Environment

Prepared for:
Minnkota Power Coop., Inc.
Center, ND

Prepared by:
AECOM
Chelmsford, MA
60491519
December 2016

1-Hour SO_2 NAAQS Compliance Modeling per the Data Requirements Rule for Minnkota Power Cooperative, Inc. Milton R. Young Station

1-Hour SO_2 NAAQS Compliance Modeling per the Data Requirements Rule for Minnkota Power Cooperative, Inc. Milton R. Young Station

Prepared By: Stephanie Carcieri

Reviewed By: Robert J. Paine

Project Quality Representative Review By: Leo J. Gendron

Contents

List of Appendices

Appendix A 30-Year Monthly Precipitation Data Listing

List of Tables

List of Figures

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, including Minnkota Power Cooperative, Inc. for the Milton R. Young Station[2] (hereafter "M.R. Young"), 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:

1) installing and operating an ambient air monitoring network; or
2) 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:

3) limits annual SO_2 emissions to less than 2,000 tons, or
4) 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 involving the M.R. Young Station for Option 2 as noted above 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 M. R. Young Station, located in Center, North Dakota. This modeling report has been prepared and submitted to the NDDH to provide a description of the modeling procedures and the results of the modeling analysis that shows that the area in the vicinity of the M.R. Young station is in compliance with the 1-hour SO_2 NAAQS.

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

[2] Minnkota Power Cooperative, Inc. owns and operates the M.R. Young Station.

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. Minnkota Power Cooperative, Inc. submitted a supplemental modeling protocol for M.R. Young Station to NDDH dated November 16, 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 Minnkota Power Cooperative, Inc.-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)[3] 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 "March 1 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 Contents of this Modeling Report

This report consists of five sections. **Section 1** provides this introductory discussion. **Section 2** provides a description of the M.R. Young Station. That section also includes a topographic map centered at the source, and tables of emission points with stack parameters included. **Section 3** presents 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 modeling results.

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

2.0 Description of Minnkota Power Cooperative, Inc. M.R. Young Station

M.R. Young Station is located about 8 kilometers southeast of Center, North Dakota in Oliver County. The station has two existing coal-fired boilers (Unit 1 & Unit 2). Unit 1 and Unit 2 each exhaust through their own separate stack, which are 171.9 meters and 167.6 meters tall, respectively.

The location of the plant is shown in **Figure 2-1**. An aerial map of the area surrounding M.R. Young is provided in **Figure 2-2**. As shown in **Figure 2-2**, the area in the immediate vicinity (i.e., within 3 km) of M.R. Young 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 M.R. Young Station. While there are other small insignificant sources of SO_2 at M.R. Young Station, they operate under emergency conditions and thus do not operate routinely and/or have very low actual SO_2 emissions. 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[4]. As such, the two coal-fired boilers are the only emission sources at the M.R. Young Station that were included in the 1-hour SO_2 modeling.

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

Unit	E. Coordinates (UTM Zone)	N. Coordinates (UTM Zone)	Stack Base Elevation (m)	Stack Height (m)	Stack Diameter (m)
Unit 1	331841.890	5214890.130	597.4	171.9	6.2
Unit 2	331746.810	5214867.970	600.5	167.6	9.1

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

[4] 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 M.R. Young Station

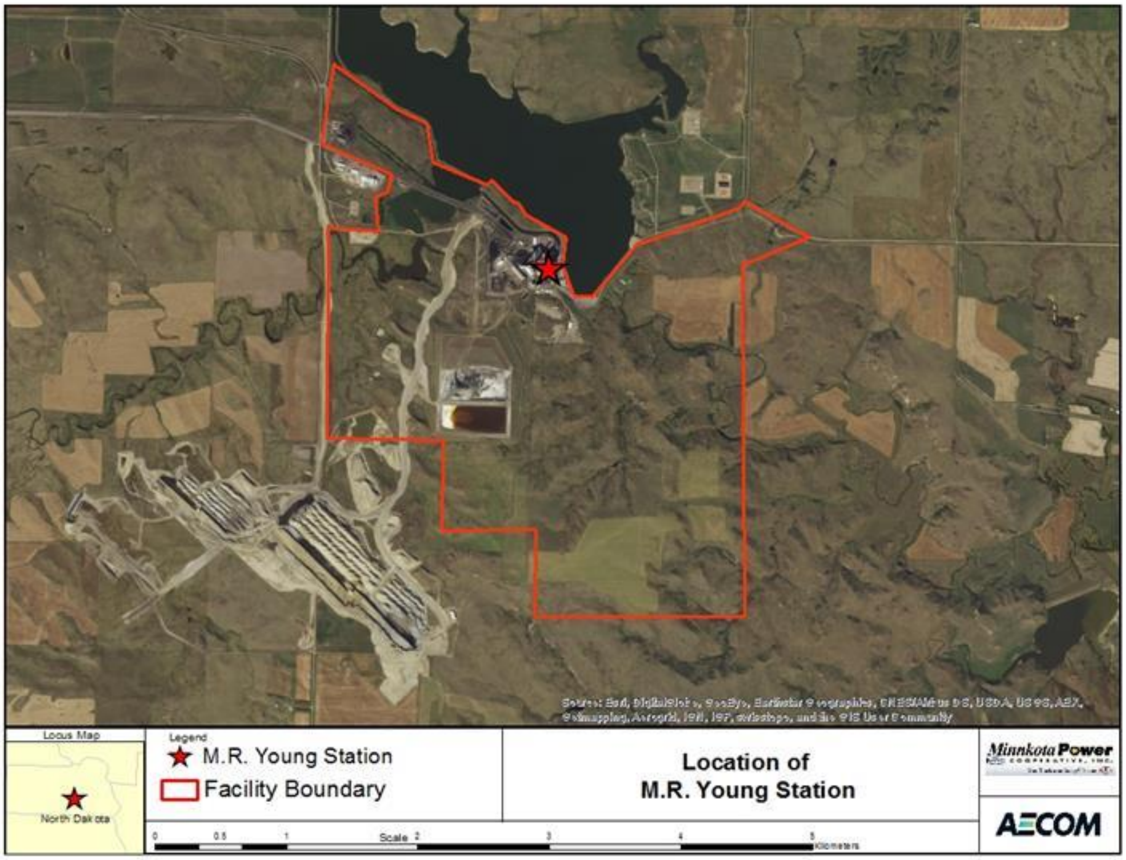
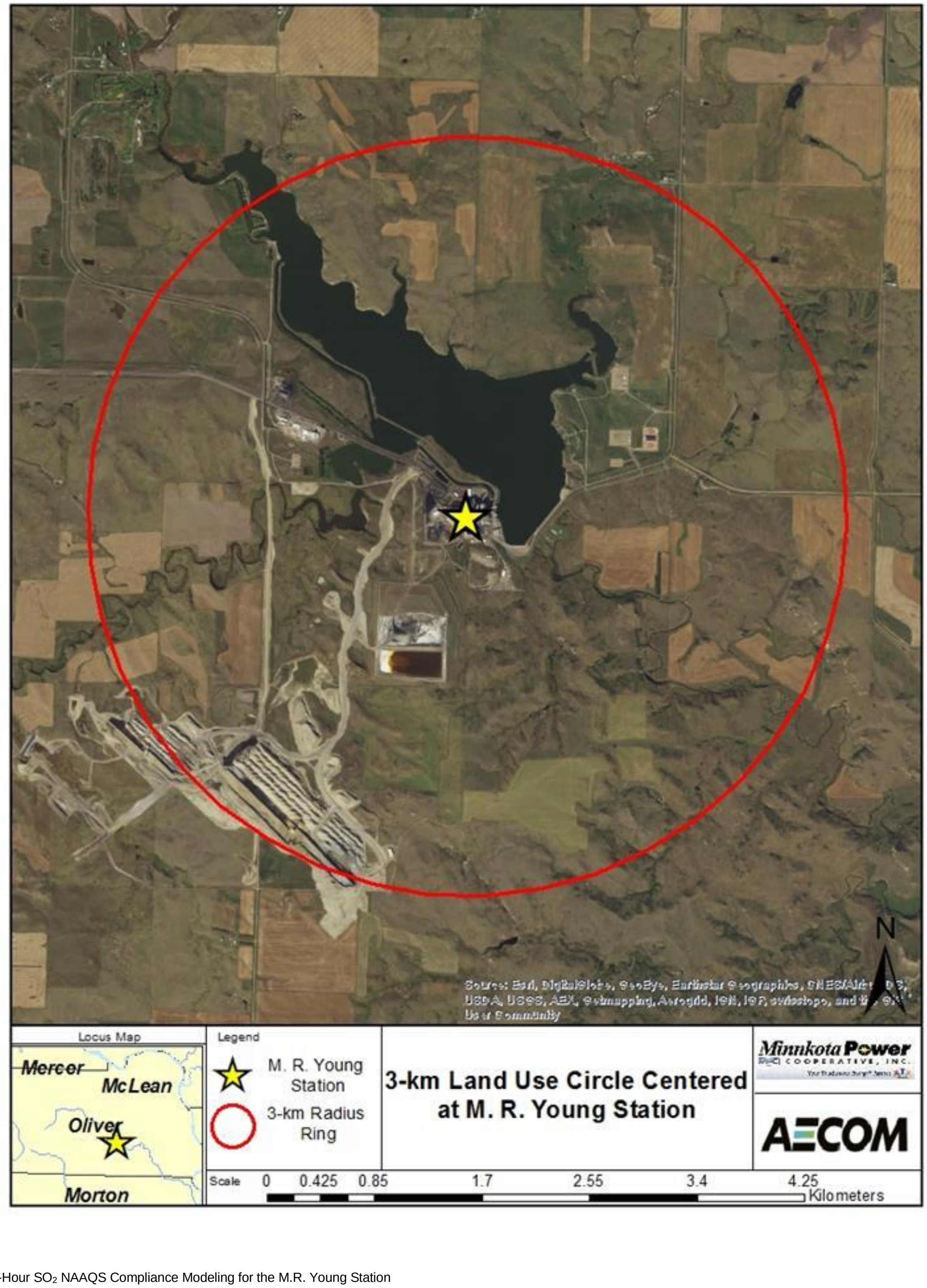


