Modeling Compliance with the 1-Hour SO_2 NAAQS

Modeling Report
for the
American Electric Power
Public Service Company of Oklahoma,
Northeastern Power Station

Prepared by the Engineering Section of the Permitting Unit
Air Quality Division
Oklahoma Department of Environmental Quality

October 17, 2016

OKLAHOMA
DEPARTMENT OF ENVIRONMENTAL QUALITY

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1. INTRODUCTION

On June 22, 2010, the Environmental Protection Agency (EPA) revised the primary sulfur dioxide (SO_2) National Ambient Air Quality Standards (NAAQS). The EPA promulgated a new 1-hour annual primary SO_2 standard at a level of 75 parts per billion (ppb), based on the 3-year average of the annual 99th percentile of the daily maximum 1-hour average concentrations. The area designation process typically relies on the air quality concentrations characterized by ambient monitoring data to identify areas that are either meeting or violating the relevant standard. However, a hybrid approach using modeling and monitoring for the designation process was proposed because of the following:

- SO_2 impacts are considered to be "source-oriented" rather than "regional" (peak concentrations of SO_2 are commonly caused by one or a few major point sources in an area and peak concentrations are typically observed relatively close to the source);
- Ambient SO_2 concentrations can be modeled accurately using well understood air quality modeling tools; and
- Only approximately 35% of the monitoring network was addressing locations of maximum (highest) concentrations of specific sources or groups of sources.

On August 21, 2015, EPA promulgated Title 40 of the Code of Federal Regulations (40 CFR) Part 51, Subpart BB, Data Requirements for Characterizing Air Quality for the Primary SO_2 NAAQS (Data Requirements Regulation or DRR). The DRR requires the State of Oklahoma to develop and submit air quality data to characterize the maximum 1-hour ambient air concentrations of SO_2 for any area in which an applicable source is located through either ambient monitoring or air quality modeling analyses. Applicable sources were defined as any source with emissions of greater than 2,000 tons per year (TPY) as determined using the most recent (2014) emission inventory data.

In accordance with § 51.1203(a), in a letter dated January 11, 2016, the State of Oklahoma submitted to EPA a list of applicable sources, identified pursuant to § 51.1202, which are located in the State of Oklahoma and had actual annual SO_2 emissions of 2,000 tons or more. In a letter dated March 21, 2016, EPA concurred with the list of applicable sources submitted by the State of Oklahoma.

In accordance with § 51.1203(b), in a letter dated June 29, 2016, the State of Oklahoma provided EPA notification whether the State of Oklahoma would characterize the peak 1-hour SO_2 concentrations for each applicable source through ambient air quality monitoring or air quality modeling techniques, or would establish federally enforceable emissions limits that would limit the applicable source's SO_2 emissions to less than 2,000 TPY. In addition to the notice of which methodology would be used for characterization of the peak 1-hour SO_2 concentration, in accordance with § 51.1203(d), the State of Oklahoma provided a technical protocol for conducting the modeling for review. The State of Oklahoma consulted with the EPA Region 6 Office when developing the modeling protocol.

In accordance with § 51.1203(d)(3), the State of Oklahoma has conducted the modeling analyses for the applicable sources and the surrounding areas for which the air quality would be characterized through modeling and has generated separate modeling reports for each applicable source.

1.1 Which applicable source is addressed in this modeling report?

This report will exclusively focus on the modeling analysis conducted for the American Electric Power Public Service Company of Oklahoma (PSO) Northeastern Power Station located in Rogers County.

PSO Northeastern Power Station 2014 SO_2 Emissions

Emission Unit	Emissions (TPY)
Unit No. 3	8,608
Unit No. 4	8,351

1.1.1 What changes have occurred at the PSO Northeastern Power Station?

Since the "Modeling Protocol for Modeling Compliance with the 1-Hour SO_2 NAAQS" dated December 30, 2015, was drafted, PSO has installed an activated carbon dry sorbent injection system on Unit No. 3 and has shut down Unit No. 4. The activated carbon dry sorbent injection system was operational on April 16, 2016 as required by the Mercury and Air Toxics Standards (MATS). The shutdown of Unit No. 4 was effective on April 16, 2016. Since Unit No. 3 will still have the potential to emit and actual emissions of more than 2,000 TPY of SO_2 after January 13, 2017, an air quality characterization using modeling was conducted for the area surrounding the facility. Because Unit No. 4 has been shut down, the air quality characterization has excluded actual SO_2 emissions from Unit No. 4 emitted during the meteorological data period used for the air quality characterization. Documentation of the shutdown of Unit No. 3314 will be provided with the January 13, 2017, modeling data submittal required by the DRR (§ 51.1203(e)).

2. WHAT MODELING PROGRAMS WERE USED FOR THE AIR QUALITY CHARACTERIZATION MODELING?

Given the source-oriented nature of SO_2, dispersion models are appropriate to characterize the air quality in the area of the applicable source. For air quality characterization modeling for the 2010 1-hour SO_2 primary NAAQS, the AMS/EPA Regulatory Model (AERMOD) was used as outlined in the August 2016, "SO_2 NAAQS Designations Modeling Technical Assistance Document." AERMOD is the preferred air dispersion model because it is capable of handling rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources (including point, area, and volume sources) to address ambient impacts for the designations process.

The AERMOD modeling system includes the following components:

- AERMOD (Version 15181): the dispersion model;

- AEMAP (Version 11103): the terrain processor for AERMOD;
- AERMET (Version 15181): the meteorological data processor for AERMOD;
- AERMINUTE (Version 15272): the 1-minute ASOS winds per-processor for AERMET;
- BPIPPRIME (Version 01274): the building input processor; and
- AERSUFACE (Version 13016): the surface characteristics processor for AERMET.

3. HOW WAS THE MODELING DOMAIN CREATED FOR THE AIR QUALITY CHARACTERIZATION MODELING?

3.1 How was the modeling domain set up?

The PSO Northeastern Power Generation Station is the only significant SO_2 source located in the area. Therefore, the modeling domain was centered over the facility. The following table shows the assigned domain identification (ID) number and name of the corresponding Oklahoma Mesonet meteorological data site.

Facility, Domain ID, and Mesonet Site

Company/Facility	Domain ID	Mesonet Site
PSO Northeastern Power Station	10	Claremore

Based on EPA guidance, the general guideline for determining the distance between an affected source and where the maximum ground level concentration will occur is generally ten (10) times the stack height in flat terrain. The terrain surrounding the PSO Northeastern Power Station was reviewed and was determined to have no hills with an elevation at or above the stack height. The facility is located in an area of relatively flat terrain. The following table shows the stack height of Unit No. 3 and the distance within which the expected maximum ground level concentration will occur in flat terrain. Aerial photos of the domain at the state and county levels are included in Appendix A.

Stack Heights and Distance for Maximum Impact

Company/Facility	Stack	Stack Ht. (ft / m)	Distance (km)
PSO Northeastern Power Station	Unit No. 3	600 / 183	1.83

Since the maximum impact is expected to occur less than 2 km from the stack, a domain extending out 10 km from the facility fence line is expected to be of sufficient size to determine the ambient air impacts.

