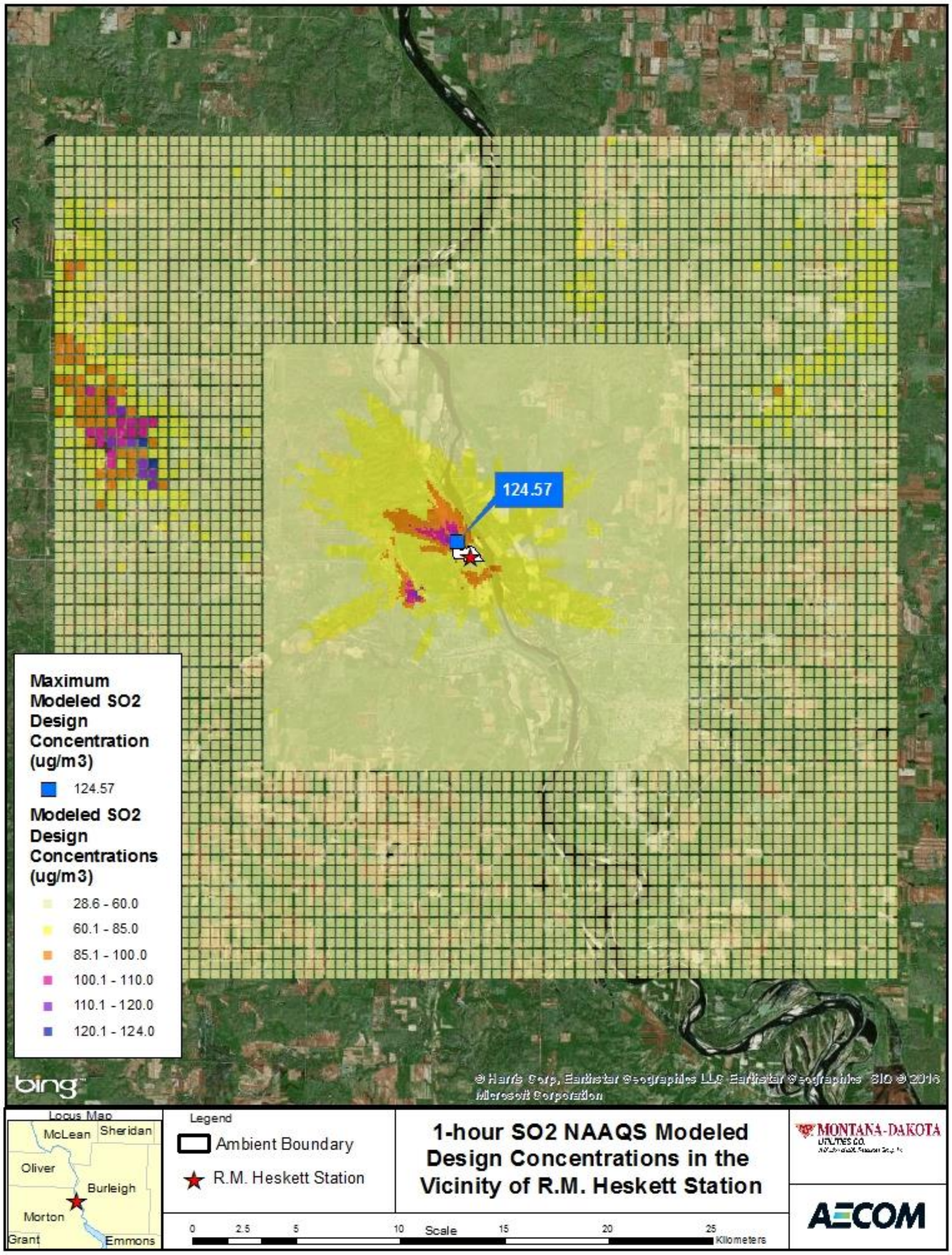


Figure 5-2: Full Receptor Grid 1-hour SO_2 Model Concentrations – Near View of Maximum Impact

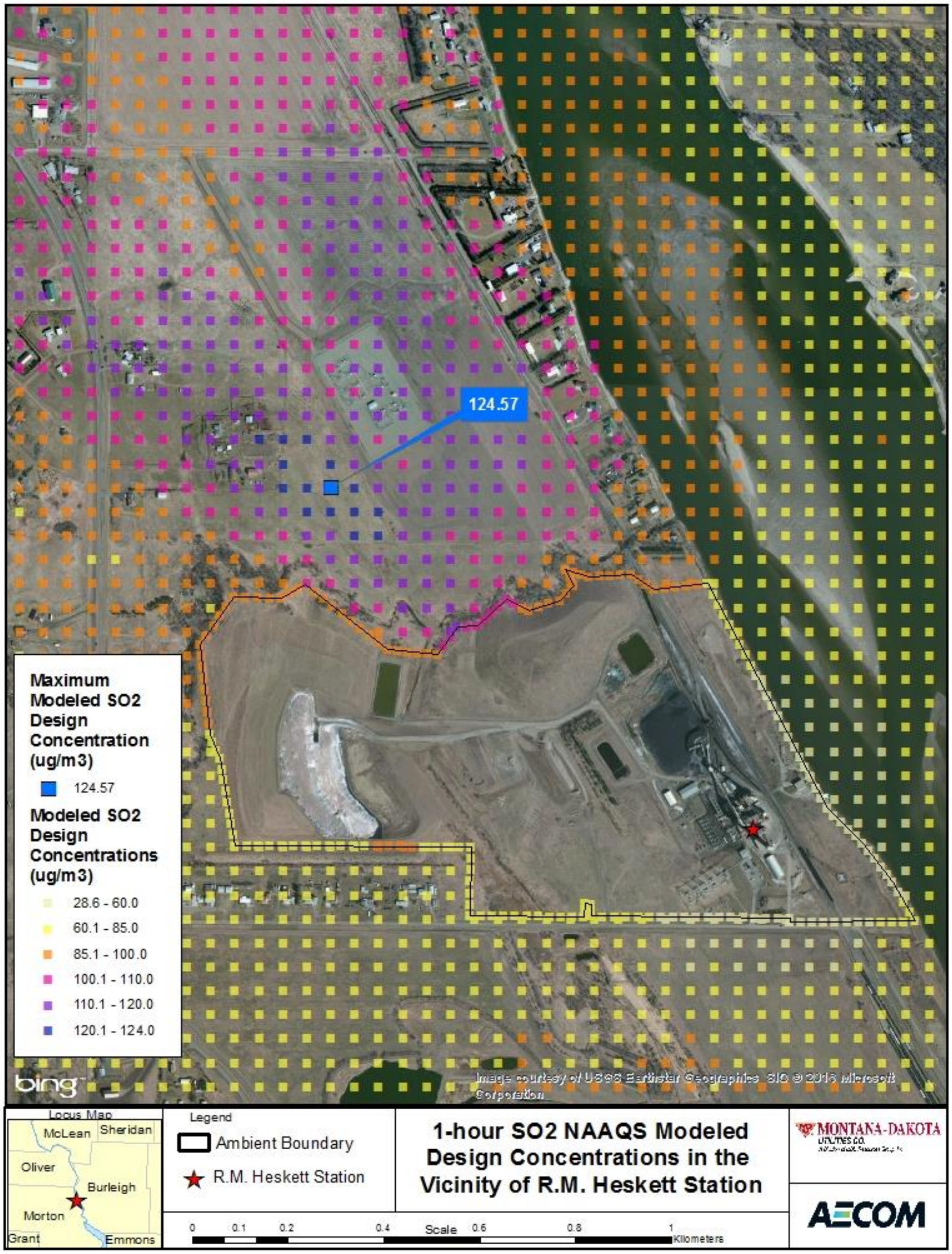
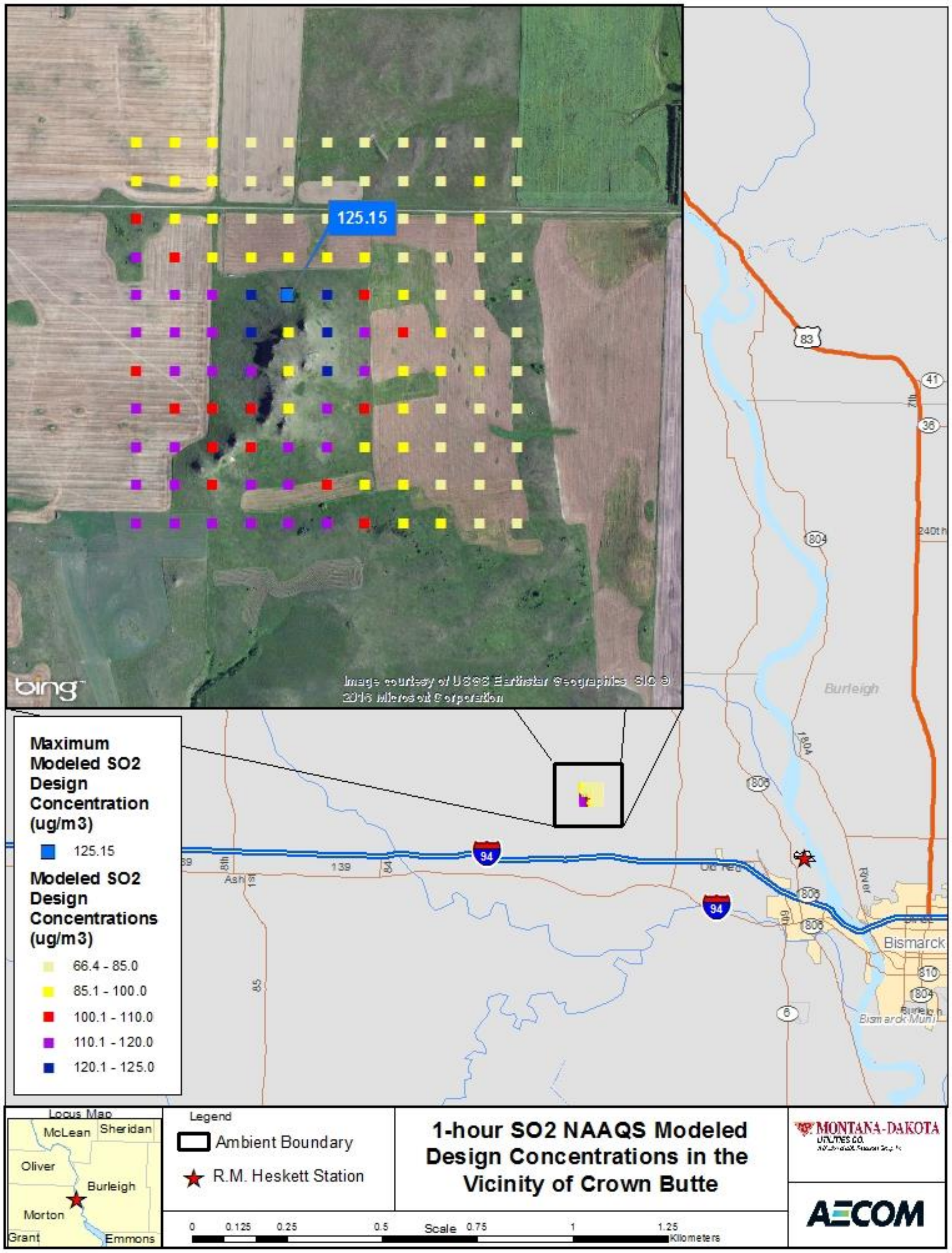


Figure 5-3: Refined Receptor Grid at Crown Butte 1-hour SO_2 Model Concentrations



Appendix A

Listing of 30 Years of Monthly Precipitation Data

Year #	YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
30-Years of Precipitation Data (Inches) For Bismarck, ND														
1	1986	0.37	0.26	0.26	3.60	3.11	3.96	4.25	1.61	4.41	0.35	2.09	0.02	24.30
2	1987	0.14	1.65	1.34	0.13	4.19	1.52	4.59	3.03	0.29	0.10	0.02	0.13	17.15