Figure 2-2: 3-km Land Use Circle Centered at M. R. Young Station with Aerial Imagery



3.0 Dispersion Modeling Selection and Options

The USEPA Guideline on Air Quality Models (Appendix W[5]) 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[6] of AERMOD (15181) using default modeling options was used in the DRR modeling for M.R. Young 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 replaced the previous version of AERMOD dated 14134.

Based on USEPA guidance in the TAD, all stacks were modeled with their actual physical stack height with the use of actual emissions to characterize actual air quality through modeling in the vicinity of the M.R. Young Station. 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 **Figure 3-1**.

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 (where public access is restricted) of Minnkota Power Cooperative, Inc. M.R. Young Station.

For this application, no receptors were excluded from water bodies, but receptors were excluded from the secured property within M.R. Young Station. Receptor spacing used in the modeling is consistent with NDDH guidelines[7] and features the most closely spaced receptors in the immediate vicinity of the M.R. Young Station.

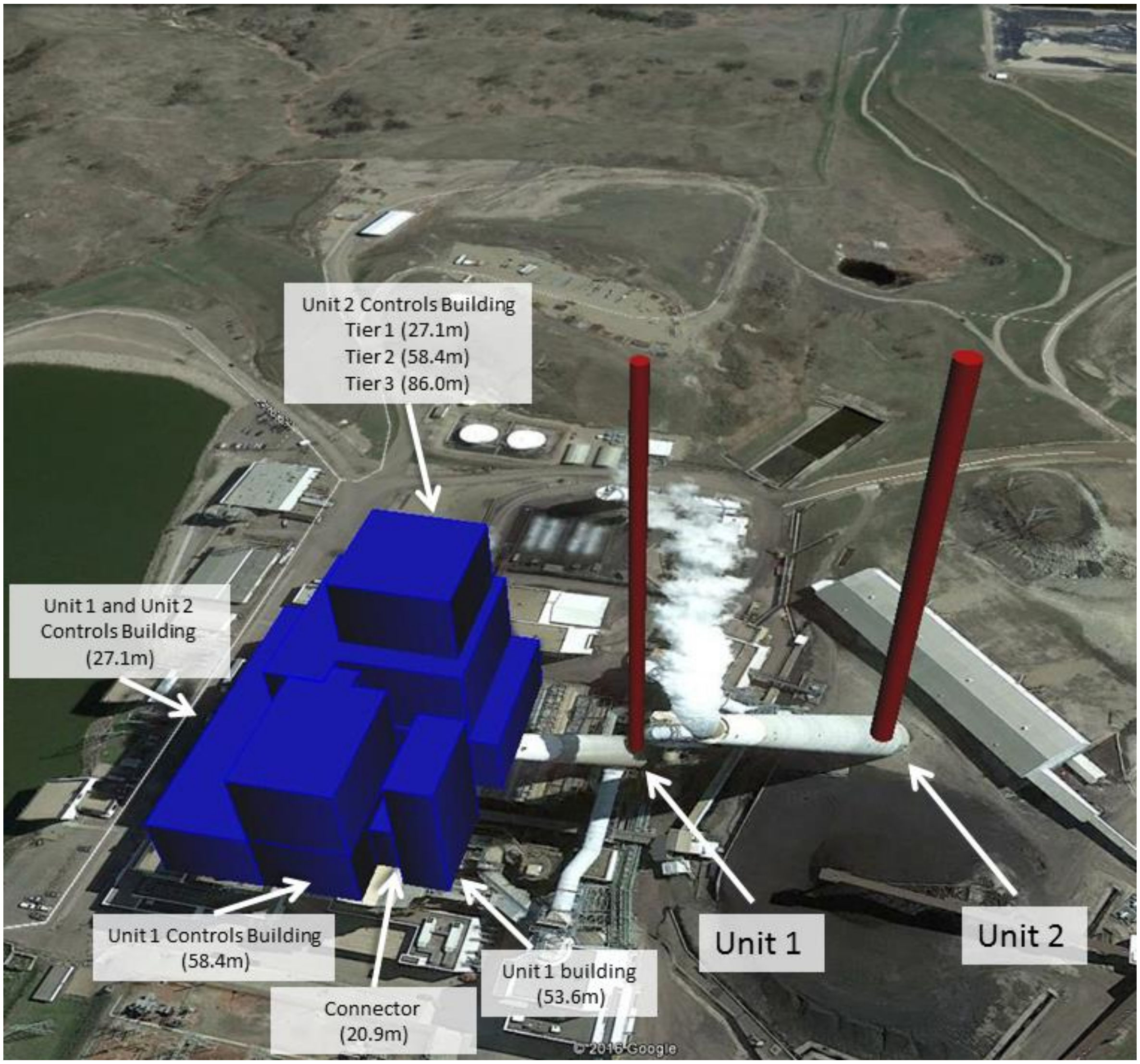
---

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

[6] As of December 20, 2016.

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

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



4.0 Modeling Configuration

4.1 Ambient Air Boundary and Receptor Network

The location of M R. Young Station is shown in **Figure 2-1**. The facility's secured property was used to establish the ambient air boundary and is denoted by the red line in **Figure 2-1**. Receptor spacing along the fence line is 25 meters. Receptor spacing is consistent with NDDH guidelines[8]. The results from this receptor grids discussed below are included in **Section 5**.

A 2-phased modeling approach was conducted for M.R. Young. The first modeling phase, focusing on emissions only from the M.R. Young Station, used the following Cartesian receptor grid extending from M.R. Young out to 25 kilometers:

- 25-m receptor spacing along the M. R. Young boundary,
- 50-m receptor spacing extending out 500m from the grid center,
- 100-m receptor spacing extending out 3 kilometers from the grid center,
- 250-m receptor spacing between 3 and 5 kilometers from the grid center,
- 500-m receptor spacing between 5 and 10 kilometers from the grid center, and
- 1000-m receptor spacing will be used beyond 10 kilometers (out to 25 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 M. R. Young.

The extent of this grid sufficiently captured the maximum modeled impacts from the Station. Moreover, the maximum impacts were well within 10 km of the M. R. Young facility (shown later in Section 5). In that case, any M. R. Young modeled impacts greater than 10 km away from M. R. Young had minimal interaction with other regional SO_2 sources. Moreover, the other facilities may have used different modeling configurations, and in some cases different meteorological and background concentration data.

The second phase of the modeling was conducted out to 10 km and included all background sources identified in the NDDH modeling protocol. The following Cartesian receptor grid was used for Phase 2 modeling extending from M.R. Young out to 10 kilometers:

- 25-m receptor spacing along the M. R. Young boundary,
- 50-m receptor spacing extending out 500m from the grid center,
- 100-m receptor spacing extending out 3 kilometers from the grid center,
- 250-m receptor spacing between 3 and 5 kilometers from the grid center, and
- 500-m receptor spacing between 5 and 10 kilometers from the grid center.

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

Figure 4-1 shows the model receptor grids for a near-field view. **Figures 4-2** and **4-3** show the model receptor grids for far-field views for Phase 1 (M.R. Young sources only) and Phase 2 (M.R. Young with background sources), respectively.

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 1/3 arc second (~10 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, were considered.