3.2 Is the domain classified as rural or urban?

The determination of whether or not the domain of an affected source should be classified as urban or rural was based primarily on land use (the preferred method). Based on the surrounding land use of the domain, the domain was classified as rural. An aerial photo indicating the area surrounding the facility is included in Appendix C.

3.3 How was the receptor grid generated?

Receptor placement was established to be of sufficient density to provide the resolution needed to detect significant concentration gradients, with receptors placed closer together near the source to detect local gradients and placed farther apart away from the source. In addition, receptors were placed along the fence line (the ambient air boundary of the affected source).

A Cartesian receptor grid was generated by spacing the receptors as follows:

- Receptors spaced at 100 m along the fence line of the affected source;
- Receptors spaced at 100 m from the fence line out to 2 km;
- Receptors spaced at 250 m from the 2 km out to 2.5 km;
- Receptors spaced at 500 m from 2.5 km to 5 km; and
- Receptors spaced at 1 km from 5 km out to 10 km (the edge of the domain).

An aerial photo of the domain with the receptors is included in Appendix B. Fence line data are contained in the Microsoft Excel workbook *SO2 DRR – Modeling Data – PSO Northeastern Power Station.xlsx*.

3.4 What terrain data was used and how was it utilized?

Terrain data obtained from the United States Geological Survey (USGS) Seamless Data Server at http://viewer.nationalmap.gov/viewer/ was used to determine the receptor base elevation and hill height elevation. The 1/3 arc-second National Elevation Data (NED) was obtained in the GeoTIFF format for use with AERMAP. Interpolation of receptor and source heights from the 1/3 arc-second NED elevation data is based on the current AERMAP guidance in Section 4.4 of the *User's Guide for the AERMOD Terrain Processor (AERMAP)* (EPA-454/B-03-0003, 10/2004). AERMAP uses a distance weighted bilinear interpolation method. This domain falls entirely in UTM Zone 15. All coordinates were based on the North American Datum (NAD) of 1983 (NAD83).

4. WHAT SOURCE DATA WILL BE USED IN THE AIR QUALITY CHARACTERIZATION MODELING?

4.1 What were the modeled source types and configuration?

All of the modeled sources were point sources. Stack parameters and facility data (building and fence line data) were submitted by the affected facility. The facility data was then reviewed and checked for consistency with emission inventory data and aerial images including location (i.e., latitude and longitude or Universal Transverse Mercator (UTM) coordinates and datum) of the emission unit's stack relative to the nearby buildings or structures. An aerial photo indicating the facility data superimposed onto the aerial photos are included in Appendix D. Stack parameters for each of the modeled sources is included in Appendix E and the Microsoft Excel workbook *SO2 DRR – Modeling Data – PSO Northeastern Power Station.xlsx*.

4.2 What nearby sources were included in the modeling domain?

In determining which nearby sources should be included in the modeling domain, all sources within 20 km of the applicable source were evaluated. All natural gas fired sources that were not part of the PSO Northeastern Power Station were excluded from the 2010 1-hour SO_2 NAAQS air quality characterization because of the following:

- They do not cause a significant concentration gradient;
- They are not expected to cause or contribute to a NAAQS violation; and
- They are represented via the background concentrations.

No nearby sources were identified that would cause a significant concentration gradient within the modeling domain.

4.3 How were intermittent sources addressed?

For the 2010 1-hour SO_2 NAAQS air quality characterizations, modeling of sources with intermittent emissions, such as emergency generators and limited intermittent startup/shutdown emissions were not included based on the recommendations in the March 1, 2011 memorandum "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standards." As a general guidance, sources that operated less than 100 hours per year were excluded. Two diesel-fired generator engines located at the PSO Northeastern Power Station were excluded from the air quality characterization.

4.4 What were the modeled sources' emission inputs based on?

Source emission inputs were based on potential to emit emission limits from the current Part 70 operating permit (Permit No. 2012-918-TVR2 (M-1)).

4.5 How was GEP stack height addressed?

Good Engineering Practice (GEP) stack height is the minimum stack height needed to prevent the stack exhaust plume from being entrained in the wake of nearby obstructions. For the 2010 1-hour SO_2 NAAQS air quality characterization, actual stack heights were used rather than following the GEP stack height policy.

Since the stack height of Unit No. 3 was greater than 65 meters (183.7 meters), a review of the GEP stack height was conducted. Unit No. 3 was constructed prior to January 12, 1979, and PSO had relied upon the equation: $Hg = 2.5H$, where Hg = GEP stack height and H is the height of the nearby structure, when establishing the GEP when obtaining the applicable Prevention of Significant Deterioration construction permit. The Unit No. 3 Boiler House is 73.08 meters. Therefore, the stack height is equal to GEP stack height.

4.6 Was building downwash included in the modeling analysis?

When one or more structures interrupt the wind flow, an area of turbulence called building downwash is created. Pollutants emitted at a fairly low level (e.g., a roof, vent, or short stack) can be caught in this turbulence, affecting their dispersion. Modeling including calculations for building downwash gives a more accurate representation of pollutant impacts than does modeling that omits consideration of downwash effects. Therefore, the air quality characterization modeling includes building downwash and was implemented using BPIP-PRIME.

PSO submitted information regarding buildings located on their property. These parameters were used as inputs into BPIP-PRIME to calculate building downwash parameters for input into AERMOD. The building data used in the modeling is included in the Microsoft Excel workbook *SO2 DRR – Modeling Data – PSO Northeastern Power Station.xlsx*.

5. WHAT METEOROLOGICAL DATA WAS USED IN THE AIR QUALITY CHARACTERIZATION MODELING?

5.1 What meteorological data was used?

When conducting air dispersion modeling, the State of Oklahoma utilizes meteorological data from the following:

- Oklahoma Mesonet 5-Minute Average Surface Data;
- National Centers for Environmental Information (NCEI), formerly National Climatic Data Center (NCDC), Integrated Surface Hourly Database (ISHD) Surface Data; and
- Earth System Research Laboratory (ESRL) Global Systems Division (GSD), formerly Forecast Systems Laboratory (FSL), Upper Air (UA) data.

Oklahoma Mesonet data is incorporated to help make more accurate forecasts of ambient impacts from modeled sources. Incorporation of Oklahoma Mesonet data makes the AERMET-processed meteorological data more accurate because the datasets contain sub-hourly values and the sites are usually closer to and are more representative of the areas being modeled. Standard ISHD surface data usually only contains a single two minute average recorded during an hour whereas Oklahoma Mesonet datasets contain twelve five minute averages for each hour.

The 2012-2014 meteorological data from the Claremore (CLRM) Oklahoma Mesonet surface station was used in conjunction with ISHD surface data from the Claremore Regional Airport (KGCM) in Rogers County, Oklahoma and ESRL UA data from the Max Westheimer Airport (OUN) in Cleveland County, Oklahoma for the modeling analysis. Information for the selected sites is included in Appendix F. A wind rose for the meteorological data utilized is contained in Appendix G.