3	1988	0.69	0.40	0.92	0.12	1.17	2.18	0.56	2.20	0.63	0.15	0.48	0.72	10.21
4	1989	0.60	0.22	0.29	1.87	1.93	0.70	1.76	1.62	1.23	0.21	0.64	0.30	11.37
5	1990	0.26	0.24	0.56	0.31	1.65	4.73	1.53	1.37	1.25	0.29	0.00	0.50	12.70
6	1991	0.17	0.24	0.62	1.62	3.34	2.64	0.65	1.78	2.50	2.33	0.75	0.16	16.79
7	1992	0.31	0.41	0.62	0.22	1.12	3.64	2.46	0.98	1.29	0.39	0.81	0.48	12.73
8	1993	0.29	0.33	0.39	1.26	2.37	4.57	13.75	1.89	0.26	0.02	1.04	0.84	27.02
9	1994	0.59	0.45	0.67	1.06	0.54	3.35	1.76	0.33	5.02	3.41	1.50	0.30	18.98
10	1995	0.42	0.33	1.67	1.00	4.15	1.39	5.00	1.99	0.80	1.12	0.52	0.56	18.94
11	1996	0.94	0.66	1.19	0.52	1.61	2.92	2.73	2.99	2.80	1.73	1.84	0.69	20.63
12	1997	0.85	0.59	0.97	3.26	0.32	1.24	2.20	1.08	1.73	2.29	0.31	0.09	14.94