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

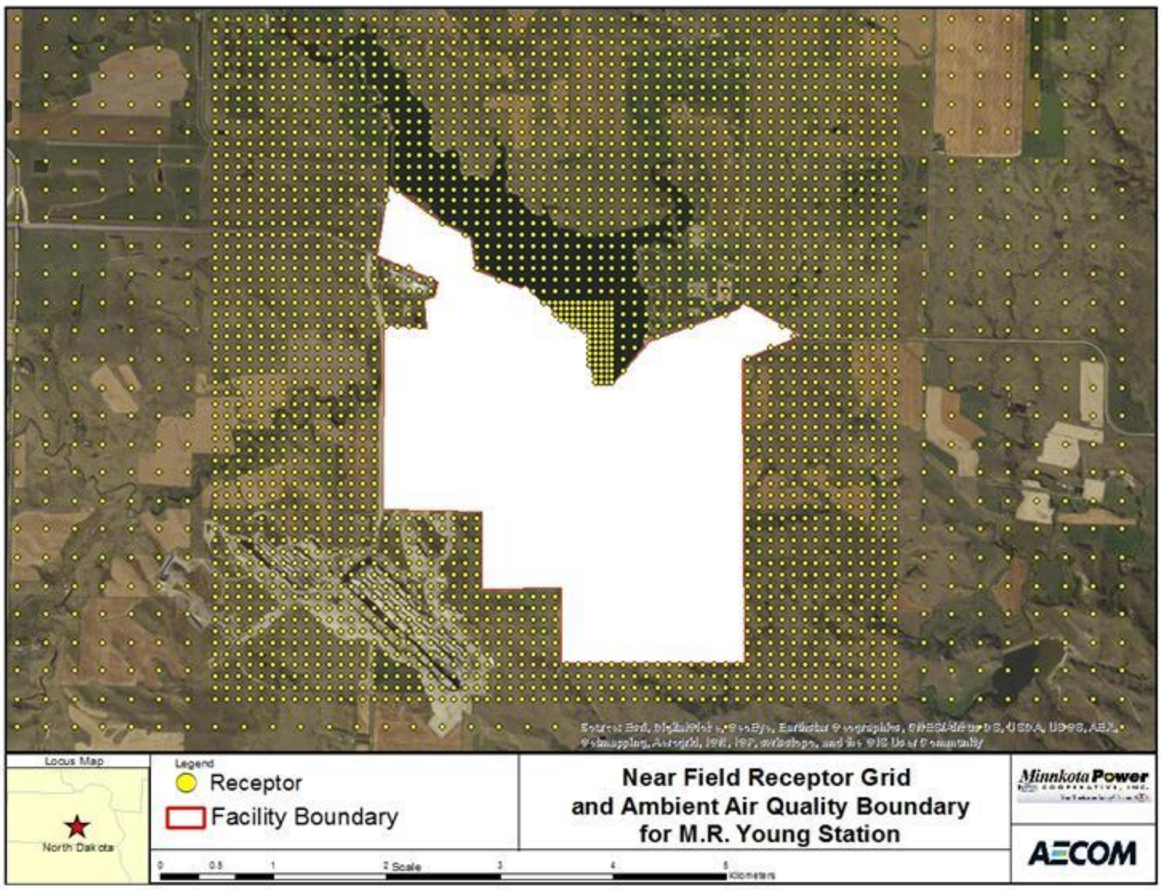


Figure 4-2: 25-km Receptor Grid for M. R. Young Station – Used for M. R. Young-only Source (Phase 1 Modeling)

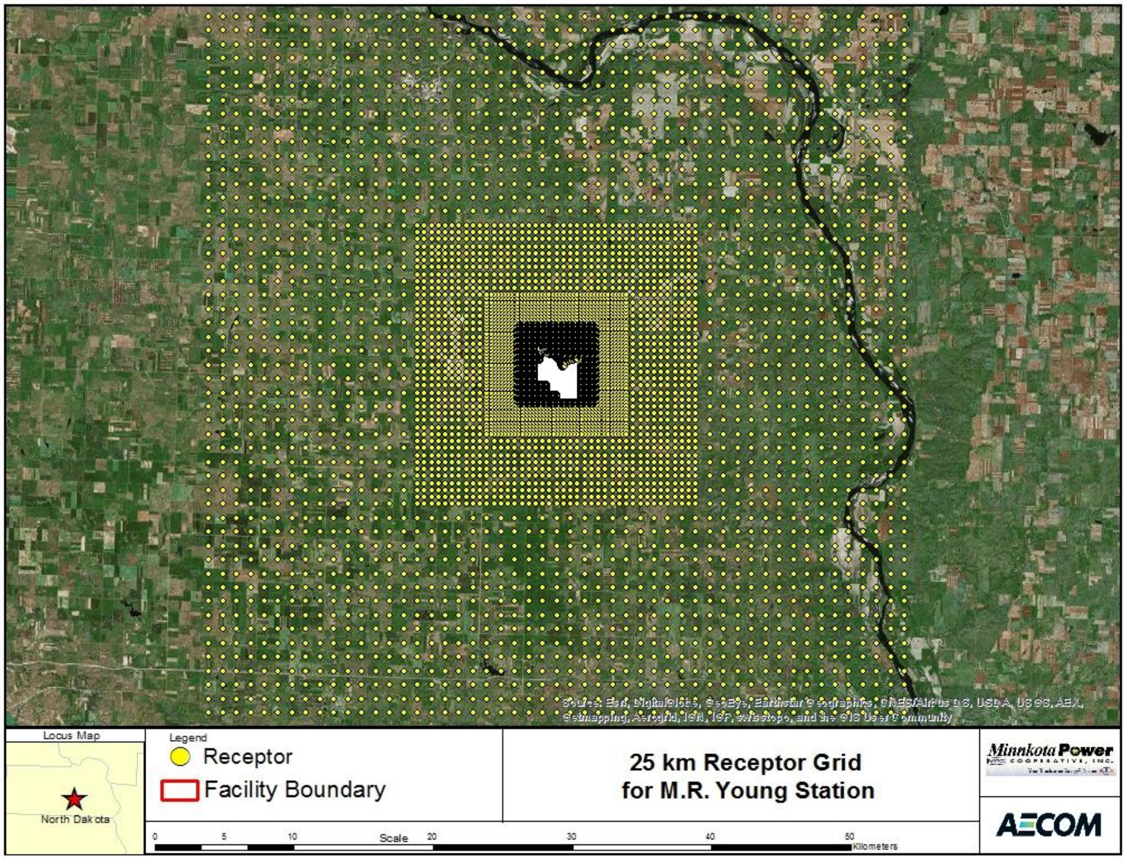
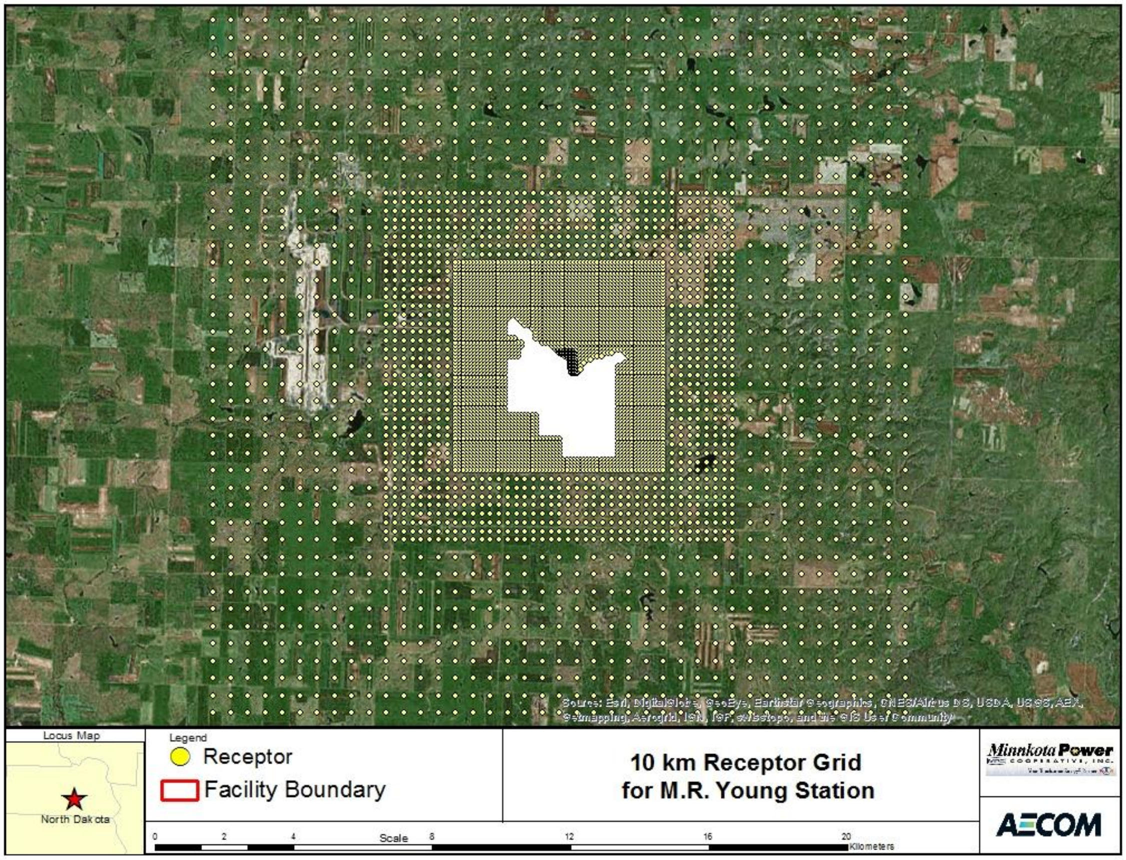