5.1.1 What is Oklahoma Mesonet data and how was it processed?

The Oklahoma Mesonet is a world-class network of meteorological monitoring stations. The Oklahoma Mesonet is unique in its capability to measure a large variety of meteorological conditions at so many sites across an area as large as Oklahoma. Oklahoma Mesonet data is provided courtesy of the Oklahoma Mesonet, a cooperative venture between Oklahoma State University (OSU) and the University of Oklahoma (OU) and supported by the taxpayers of Oklahoma. Additional information regarding the Oklahoma Mesonet can be viewed at the following web site: http://www.mesonet.org. At each site, the meteorological conditions are continuously measured and packaged into 5-minute observations. These 5-minute observations from the Oklahoma Mesonet were processed into an AERMET acceptable format. Meteorological data from Oklahoma Mesonet sites surrounding PSO Northeastern Power Station were utilized to evaluate the wind flow patterns in the area. The CLRM Oklahoma Mesonet station (located approximately 12.6 km S 20.7°E from the center of the domain) was determined to be the most representative Oklahoma Mesonet station for the domain.

Although the CLRM Oklahoma Mesonet station was determined to be the most representative Oklahoma Mesonet station for the domain, it stopped operations on April 30, 2014, and was moved 18 miles north-northeast and renamed the Talala (TALA) Oklahoma Mesonet station (located approximately 16.9 km N 12.4°W from the center of the domain). The TALA Oklahoma Mesonet station did not begin recording data until September 30, 2014. Therefore, data from the Nowata (NOWA) Oklahoma Mesonet station (located at approximately 36.2 km N 14.7°E from the center of the domain) was chosen to be the most representative Oklahoma Mesonet site to use for data substitution for the missing period.

5.1.2 How was data from the ISHD processed?

The ISH data files were downloaded from the NCDC ISHD web site: ftp://ftp.ncdc.noaa.gov/pub/data/noaa. The ISH data was reviewed for completeness by evaluating the number of hours that were recorded and the number of cloud cover values that were recorded. The primary ISH station (KGCM), located approximately 24.5 km S 51.0°E from the center of the domain, was determined to be the most representative site for the domain. Records with missing cloud cover data were substituted with cloud cover data from other records during the same hour. The Tulsa International Airport (KTUL) in Tulsa, Oklahoma, was designated as the secondary ISH station and is located approximately 30.0 km S 34.1°W from the center of the domain. The secondary ISH station was used for additional data substitution. Records from KTUL were used to replace hours of KGCM data that were completely missing and to replace missing cloud cover data.

5.1.2.1 Was AERMINUTE utilized in the modeling analysis?

There are two types of ISHD surface stations; Automated Surface Observing Systems (ASOS) and Automated Weather Observing Systems (AWOS). All ASOS stations record continuous sub-hourly (2-minute averages) wind data. Sub-hourly wind data is not available for AWOS stations. KGCM is an AWOS site. Therefore, AERMINUTE was not utilized for this air quality characterization.

5.1.3 How was the upper air data processed?

The ESRL data files were downloaded from the ESRL ROAB web site: http://esrl.noaa.gov/raobs/. Selection of appropriate ESRL UA data to use in the meteorological data set was primarily based on proximity to the domain and included a review for missing soundings. Upper air data from the Max Westheimer Airport (OUN) in Norman, Oklahoma (located at approximately 208 km S 52.4°W from the center of the domain) was determined to be the most representative upper air site for the domain. The ESRL UA stations usually take soundings twice a day. A single missing sounding can cause a whole day (24 hours) of missing meteorological data values. To reduce the number of missing meteorological data, replacement soundings were substituted for the missing soundings. The replacement soundings were selected from a site with similar thermodynamic profiles. The upper air data from the Dallas-Fort Worth Airport (DFW) in Fort-Worth, Texas was used to substitute missing soundings.

5.1.4 How were surface characteristics determined?

When using AERMET, three surface characteristics (Albedo, Bowen Ratio, and Surface Roughness Length) must be determined for the meteorological stations. Albedo is the fraction of total incident solar radiation reflected by the surface back to space without absorption. Bowen ratio, an indicator of surface moisture, is the ratio of sensible heat flux to latent heat flux. Surface roughness length is related to the height of obstacles to the wind flow and is an important factor in determining the magnitude of mechanical turbulence and the stability of the boundary layer. Albedo and Bowen Ratio are used for determining planetary boundary layer parameters for convective conditions driven by the surface sensible heat flux.

AERSURFACE uses land cover data from the U.S. Geological Survey (USGS) National Land Cover Data 1992 archives (NLCD92) to determine the land cover types for a specified location. AERSURFACE matches the NLCD92 land cover categories to seasonal values of Albedo, Bowen Ratio, and Surface Roughness and then calculates the surface characteristics for input into AERMET. NLCD92 data in GeoTIFF format was downloaded from the Multi-Resolution Land Characteristics (MRLC) Consortium at the following link: http://www.mrlc.gov/viewerjs/. Seasonal surface characteristics for the PSO Northeastern Power Station, CLRM, TALA, NOWA, and KGCM, are included in Appendix H.

5.1.5 What was used to determine the surface moisture conditions?

The monthly rainfall for the Oklahoma Mesonet site was analyzed from the beginning of the establishment of the Oklahoma Mesonet program (approximately 20 years). The surface moisture conditions (Average, Wet, Dry) for each month were then determined using the monthly rainfall amounts compared to the average rainfall. These determinations were based on the guidance contained in the AERSURFACE User's Guide. The Bowen Ratio was then assigned as either average, dry, or wet based on the monthly surface moisture conditions for the CLRM Oklahoma Mesonet station. Moisture conditions for each month are included in Appendix H.

6. WHAT BACKGROUND MONITORING DATA WAS USED IN THE AIR QUALITY CHARACTERIZATION MODELING?

6.1 What background monitoring data will be utilized?

Background concentrations were added to the impacts from the 2010 1-hour SO_2 NAAQS air quality characterization modeling analyses. Monitoring data was obtained from the EPA air data web site: http://www.epa.gov/air/data/index.html. Background concentrations were based on the most recent complete year(s) of available monitoring data in the form of the standard indicated below. Only data meeting the minimum data collection requirements or the minimum percent observations were used when determining the design values.

Pollutant	Averaging Period	Basis of Design Value
SO_2	1-hour	3 year average of 99th Percentile 1-hour daily maximum

The inclusion of ambient monitored background concentrations in the model results is important in determining the projected cumulative impact of the affected sources and other contributing nearby sources impacts. A uniform monitored background concentration based on the monitored design values for the latest 3-year period was based on a "regional site" (i.e., a site that is located away from the areas of interest but is impacted by similar natural and distant man-made sources). The design concentration for the closest monitoring site is shown in the following table.

2012-2014 Monitoring Design Values

Monitor ID	County	Latitude	Longitude	Conc. µg/m^3
40-143-1127	Tulsa	36.2049	-95.9765	36.7

The impacts from the North Tulsa monitor were used to represent background impacts for this air quality characterization.