13	1998	0.09	1.68	0.39	0.67	1.10	2.91	1.89	9.29	0.98	3.09	1.40	0.24	23.73
14	1999	1.13	0.39	0.25	1.61	6.96	3.61	2.52	7.91	1.31	0.43	0.10	0.23	26.47
15	2000	0.39	1.74	1.28	1.52	2.73	5.11	4.03	1.00	0.98	2.48	1.53	0.24	23.03
16	2001	0.46	0.44	0.24	1.88	2.00	6.92	7.31	0.00	1.07	0.85	0.06	0.13	21.38
17	2002	0.33	0.13	0.80	1.15	0.52	1.53	2.61	2.40	0.63	0.79	0.13	0.33	11.35
18	2003	0.27	0.23	0.43	0.85	5.26	2.11	1.36	0.26	1.77	0.63	0.43	0.48	14.09
19	2004	0.59	0.32	1.25	0.78	1.39	3.17	2.83	2.29	2.07	1.09	0.14	0.19	16.14
20	2005	0.36	0.11	0.54	1.04	2.37	6.23	2.65	2.87	0.26	1.21	0.74	0.85	19.24
21	2006	0.19	0.21	0.55	0.74	1.77	0.84	0.58	2.50	1.74	1.11	0.09	0.83	11.15