Figure 4-3: 10-km Receptor Grid for M. R. Young Station – Used for M.R. Young and Background Sources (Phase 2 Modeling)



4.2 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 were processed from the state-operated meteorological station in Beulah, ND. Sub-hourly (1-minute) wind data (used as backup to Beulah) were processed from nearby Garrison Municipal Airport in Garrison, ND. Cloud cover observations were available from the regional observing stations at Hazen and 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.

4.2.1 Available Offsite Meteorological Data and NWS Upper Air Data

The hourly meteorological data for M.R. Young 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 Beulah station along with concurrent upper air data from Bismarck, ND. Sub-hourly observations were obtained from Garrison Municipal Airport for 2013-2015 as backup to the observations at Beulah. Since cloud cover data is not recorded from the Beulah meteorological station, cloud cover observations were taken from nearby Mercer County Airport in Hazen, ND. For periods (such as in portions of 2015) when cloud cover observations from the Mercer County Airport were missing, cloud cover data from the Bismarck Airport were substituted. This approach led to hourly observations to have at least 94% data capture, as shown in **Table 4-1**. Missing upper air data from Bismarck, ND were substituted with data from Glasgow, MT[9]. **Figure 4-4** shows the location of meteorological stations in relationship to the M.R. Young.

The AERMET inputs were based on surface meteorological data from the NDDH database along with 1-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 the Beulah station for the years 2013-2015 is shown in **Figure 4-5**.

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	99.21%	99.31%	98.91%	99.64%	99.27%	90.00%
2014	99.63%	99.82%	98.91%	99.18%	99.39%	90.00%
2015	100.00%	99.08%	94.84%	97.37%	97.82%	90.00%

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

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

Met Site	Latitude	Longitude	Base Elevation (m)	Data Source	Data Format
Beulah, ND	47.229	-101.767	630	NDDH	TEXT
Garrison Municipal Airport – Garrison, ND	47.646	-101.439	583	NCDC	1 min ASOS
Mercer County Airport – Hazen, ND[1]	47.287	-101.557	553	NCDC	ISHD
Bismarck Airport – Bismarck, ND[1]	46.774	-100.748	506	NCDC	ISHD
Bismarck, ND	46.774	-100.748	506	FSL	FSL
Glasgow, MT	48.200	-106.620	693	FSL	FSL

[1] Sites used to obtain cloud cover data for AERMET processing.

Figure 4-4: Location of Meteorological Stations Relative to M.R. Young

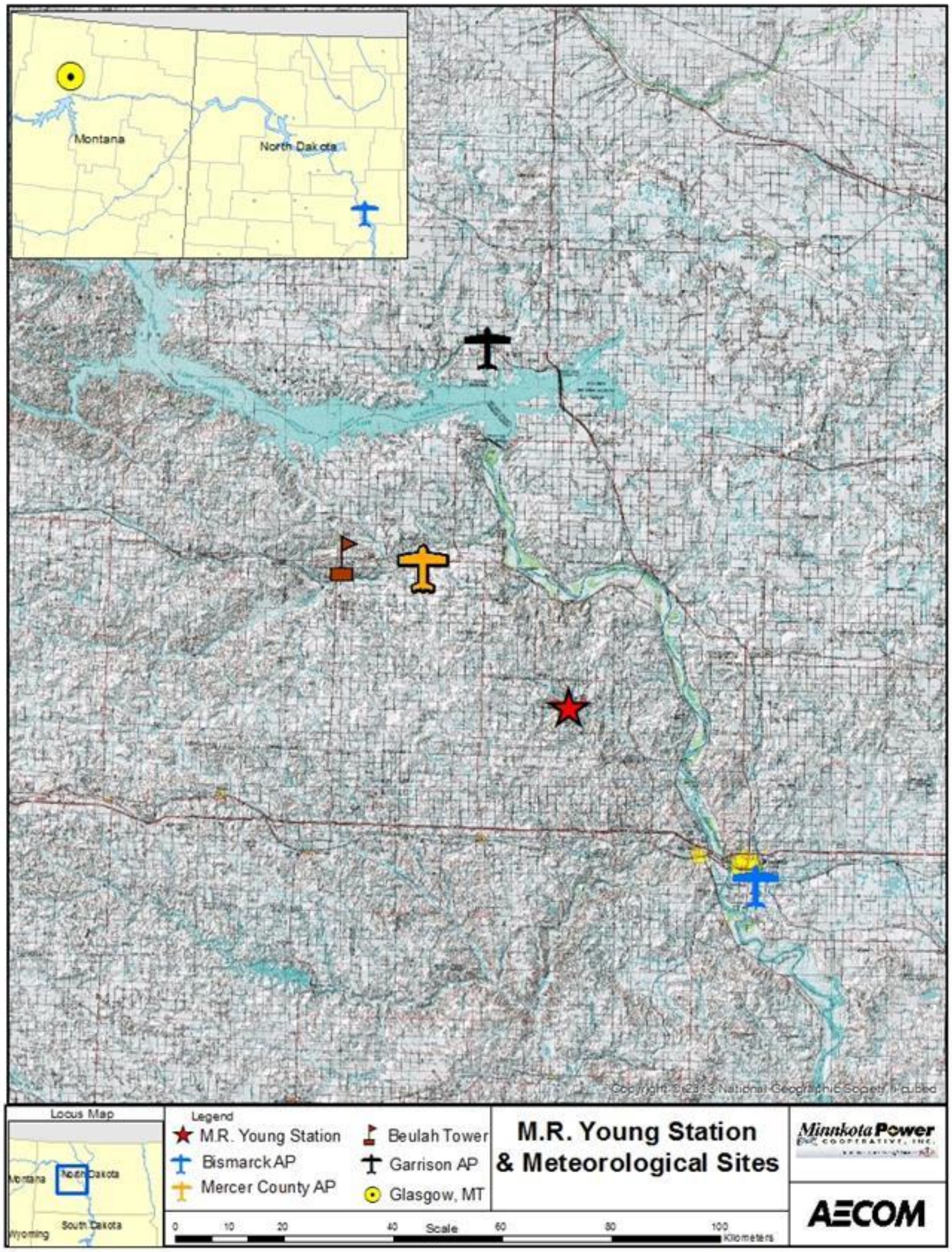
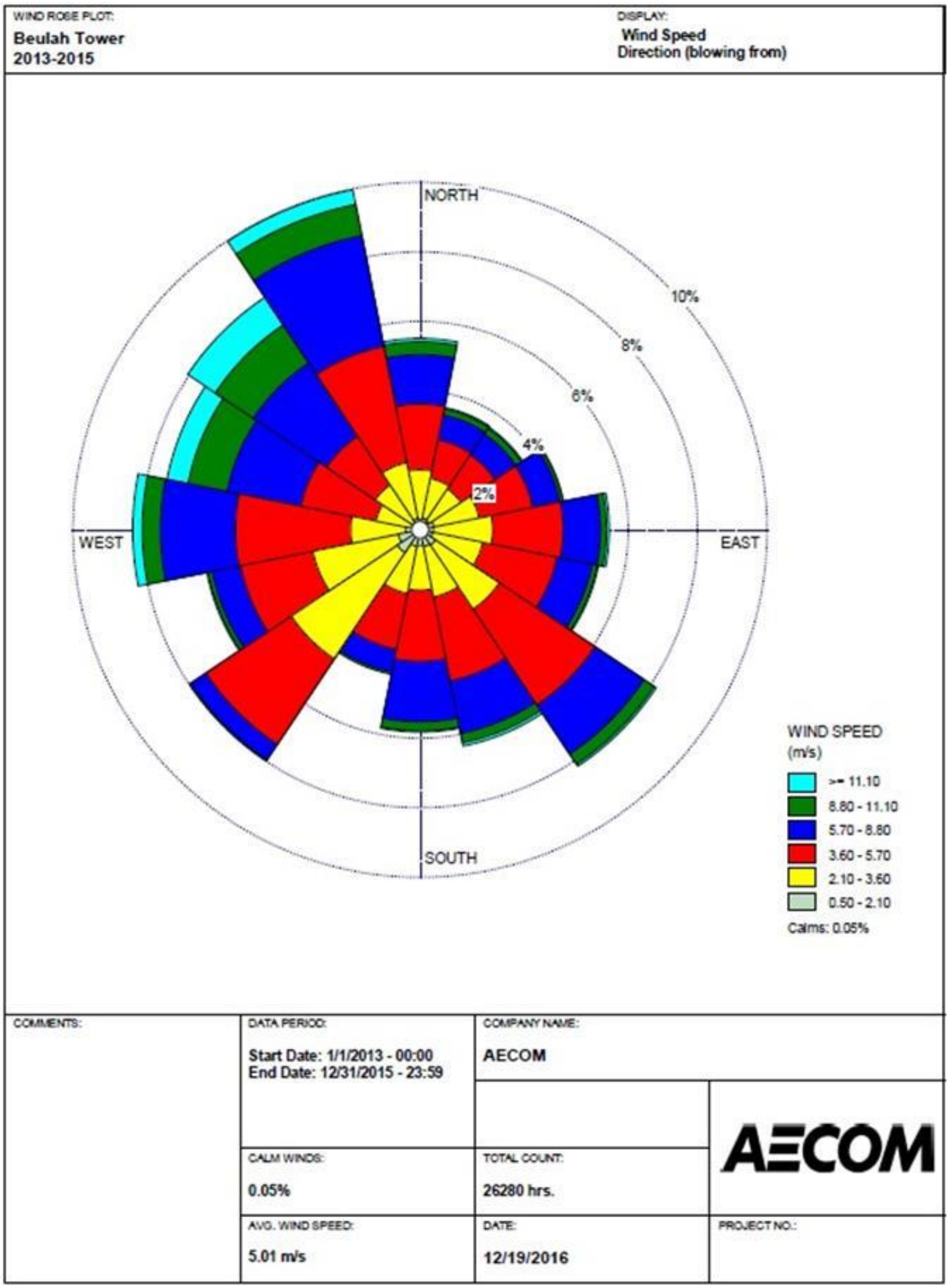