7. WHAT WERE THE MODELING RESULTS?

The table below shows the results of the air quality characterization analysis for the PSO Northeastern Power Station. The results of the modeling analysis are the three year average of the highest fourth highest (H4H) daily maximum impact or the three year average of the 99th percentile daily maximum impact.

Modeling Impacts for the PSO Northeastern Power Station

Domain	Source Group	Modeled Impact (µg/m^3)	Background (µg/m^3)	Total Impact (µg/m^3)
D10	NAAQS3[1]	75	37	112

[1] – The NAAQS3 source group is one of several source groups created for informational purposes and different operating scenarios. The NAAQS3 source group includes potential to emit emissions from all the sources currently operating at the PSO Northeastern Power Station.

Based on the modeling review, the domain is in compliance with the 2010 1-hour SO_2 NAAQS of 75 ppb (196.4 µg/m^3 based on EPA Reference Conditions, 40 CFR §50.3).

8. WHAT REFERENCES WERE USED?

- *Additional Clarification Regarding Applicability of Appendix W Modeling Guidance for the 1-hour NO_2 NAAQS* (March 1, 2011);
  - http://www.epa.gov/ttn/scram/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

- *Guidance Concerning the Implementation of the 1-hour SO_2 NAAQS for the Prevention of Significant Deterioration Program* (August 23, 2010);
  - https://www.epa.gov/sites/production/files/2015-07/documents/appwso2.pdf

- *Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 NAAQS* (August 23, 2010);
  - http://www.epa.gov/ttn/scram/guidance/clarification/ClarificationMemo_AppendixW_Hourly-SO2-NAAQS_FINAL_08-23-2010.pdf

- *SO_2 NAAQS Designations Modeling Technical Assistance Document* (August 2016);
  - https://www.epa.gov/sites/production/files/2016-06/documents/so2modelingtad.pdf

- Guidance for 1-Hour SO2 NAAQS SIP Submissions (April 23, 2014);
  - https://www.epa.gov/sites/production/files/2016-06/documents/20140423guidance_nonattainment_sip.pdf

- User's Guide for the AMS/EPA Regulatory Model - AERMOD
  - http://www.epa.gov/ttn/scram/models/aermod/aermod_userguide.zip.

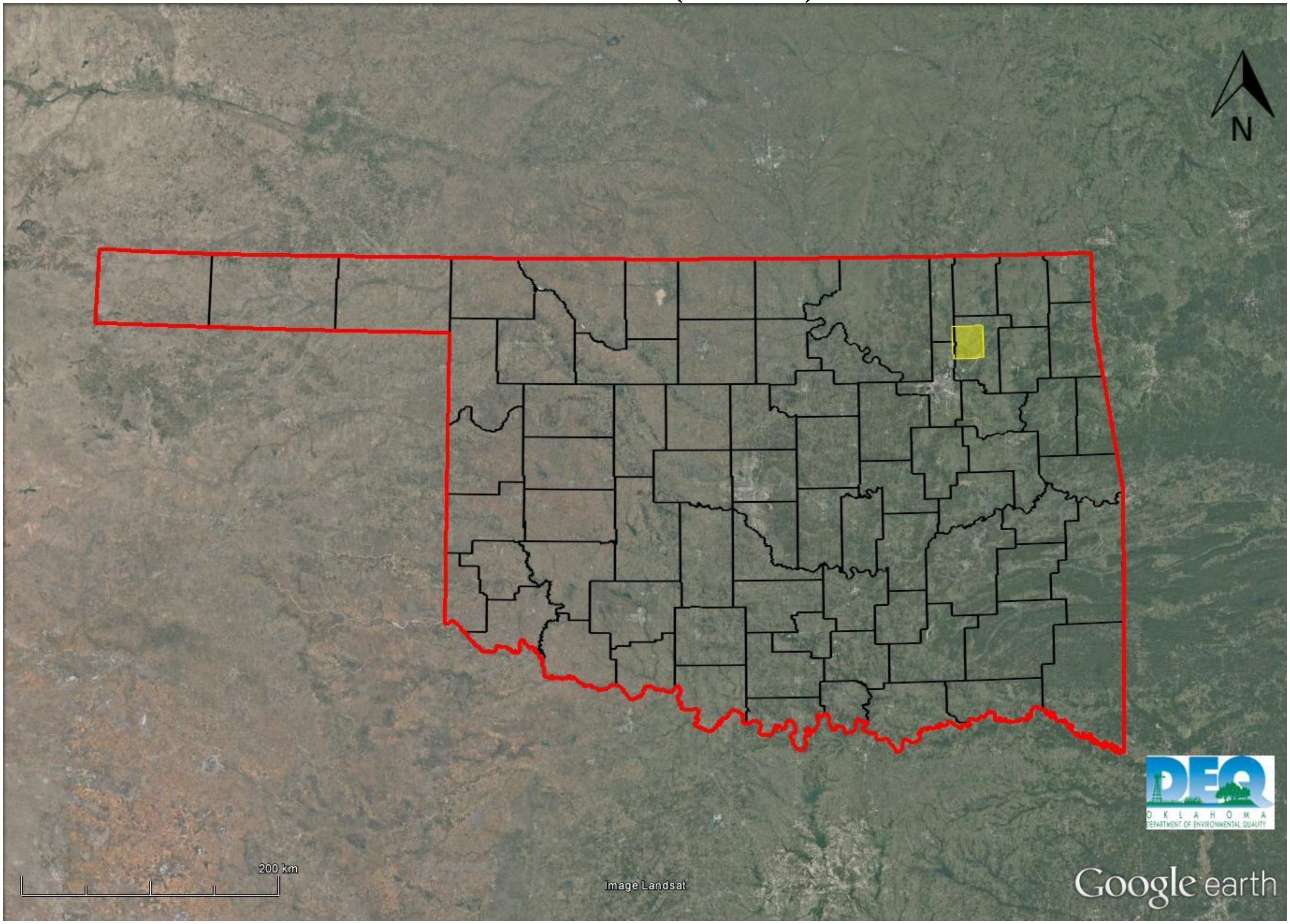
- User's Guide for the AERMOD Meteorological Data Preprocessor (AERMET)
  - http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.zip.

- AERMINUTE User's Instruction
  - http://www.epa.gov/ttn/scram/7thconf/aermod/aerminute_14337.zip.