22	2007	0.14	0.75	1.18	0.80	5.43	3.32	1.25	3.26	1.78	0.83	0.14	0.23	19.11
23	2008	0.11	0.41	0.45	0.73	1.28	3.93	2.85	1.13	2.46	1.73	2.25	1.41	18.74
24	2009	0.83	0.78	2.73	0.70	2.02	7.94	3.14	0.58	1.24	2.21	0.04	0.91	23.13
25	2010	0.70	0.63	1.06	3.09	3.05	2.48	3.01	2.74	3.61	0.68	0.76	1.40	23.22
26	2011	1.14	0.58	1.56	2.35	2.32	3.19	5.24	4.02	0.97	1.35	0.06	0.47	23.26
27	2012	0.30	0.48	0.54	1.71	1.99	2.15	2.65	2.33	0.05	1.03	1.07	0.64	14.94
28	2013	0.26	0.35	0.84	1.81	7.37	2.70	1.63	1.37	4.36	4.73	0.09	1.27	26.78
29	2014	0.39	0.19	0.82	1.95	0.86	3.03	0.73	4.76	0.37	0.15	0.61	0.11	13.97
30	2015	0.76	0.40	0.45	0.37	5.31	4.98	1.50	1.41	0.37	1.07	0.21	0.91	17.75