Figure 4-5: Wind Rose for Beulah Meteorological Station, Beulah, ND



4.2.2 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)[10].

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[11] 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[12] (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[13] provided by NDDH were used for the M. R. Young SO_2 DRR modeling demonstration. This includes using a 1-km radius circular area, which was divided into twelve sectors for surface roughness determination. The recently revised AERMOD Implementation Guide (AIG)[14] issued by the US Environmental Protection Agency recommends this circular area be centered at the meteorological station site. Since the meteorological site is at a state-operated meteorological

---

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

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

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

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

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

monitor site, the AERSURFACE input was not marked as an airport. A secondary set of surface characteristics for the twelve sectors was developed around the backup NWS Hazen airport. Due to some missing cloud cover data at Hazen in 2015, a secondary backup set of surface characteristics for the twelve sectors was developed around the Bismarck airport. In AERMET Stage 3, the primary set of characteristics were applied for those hours in which the onsite data are used and the secondary set were applied for those hours in which the NWS surface file or 1-minute ASOS wind data are substituted for missing or calm onsite data. Additional details on the seasonal classification and surface moisture determination are provided in the following sub-sections.

4.2.2.1 Seasonal Classification

The AERSURFACE seasonal categories by month were developed for each modeled year and applied for the primary (Beulah site) and secondary (Hazen airport in 2013-2014; Bismarck airport in 2015) sites, as shown in **Table 4-3**. A month was selected as a "winter with continuous snow on the ground" if a month had at least half of the days with recorded snow on the ground. Daily snow cover records were obtained for the Garrison and Bismarck airports from the National Climatic Data Center (NCDC)[15].

Table 4-3 : Selected Seasonal Categories for AERSURFACE

Season Description	2013	2014	2015
Late autumn after frost and harvest, or winter with no snow	3,4	3	11, 2, 3
Winter with continuous snow on the ground	12,1,2	11, 12, 1, 2	12, 1
Transitional spring	5	4, 5	4, 5
Midsummer with lush vegetation	6,7,8	6,7,8	6,7,8
Autumn with unharvested cropland	9,10,11	9,10	9,10

4.2.2.2 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 the AERSURFACE User's Guide, the surface moisture condition for each season was determined by comparing precipitation for the period of data to be processed to a recent 30-year record at Garrison airport (for 2013-2014) and Bismarck airport (for 2015) precipitation records. This procedure selected "wet" conditions if precipitation was in the upper 30th percentile, "dry" conditions if precipitation was in the lower 30th percentile, and "average" conditions if precipitation was in the middle 40th percentile. Surface moisture data for M. R. Young Station is

[15] http://www.ncdc.noaa.gov/cdo-web/search

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

Table 4-4: AERSURFACE Bowen Ratio Condition Designations

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

[A] Precipitation from Garrison airport.
[B] Precipitation from Bismarck airport.

4.2.3 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 were determined following procedures outlined below. In running AERMET, the observed airport hourly wind directions (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.

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

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

M.R. Young Station, the profile file contains a single level of wind data (10 meters) and the temperature data only, corresponding to the Beulah tower observation.

4.3 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 are to be used in the dispersion modeling analysis. Conversely, if more than 50% of the area is urban, urban dispersion coefficients are used. As shown in **Figure 2-2**, there is much less than 50% compact residential and industrial development in the 3-km radius surrounding M.R. Young Station. Therefore, rural dispersion characterization was used for this modeling effort.

4.4 Nearby Sources and Ambient Background Concentrations

4.4.1 Nearby Sources to be Modeled

NDDH identified several nearby sources to be explicitly modeled as background sources for the M.R. Young Station. The Coal Creek Plant, Stanton Plant, LeLand Olds Plant, Otter Tail Power, Coyote Station and M.R. Heskett Station were identified by NDDH as nearby sources to M.R. Young and therefore were included as part of the modeling for M.R. Young Station. Stack parameters which were provided by NDDH were used to model these nearby sources, and are listed in **Table 4-5**. The emissions for modeling of the nearby sources consisted of actual hourly CEM data for the most recent three calendar years (2013-2015), except for LeLand Olds, which used a NDDH-approved emission rate of 488.36 g/s[17].

Table 4-5: Stack Parameters and Locations for Nearby Sources Included in Modeling for M.R. Young

	UTM E (m)	UTM N (m)	Base Elevation (m)	Stack Height (m)	Stack Diameter (m)
LeLand Olds	324459.257	5238977.568	518.617	182.880	9.976
Coyote	286869.200	5233589.000	590.520	151.790	6.400
Coal Creek U1	337123.342	5249489.285	591.312	205.740	7.849
Coal Creek U2	337224.813	5249490.233	591.312	205.740	7.849
Heskett U1	356414.500	5192141.500	505.206	91.084	2.210
Heskett U2	356448.500	5192035.200	505.206	91.084	3.658
Stanton	323642.150	5239607.700	517.703	77.724	4.600