- AERSURFACE User's Guide
  - http://www.epa.gov/ttn/scram/7thconf/aermod/aersurface_userguide.pdf

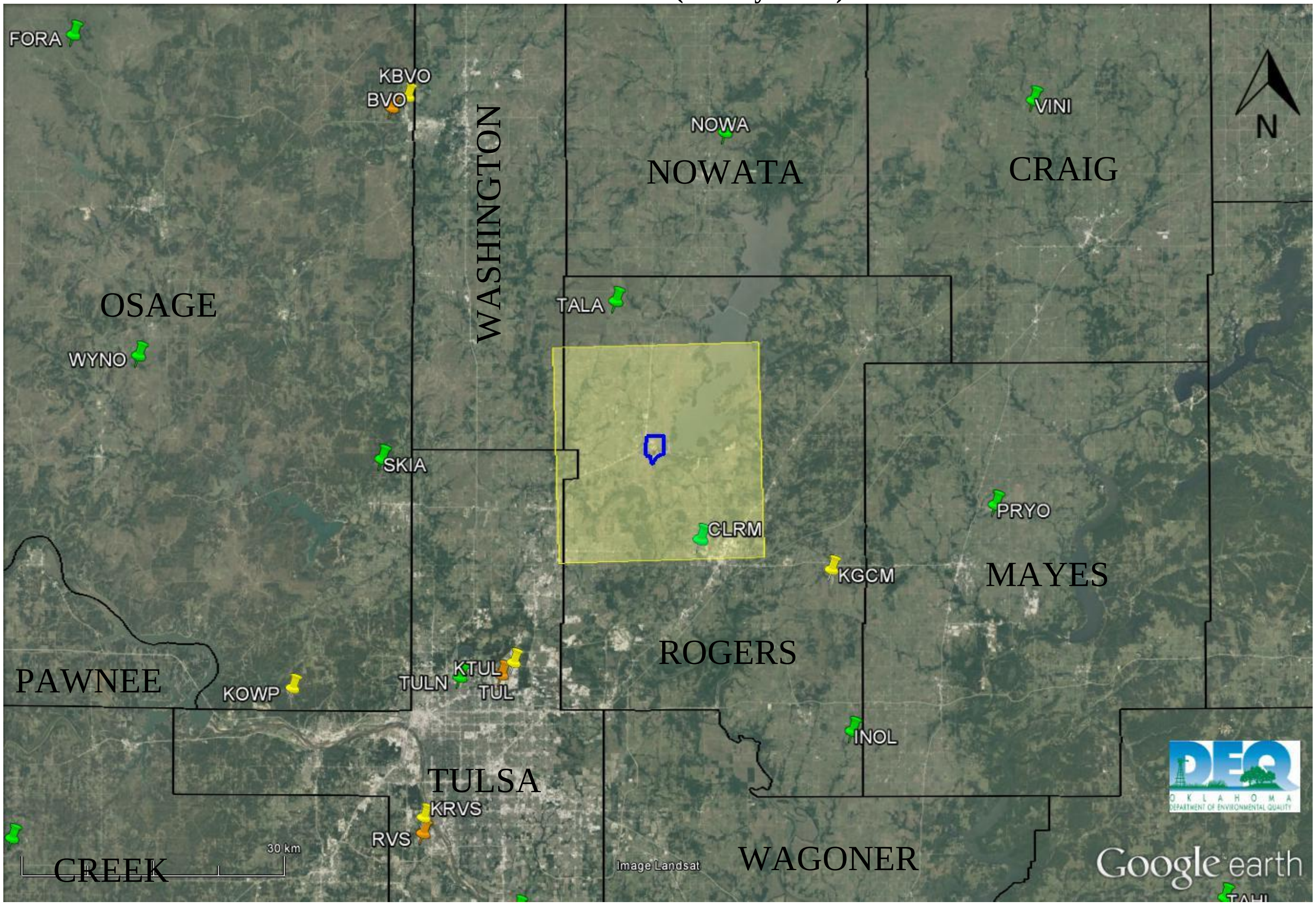
APPENDIX A DOMAIN LOCATION

Domain Location (State Level)



* Boundaries: Red – State of Oklahoma; Black - Oklahoma Counties; Yellow – Modeling Domain.

Domain Location (County Level)

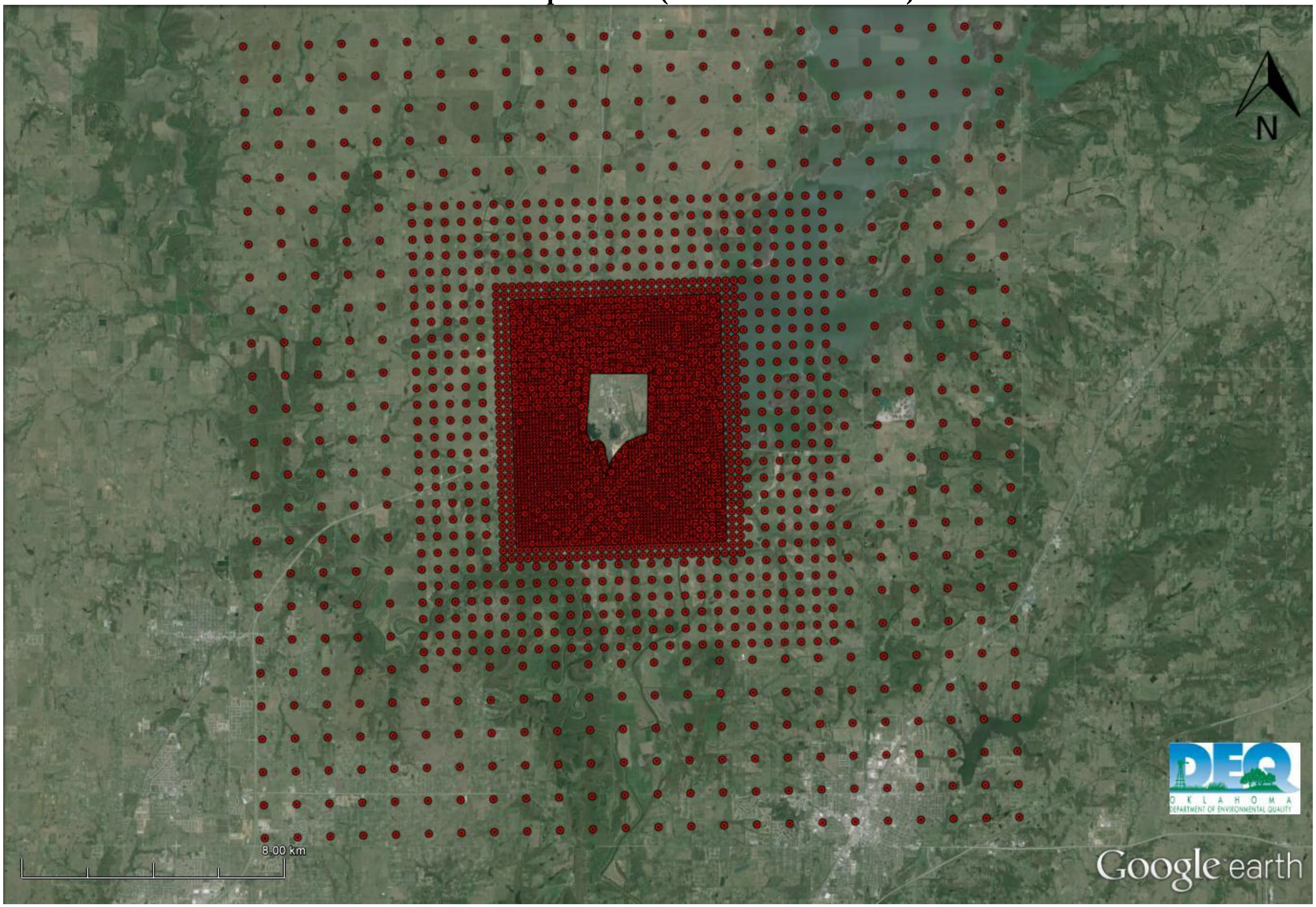


* Black - Oklahoma County Lines; Yellow Area – Modeling Domain; Green Push-Pin – Mesonet Stations; Yellow Push Pins – ISH Stations; Orange Push-Pin – ASOS stations.