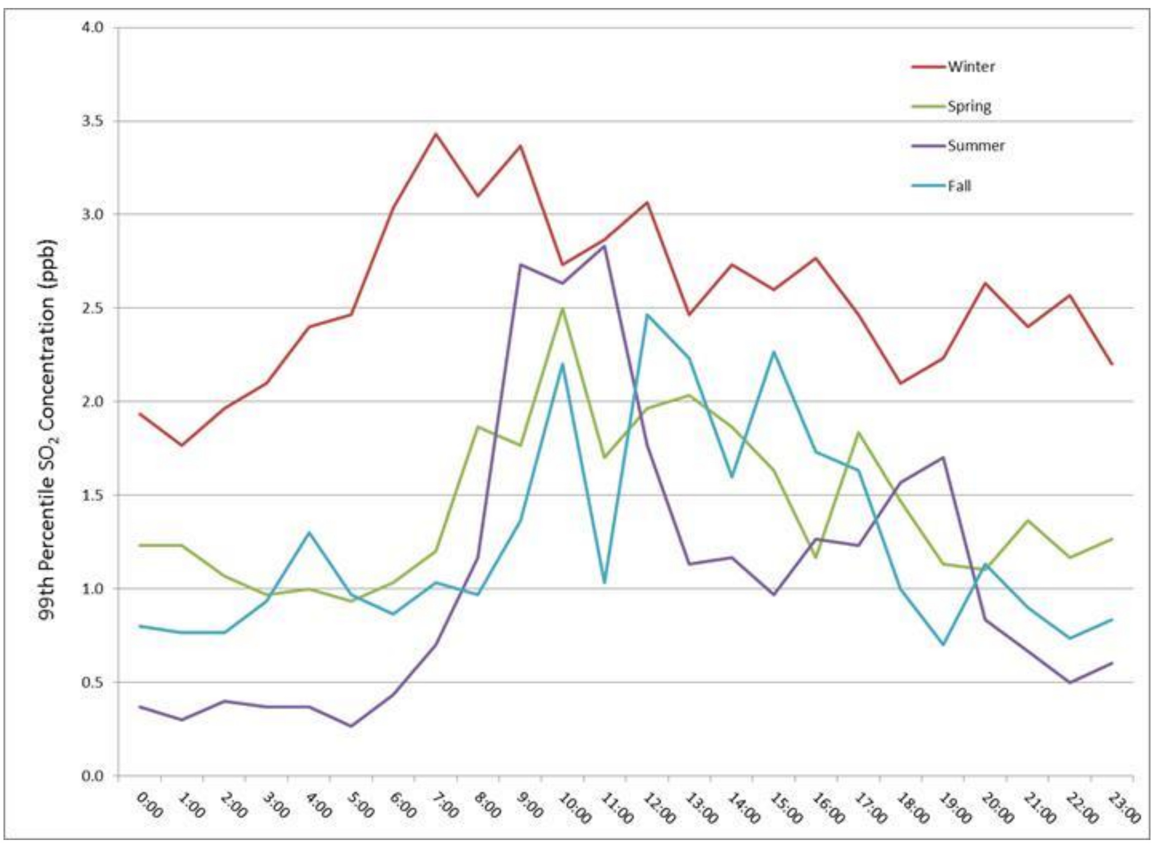
[17] This is emission rate is the maximum short-term emission rate at full load as used in its recent remodeling for the CD process.

4.4.2 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 was added to a set of measured ambient background concentrations to estimate the total design concentration. This total design concentration was used to characterize the area as attainment or non-attainment for the 1-hour SO_2 NAAQS.

The background concentration was calculated as a 3-year (2013-2015) average of the 99th percentile by season and hour-of-day and added internally in AERMOD to the AERMOD-predicted concentration for comparison with the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS) of196.5 $\mu g/m^3$. The Dunn Center seasonal SO_2 concentrations are displayed in **Figure 2-6**.

Figure 4-6: 2013-2015 Average 99th Percentile Concentration at Dunn Center SO_2 Monitor



5.0 SO_2 Characterization Assessment Results

The 1-hour SO_2 characterization modeling for the M.R. Young 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), and (4) direction received from the NDDH Modeling Staff.

The 1-hour SO_2 characterization modeling was conducted using AERMET (version 15181) and AERMOD (version 15181) with default model options, the meteorological data described in **Section 4.2**, and the emission rates discussed in **Section 2** and **Section 4.4.1** for M.R. Young Station and the NDDH-identified nearby sources respectfully. Modeled concentrations were predicted over the receptor grids described in **Section 4.1**.

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 Dunn Center monitor as described in **Section 4.4.2**. The total design concentration was then compared to the 1-hour SO_2 primary NAAQS to determine if the area surrounding M.R. Young Station should be designated as attainment or non-attainment.

A summary of the 1-hour SO_2 modeling results is presented in **Tables 5-1 and 5-2**. **Figure 5-1** illustrates the overall pattern of the SO_2 concentrations along with the location of the maximum design concentrations from M.R. Young only. The maximum total design concentration on the 25-kilometer receptor grid occurs approximately 2,000 meters to the northwest of the main plant area just beyond the ambient air boundary within the 100-meter receptor spacing tier. **Figure 5-2** provides a close-up view of the maximum impact from M.R. Young.

Figure 5-3 shows the location of the maximum design concentrations for M.R. Young, nearby sources and ambient background. The maximum total design concentration for the cumulative modeling using the 10-km receptor grid (as described in **Section 4.1**) is approximately 10.3 km to the southeast of M.R. Young. Additional 100-meter spaced receptors were placed around the area of maximum impact for a refined modeling assessment. **Figure 5-4** illustrates the location and magnitude of the concentration on the 100-meter spaced receptor grid for the maximum cumulative impacts. The maximum impact receptor from the cumulative modeling is predominantly affected by emissions from the distant R.M. Heskett Station[18].

As shown in **Table 5-2**, the cumulative modeled concentrations of 1-hour SO_2 are well below the NAAQS. The most refined receptor spacing produced an impact that is only about 40.9 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. In addition, given how low the results are relative to the NAAQS, additional future maintenance modeling should not be

[18] Note that for this modeling application, the emissions from R.M. Heskett Station were modeled with default options, but for a separate modeling study focusing upon that station, the ADJ_U* option was used (after receiving site-specific EPA approval) along with meteorological data from the Bismarck airport.

warranted since the peak impacts were less than 50% of the NAAQS (as noted in the Data Requirements Rule (80 FR 51081).

The modeling archive (accompanying this report as an attachment) contains all the electronic files needed to review and produce the results contained in this report.

Table 5-1: Summary of 1-hour SO_2 Modeling Analysis for M.R. Young Only

Pollutant	Averaging Period	M.R. Young Predicted Concentration* (μg/m³)	NAAQS (μg/m³)	Percent of NAAQS (%)
SO_2 *25-km Receptor Grid*	1-Hour	23.19	196	11.8%

** Model predictions do not include monitored background concentrations.*

Table 5-2: Summary of 1-hour SO_2 Cumulative Modeling Analysis

Pollutant	Averaging Period	Total Predicted Concentration* (μg/m³)	NAAQS (μg/m³)	Percent of NAAQS (%)
SO_2 *100-m Refined Receptor Grid*	1-Hour	80.13	196	40.9%

** Model predictions include monitored background concentrations.*

Figure 5-1: 25-km Receptor Grid 1-hour SO_2 Model Concentrations – M.R. Young Station Only

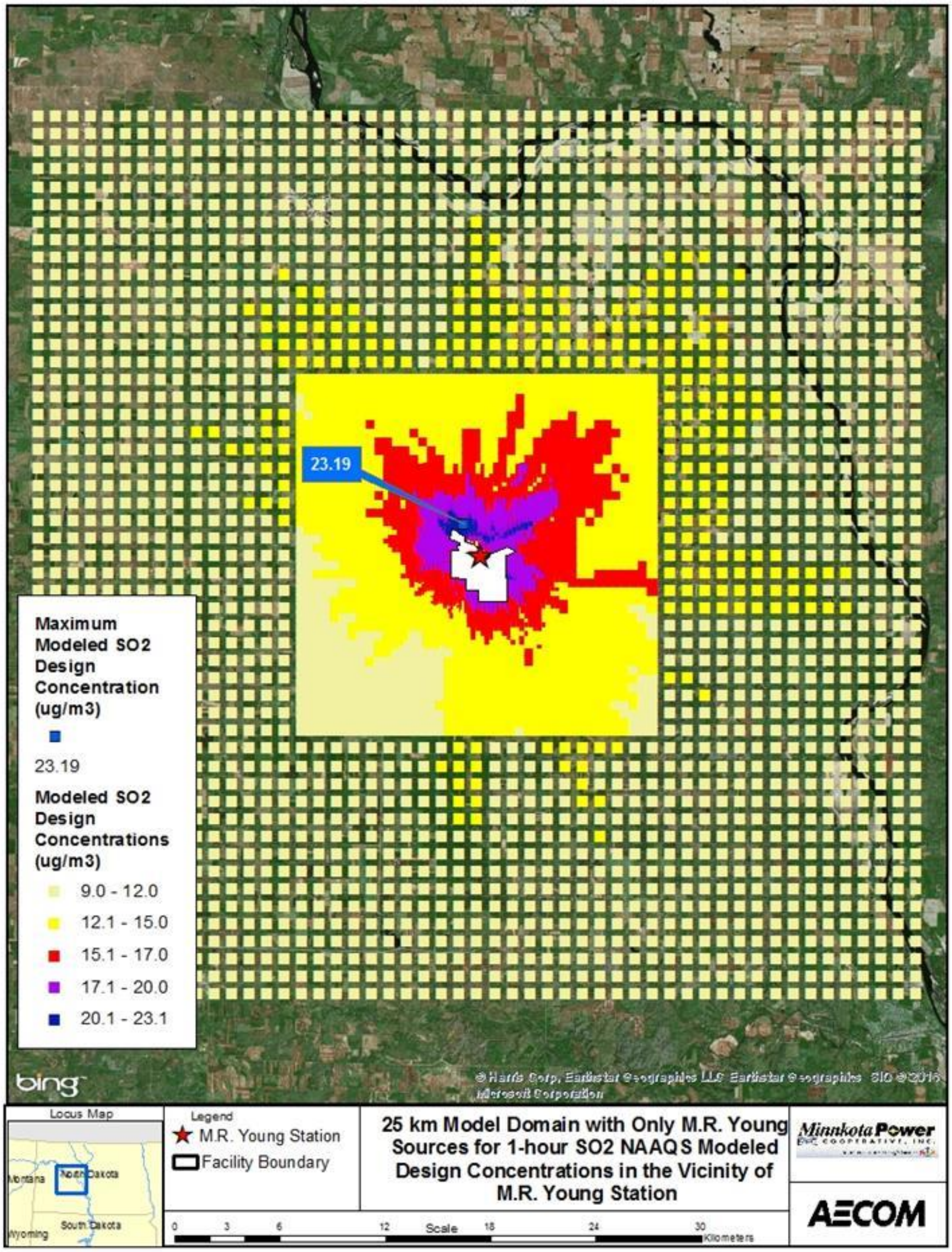


Figure 5-2: 25-km Receptor Grid 1-hour SO_2 Model Concentrations – M.R. Young Station Only Near View of Maximum Impact