** Blue property boundary identifies the PSO Northeastern Power Station.

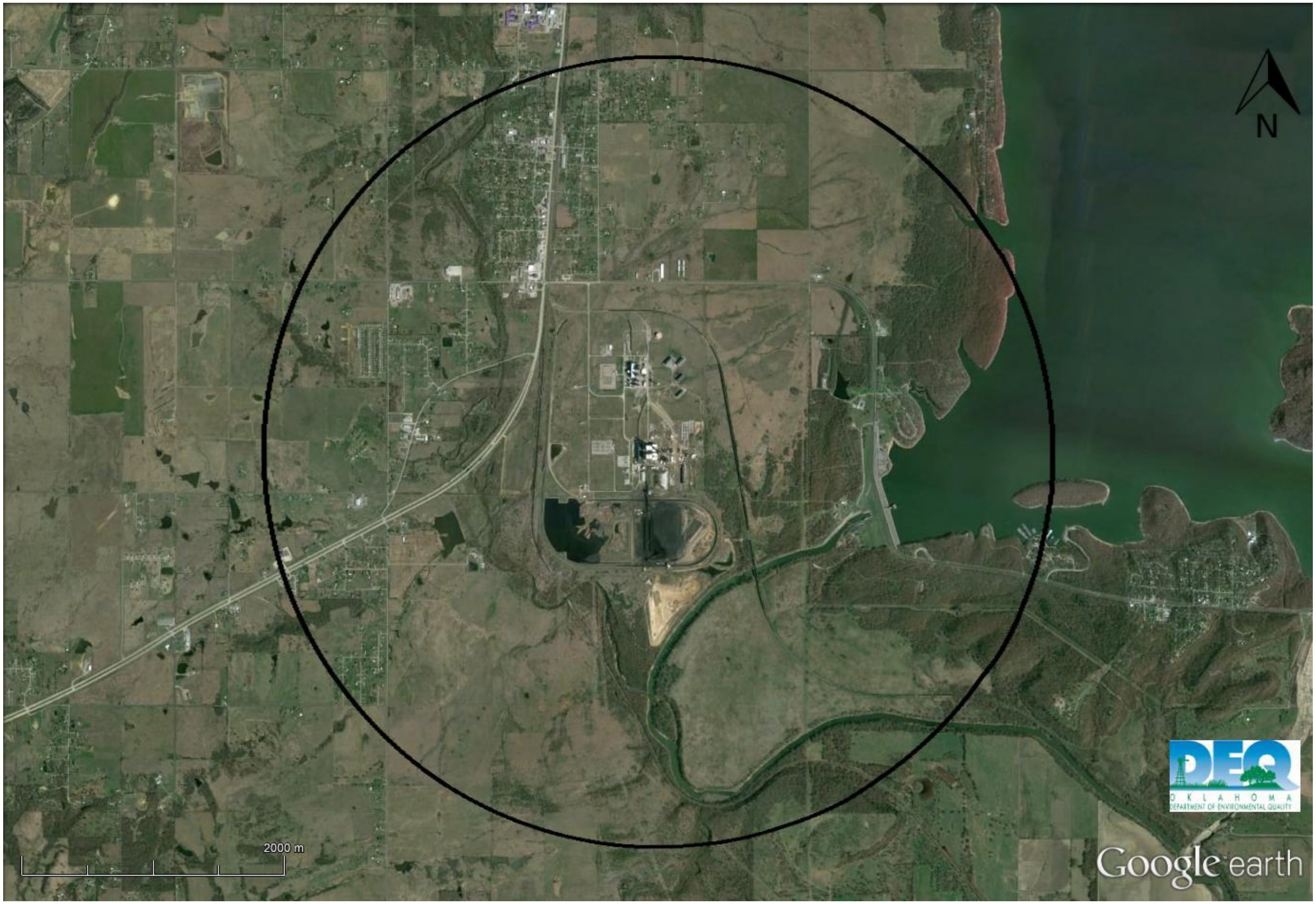
APPENDIX B DOMAIN RECEPTOR GRID

Domain Receptor Grid (10 km from fence line)



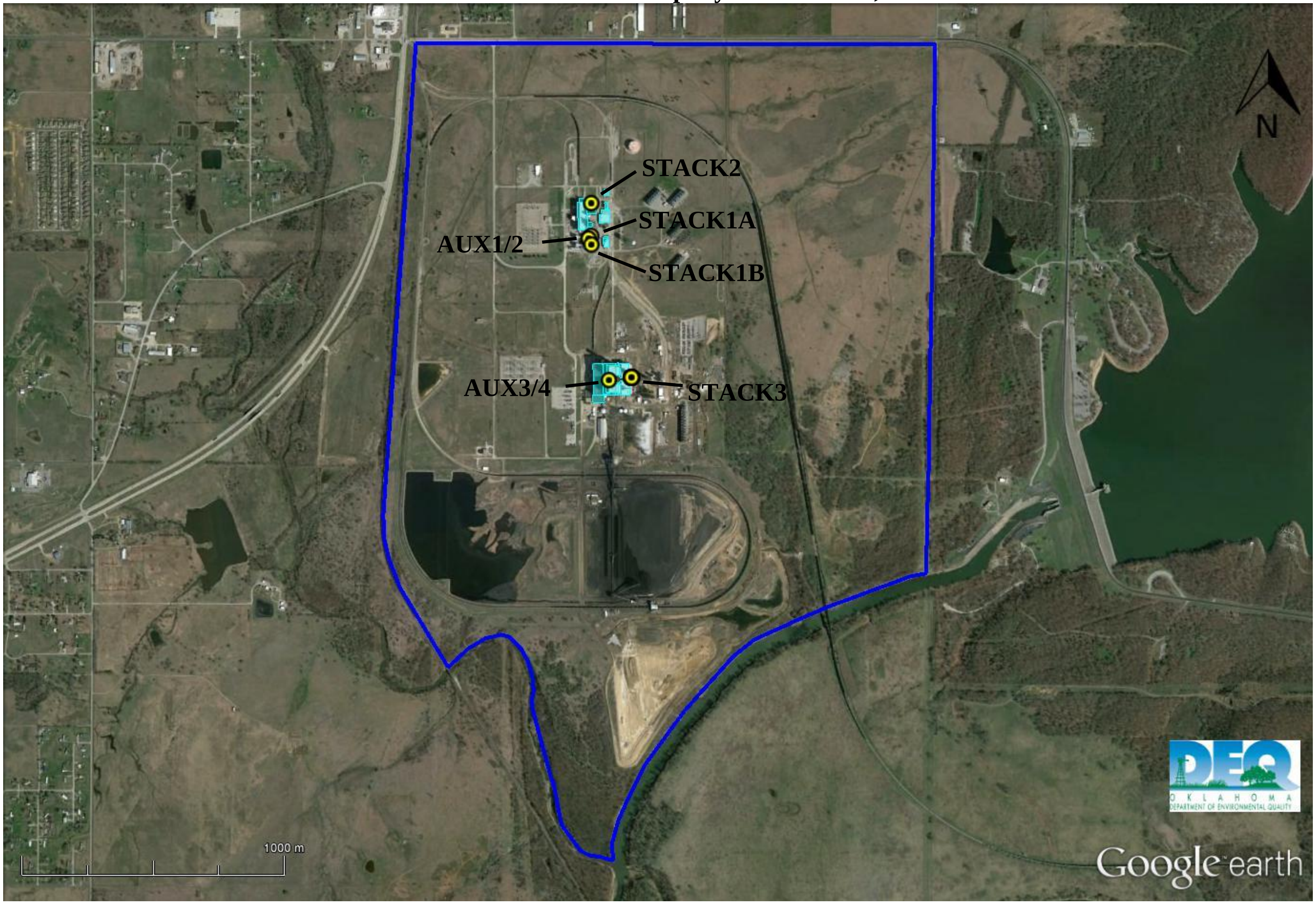
APPENDIX C LAND USE/LAND COVER AREAL PHOTO

Aerial Photo with 3 km Radius Circle



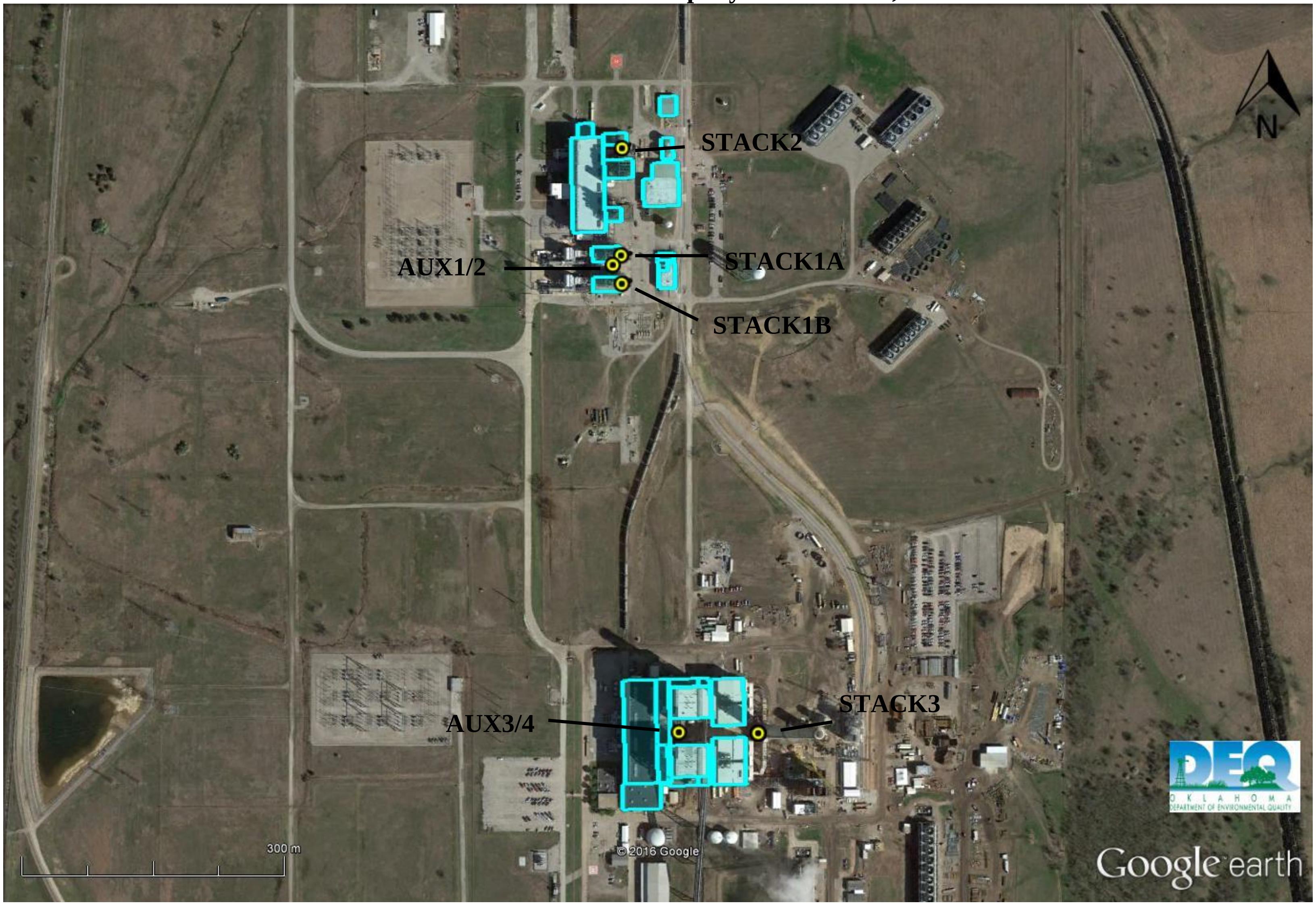
APPENDIX D AERIAL PHOTO OVERLAID WITH FACILITY DATA

American Electric Power Public Service Company of Oklahoma, Northeastern Power Station



* Cyan – Buildings; Blue – Property boundary; Yellow – Point Sources.

American Electric Power Public Service Company of Oklahoma, Northeastern Power Station



* Cyan – Buildings; Yellow – Point Sources.

APPENDIX E SOURCE DATA

PSO Northeastern Power Station Source Data

Source ID	Description	Easting	Northing	Elevation	Stk Ht.	Temp.	Velocity	Stk. Dia.	SO_2
		(m)	(m)	(m)	(ft)	(°F)	(fps)	(ft)	(lb/hr)
STK3_4*	Coal Fired Boiler	257,998.2	4,034,616.3	195.69	600	320	92.73	27.00	3,632.31
STACK3	Coal Fired Boiler	257,998.2	4,034,616.3	195.69	600	296	60.31	27.00	3,632.31
STACK1A	Turbine 1A	257,857.7	4,035,159.9	195.32	150	200	83.56	18.83	1.18
STACK1B	Turbine 1B	257,857.8	4,035,127.8	195.10	150	200	83.56	18.83	1.18
STACK2	Gas Fired Boiler	257,862.3	4,035,280.8	195.55	183	249	97.21	18.00	2.80
AUX1/2	Gas Fired Boiler	257,848.1	4,035,149.5	195.21	168.5	555	103.02	4.50	0.13
AUX3/4	Gas Fired Boiler	257,908.2	4,034,619.9	195.06	40	669	39.40	8.00	0.13
STKPTE*	STACK3: PTE	257,998.2	4,034,616.3	195.69	600	296	53.68	27.00	1,910

* Sources were included in the model for informational purposes allowing for modeling of various operating scenarios.