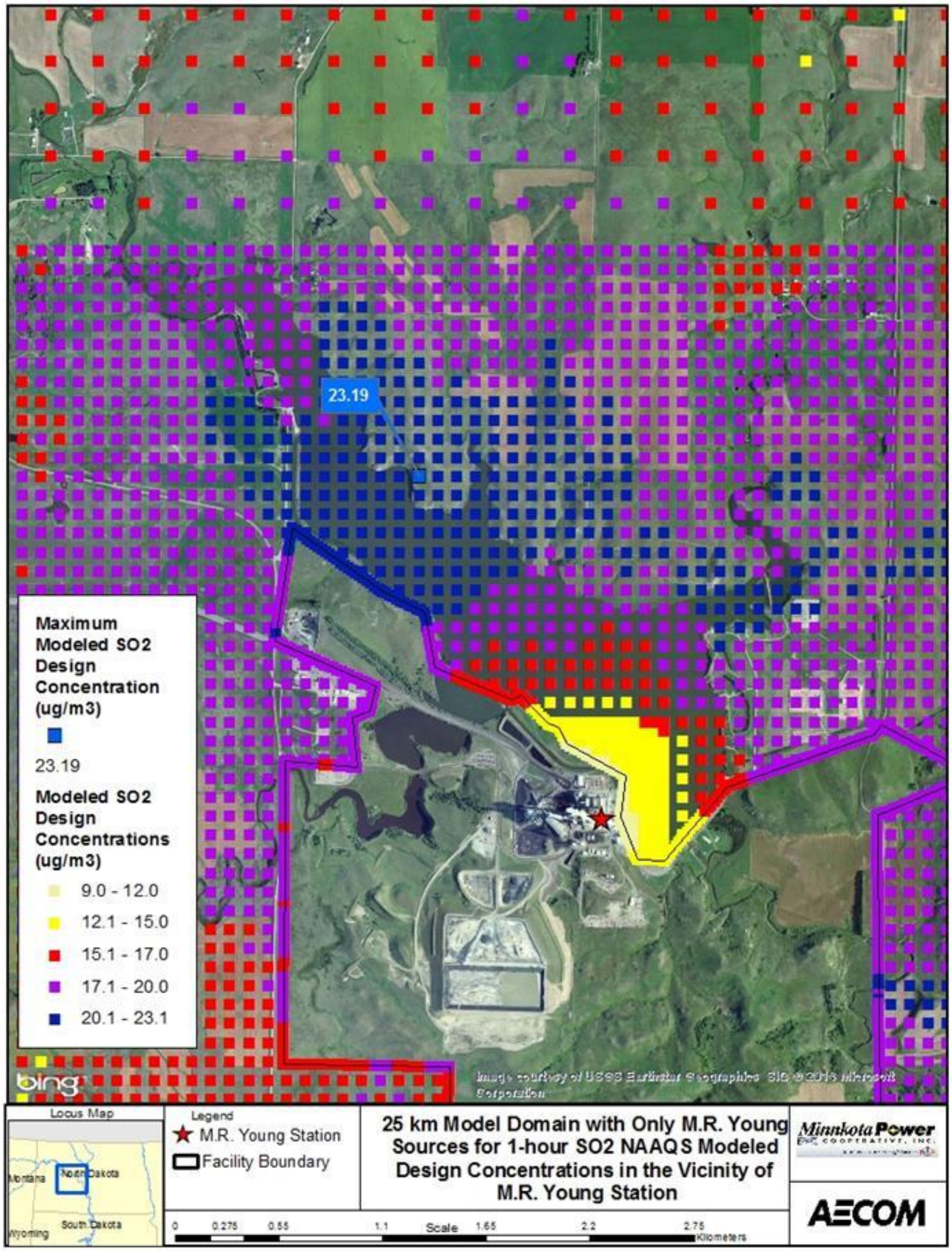


Figure 5-3: 10-km Cumulative 1-hour SO_2 Model Concentrations (Initial Receptor Grid)

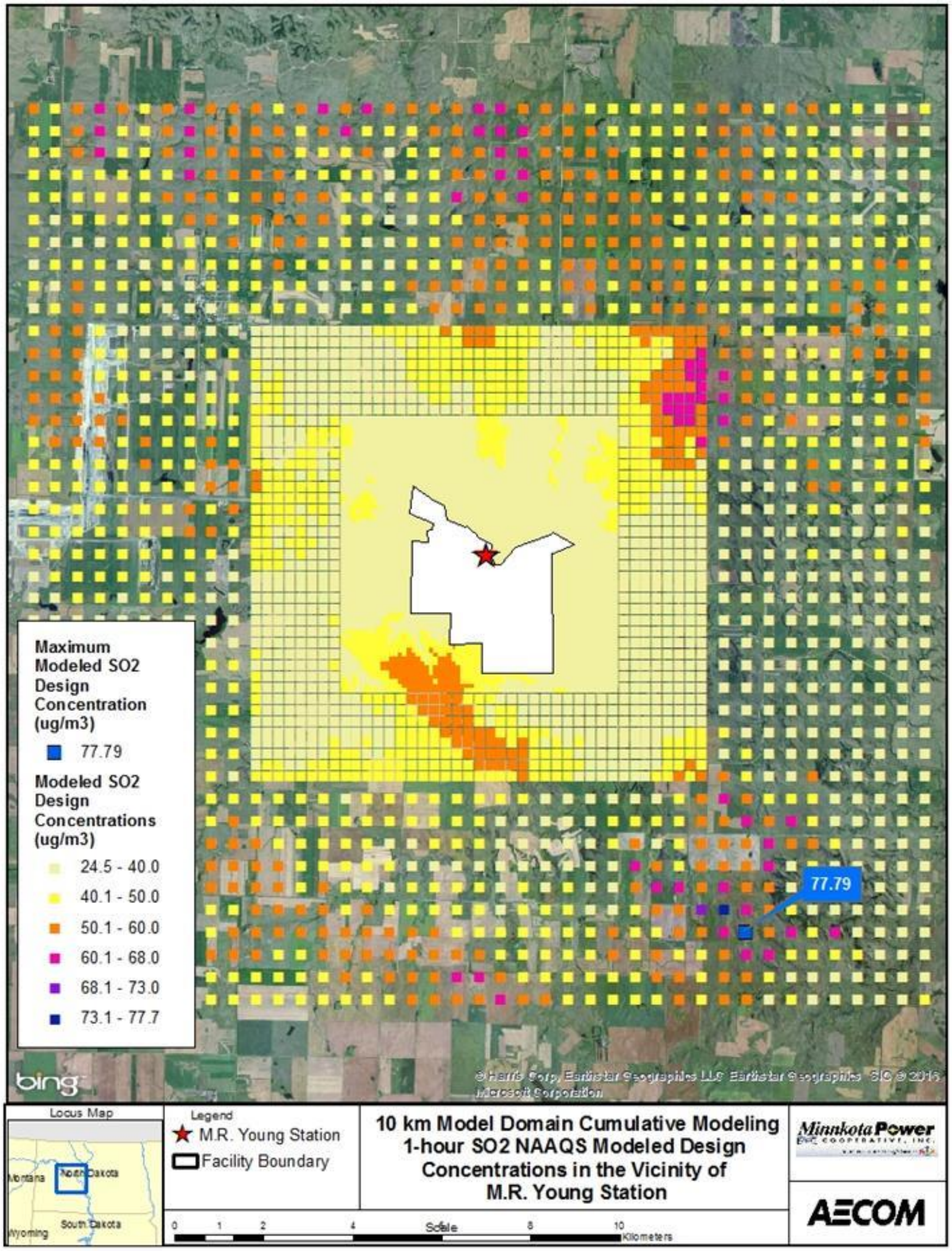
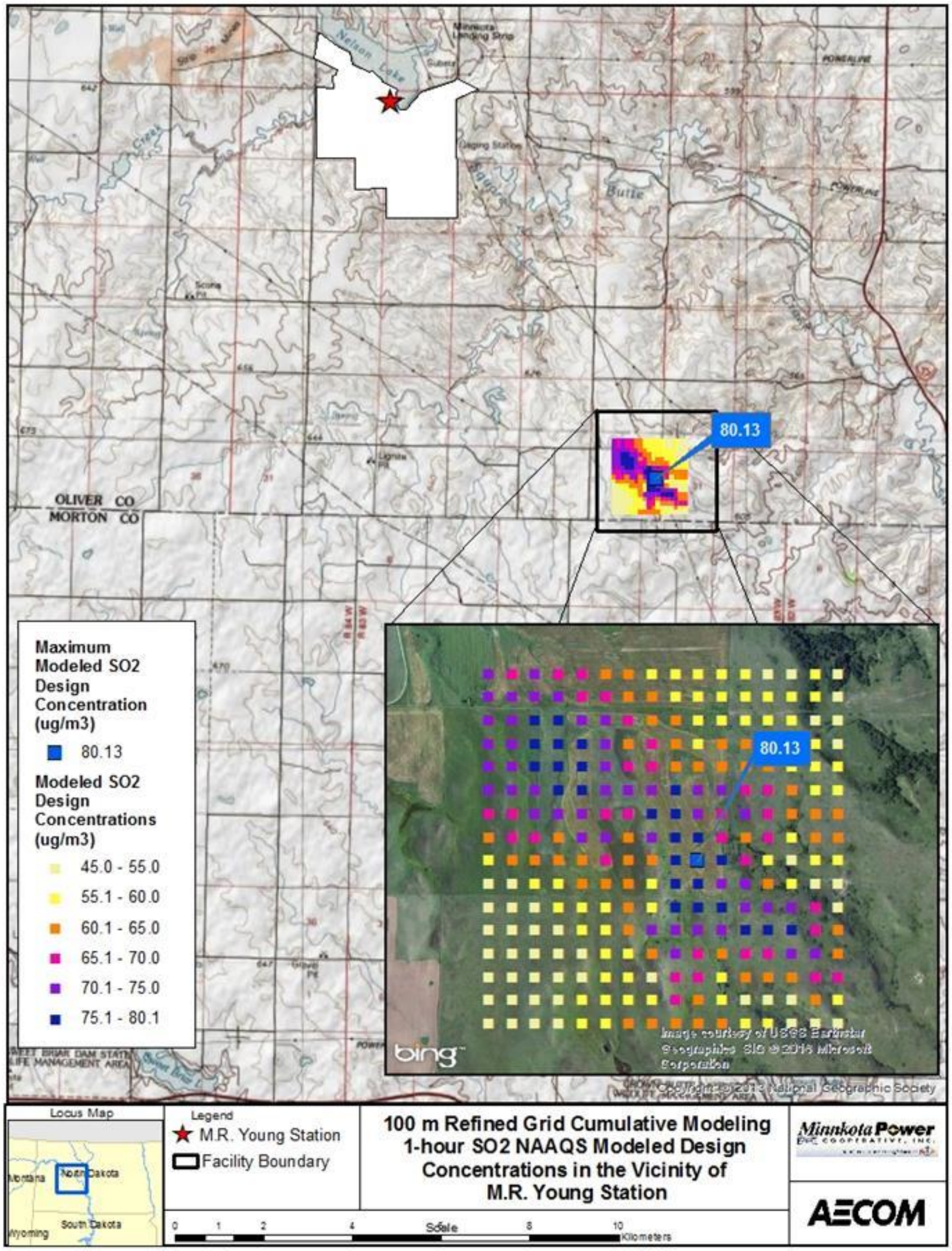