Modeled Source Groups

Source ID	NAAQS1	NAAQS2	NAAQS3
STK3_4	X		
STACK3		X	
STACK1A	X	X	X
STACK1B	X	X	X
STACK2	X	X	X
AUX1/2	X	X	X
AUX3/4	X	X	X
STK3PTE			X

APPENDIX F 2012-2014 OKLAHOMA MESONET SITE & ASSOCIATED ISH & ESRL STATION

Mesonet Stations

Station Name	Station #	Name/City	County	State	Latitude	Longitude	Elevation (meters)	Commissioned	Retired
CLRM	122	Claremore	Rogers	OK	36.3211	-95.6462	207	07/10/2002	04/30/2014
NOWA	70	Nowata	Nowata	OK	36.7437	-95.6079	206	01/01/1994	NA
TALA	138	Talala	Rogers	OK	36.5743	-95.7451	228	09/30/2014	NA

ISHD Stations

Call Sign	USAF #	WBAN #	Name	County	State	Latitude	Longitude	Elevation (meters)
KGCM	722091	53940	Claremore Regional Airport	Rogers	OK	36.2918	-95.4825	216.1
KTUL	723560	13968	Tulsa International Airport	Tulsa	OK	36.1986	-95.8783	196.3

ESRL Stations

Call Sign	WMO #	WBAN #	Name	County	State	Latitude	Longitude	Elevation (meters)
OUN	723570	03948	Norman/Max Westheim Airport	Cleveland	OK	35.23	-97.47	362

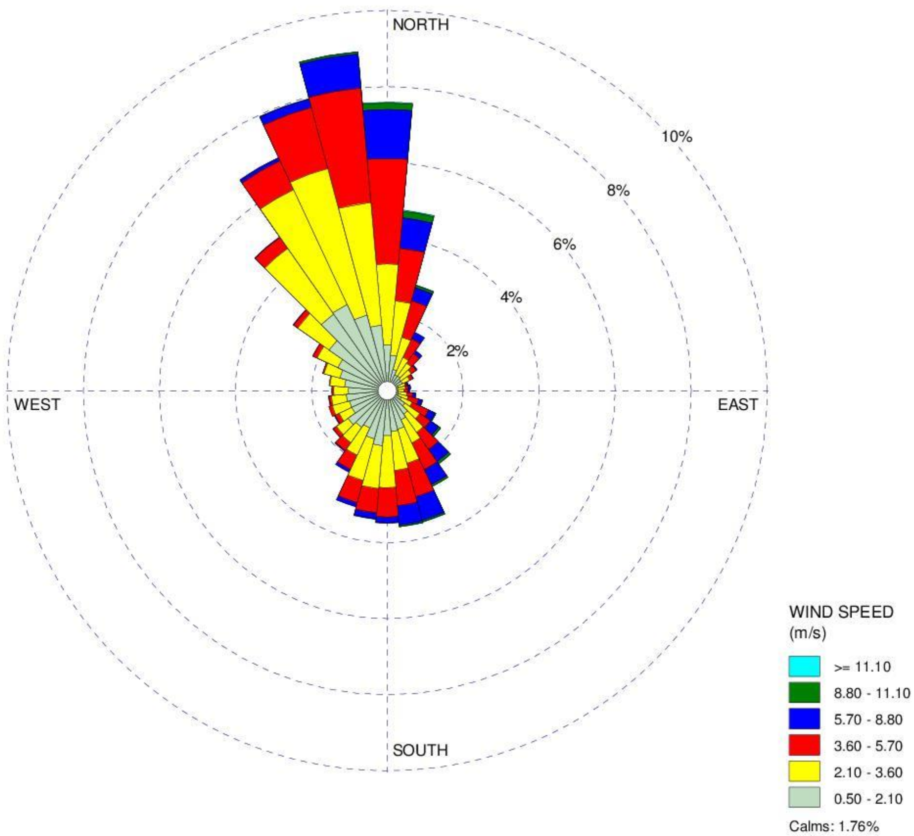
APPENDIX G WIND ROSES

WIND ROSE PLOT:

CLRM/NOWA/TALA

DISPLAY:

Wind Speed
Flow Vector (blowing to)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
CLRM ended on 2014/04/29/23/55. TALA started on 2014/09/30/20/15. NOWA was used to replace missing data between the two dates.	**Start Date: 1/1/2012 - 00:00** **End Date: 12/31/2014 - 23:59**	MODELER:	
	CALM WINDS: **1.76%**	TOTAL COUNT: **26286 hrs.**	
	AVG. WIND SPEED: **2.92 m/s**	DATE: **9/26/2016**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

APPENDIX H SURFACE CHARACTERISTICS

Facility Domain Surface Characteristics

PSO NE	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.17	0.61	0.35	1.28	0.049
Spring	0.15	0.32	0.22	0.78	0.086
Summer	0.17	0.41	0.26	0.94	0.148
Fall	0.17	0.61	0.35	1.28	0.148

Modeling Domain Surface Characteristics

CLRM	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.18	0.82	0.43	1.92	0.062
Spring	0.15	0.45	0.28	1.19	0.096
Summer	0.18	0.50	0.31	1.23	0.257
Fall	0.18	0.82	0.43	1.92	0.257

Modeling Domain Surface Characteristics

NOWA	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.18	0.73	0.39	1.66	0.017
Spring	0.15	0.37	0.24	0.97	0.034
Summer	0.18	0.48	0.29	1.18	0.137
Fall	0.18	0.73	0.39	1.66	0.137

Modeling Domain Surface Characteristics

TALA	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.19	0.88	0.46	1.93	0.012
Spring	0.17	0.37	0.27	1.00	0.044
Summer	0.18	0.65	0.35	1.68	0.106
Fall	0.18	0.88	0.46	1.93	0.106

Modeling Domain Surface Characteristics

KGCM	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.18	0.81	0.42	1.88	0.026
Spring	0.16	0.38	0.25	1.03	0.045
Summer	0.18	0.53	0.31	1.36	0.173
Fall	0.18	0.81	0.42	1.88	0.173

Modeling Domain Moisture Conditions[1]

Year	2012	2013	2014
January	A	A	D
February	A	W	D
March	W	A	A
April	A	A	D
May	D	A	D[2]
June	A	D	W[2]
July	D	W	A[2]
August	A	D	D[2]
September	D	A	A[2]
October	W	A	W[3]
November	A	A	A[3]
December	D	A	A[3]

[1] – Moisture conditions based on rainfall data from the CLRM Oklahoma Mesonet station unless otherwise noted.
[2] – Moisture conditions based on rainfall data from the NOWA Oklahoma Mesonet station.
[3] – Moisture conditions based on rainfall data from the TALA Oklahoma Mesonet station.
A – Average (precipitation in the middle 40^{th} percentile);
D – Dry (precipitation in the lower 30^{th} percentile);
W – Wet (precipitation in the upper 30^{th} percentile).