Figure 5-4: 100-m Refined Grid Cumulative 1-hour SO_2 Model Concentrations – Near View of Maximum Impact



Appendix A

30-Year Monthly Precipitation Data Listing

30 Years of Precipitation Data (Inches) For Garrison, ND

Year #	YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1	1982	0.84	0.22	0.70	0.37	1.90	4.39	2.26	2.70	0.79	4.40	0.29	0.65	19.52
2	1983	0.52	0.17	1.74	0.65	1.27	2.84	2.37	1.17	1.45	0.53	0.47	0.54	13.72
3	1984	0.72	0.06	1.00	4.17	0.27	2.90	1.06	2.87	0.87				13.92
4	1985						2.88	1.31	1.77	1.93	1.01	0.03		8.93
5	1986			0.00	3.13	2.60	0.90	6.21	1.72	2.08	0.58	1.28	0.00	18.50
6	1987	0.09	0.47	1.95	0.20	2.21	2.17	8.43	2.33	0.54	0.01	0.03	0.00	18.45
7	1988	0.45	0.06	0.76	0.00	1.40	0.85	1.42	0.68	1.36	0.16	0.60	0.68	8.42
8	1989	0.63	0.08	0.54	1.67	2.62	3.21	1.42	1.98	1.06	0.56	0.32	0.18	14.28
9	1990	0.00	0.00	0.31	0.79	2.65	6.98	5.03	0.70	1.34	0.87	0.12	0.23	19.03
10	1991	0.02	0.02	0.20	1.95	3.09	5.82	1.16	2.63	2.57	0.77	0.25	0.00	18.48
11	1992	0.06	0.05	0.90	0.30	0.85	1.58	2.17	1.22	0.33	0.15	0.78	0.28	8.66
12	1993	0.39	0.18	0.19	1.57	2.11	3.33	8.78	0.47	0.18	0.24	1.19	0.04	18.69
13	1994	0.52	0.22	0.05	0.50	1.94	2.81	1.11	0.44	0.59	6.48	0.62	0.14	15.44
14	1995	0.30	0.04	0.84	0.68	2.43	1.39	3.56	0.72	0.56	0.44	0.56	0.49	12.02
15	1996	0.73	0.46	1.02	0.77	2.15	2.58	1.33	0.95	1.00	0.69	1.01	0.70	13.40
16	1997	0.42	0.10	0.56	1.10	0.55	3.79	3.99	0.48	0.41	0.85	0.31	0.00	12.56
17	1998	0.28	2.42	0.14	0.34	1.78	3.82	1.41	2.96	0.95	3.52	0.82	0.38	18.81
18	1999	0.88	0.20	0.10	0.61	5.16	6.22	1.29	6.37	1.46	0.26	0.04	0.07	22.66
19	2000	0.26	0.55	0.30	2.29	4.22	3.70	2.04	4.93	1.56	1.37	1.87	0.20	23.29
20	2001	0.25	0.15	0.00	1.18	1.48	3.88	2.42	0.23	1.20	0.31	0.14	0.21	11.46
21	2002	0.60	0.05	0.82	1.91	1.06	4.30	2.29	5.21	0.42	0.82	0.02	0.42	17.92
22	2003	0.28	0.28	0.51	0.79		2.98	3.51	1.37	2.34	0.49	0.41	0.45	13.42
23	2004	0.93	0.43	1.07	0.62	2.39	1.00	2.52	3.31	0.52	1.40	0.13	0.26	14.58
24	2005			0.83	0.32	4.16	11.86	1.13	1.75	1.28	1.19	1.21	0.27	24.00
25	2006	0.04	0.27	0.33	1.63	1.20	1.43	2.24	2.94	1.38	0.78	0.06	0.55	12.85
26	2007	0.21	0.48	1.17	1.09	7.83	4.42	1.56	2.09	1.31	0.14	0.14	0.17	20.60
27	2008	0.47	0.26	0.00	0.33	1.42	3.41	0.91	1.60	1.88	1.47	2.20	1.82	15.79
28	2009	1.14	1.32	0.94	0.92	2.79	2.80	3.18	1.23	1.91	1.11	0.00	0.63	17.97
29	2010	0.73	0.02	1.18	1.63	3.80	6.22	5.50	3.09	4.27	0.43	0.17	0.67	27.72
30	2011	0.60	0.23	1.93	1.40	3.76	2.46	2.11	1.69	2.00	1.09	0.02	0.26	17.55
31	2012	0.22	0.44	0.46	3.22	2.09	3.32	2.17	1.13	0.11	2.54	0.83	0.61	17.14
32	2013	0.06	0.21	0.73	1.82	5.56	5.96	3.17	2.72	3.13	3.65	0.39	0.66	28.06
33	2014	0.32	0.12	0.47	2.24	2.90	3.48	1.12	7.04	0.99	0.74	0.63	0.02	20.07
34	2015	0.41	0.34	0.66	0.76	3.71	4.69	3.55	0.72	1.43	1.45	0.26	0.32	18.30

30-Years of Precipitation Data (Inches) For Bismarck, ND														
Year #	**YEAR(S)**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANN**
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