Modeling Compliance with the 1-Hour SO_2 NAAQS

Modeling Report
for the
AES Shady Point, L.L.C.
Cogeneration Plant

Prepared by the Engineering Section of the Permitting Unit
Air Quality Division
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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 AES Shady Point, L.L.C. (AES) Cogeneration Plant located in LeFlore County.

AES Cogeneration Plant 2014 SO_2 Emissions

Emission Unit	Emissions (TPY)
Boiler 1A	921
Boiler 1B	1,057
Boiler 2A	937
Boiler 2B	1,020

Emissions from all of the boilers are routed to the same stack.

1.1.1 What changes have occurred at the AES Cogeneration Plant?

Since the "Modeling Protocol for Modeling Compliance with the 1-Hour SO_2 NAAQS" dated December 30, 2015, was drafted, the facility has installed an activated carbon dry sorbent injection system and increased the dry lime injection rate to comply with the Mercury and Air Toxics Standards (MATS). The AES Cogeneration Plant has estimated that the facility has reduced its potential to emit (PTE) by 25%. Since the facility will still have potential 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.

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 AES Cogeneration Plant is the largest source of SO_2 emissions 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
AES Cogeneration Plant	40	Sallisaw

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 AES Cogeneration Plant was reviewed and was determined to have some hills with an elevation at or above the stack height. The facility is located in an area of relatively flat terrain with complex terrain located at or near the extents of the domain. The following table shows the stack height 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)
AES Cogeneration Plant	Boilers 1A&B/2A&B	350 / 106.7	1.07

Since the maximum impact is expected to occur less than 1 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 1 km;
- Receptors spaced at 250 m from 1 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).

The initial receptor grid was modified by extending the 1 km receptor grid 2 km to the south to take into account terrain that was at the edge of the domain. A fine receptor grid with 100 m spacing was also added to determine the localized maximum in the area of the highest predicted impacts in the area of the terrain.

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 - AES Cogeneration Plant.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 - AES Cogeneration Plant.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 AES Cogeneration Plant 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.

There were no other facilities located near the domain that would cause a significant concentration gradient within the 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. Diesel-fired generator engines located at the AES Cogeneration Plant were excluded from the air quality characterization.

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

Since the modeling is being used as a surrogate to ambient monitoring (i.e., modeling simulates a monitor), the emissions included in the modeling were based on the most recent three years of actual emissions data that were concurrent with the meteorological dataset.

4.4.1 How were hourly emissions from the modeled sources determined?

Actual emission data for input into AERMOD was generated for the modeled source. Most electric generating units (EGU) have continuous emissions monitoring systems (CEMS). CEMS data was used to generate hourly emissions files for the AES Cogeneration Plant using the following methodology:

Step 1: CEMS data provided by AES was used to generate emissions, stack temperature, and velocity for the hourly emission file.

Step 2: The data was reviewed for continuity and for missing data. Missing data was replaced based on review of operational data.

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 at the AES Cogeneration Plant exceeds 65 meters (350 ft/106.7 m), a GEP stack determination was conducted.

The AES Cogeneration Plant was constructed after January 12, 1979, and AES had to rely on the equation: Hg = H + 1.5L, where Hg = GEP stack height, H is the height of the nearby structure, and L is the lesser dimension of the nearby structure, when establishing the GEP stack height when obtaining the applicable Prevention of Significant Deterioration construction permit (86-045-C PSD). The Boiler House height is 105 m and the lesser dimension is 34 m. The calculated GEP Stack height is 156 m. Therefore, the actual stack height is less than the 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.

AES 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 - AES Cogeneration Plant.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 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 ISHD meteorological data from the Robert S. Kerr Airport (KRKR) in Poteau, Oklahoma was used in conjunction with ESRL UA data from the North Little Rock Municipal Airport (LZK) in Little Rock, Arkansas 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 AES Cogeneration Plant were utilized to evaluate the wind flow patterns in the area. The WIST Oklahoma Mesonet station (located approximately 23.4 km S 9.1°W from the center of the domain) was the closest Oklahoma Mesonet station. However, it was determined based on the terrain and wind rose that the station was located in a valley and was not representative of the meteorology of the facility domain.

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 (KRKR), located approximately 19.5 km S 7.2°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 Fort Smith Regional Airport (KFSM) northeast of Fort Smith, Arkansas, was designated as the secondary ISH station and is located approximately 30.0 km W 31.5°N from the center of the domain. The secondary ISH station was used for additional data substitution. Records from KFSM were used to replace hours of KRKR 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. KRKR 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 North Little Rock Municipal Airport (LZK) in Little Rock, Arkansas (located approximately 220 km W 90.9°S 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 missing soundings. The replacement soundings were selected from a site with similar thermodynamic profiles. The upper air data from the Springfield-Branson National Airport (SFG) in Springfield, Missouri 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 AES Cogeneration Plant, KRKR, and KFSM, 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 SALL 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 99^{th} 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 source 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). All of the monitoring sites in the state of Oklahoma and their related design concentrations are shown in the following table.

2012-2014 Monitoring Design Values

Monitor ID	County	Latitude	Longitude	Conc. $\mu g/m^3$
40-001-9009	Adair	35.75074	-94.66970	39.5
40-071-0604	Kay	36.69727	-97.08130	99.5
40-101-0167	Muskogee	35.79313	-95.30220	129.2
40-109-1037	Oklahoma	35.61413	-97.47510	9.6
40-143-0175	Tulsa	36.14988	-96.01170	100.4
40-143-0179	Tulsa	36.15483	-96.01580	72.0
40-143-0235	Tulsa	36.12695	-95.99890	46.3
40-143-1127	Tulsa	36.20490	-95.97650	36.0

All of the monitoring sites are impacted by large SO_2 sources except for the monitor located in Oklahoma County. The monitors in Tulsa County are impacted by the Holly Tulsa Refinery and the PSO Northeastern Power Station. The monitor located in Muskogee County is impacted by the OG&E Muskogee Generating Station and the Georgia Pacific Muskogee Mill. The monitor in Kay County is impacted by the Continental Carbon Ponca City facility and the Phillips 66 Ponca City Refinery. The monitor in Adair County is impacted by the Flint Creek Power Plant. Therefore, the impacts from the Oklahoma County monitor were used to represent background impacts from area sources.

The modeled sources include the only large source of SO_2 emissions in the area of the facility (i.e. AES Cogeneration Plant). Therefore, only area sources of SO_2 need to be accounted for making the Oklahoma City monitor the most representative.

7. WHAT WERE THE MODELING RESULTS?

The table below shows the results of the air quality characterization analysis for the AES Cogeneration Plant. 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 AES Cogeneration Plant Domain

Domain	Source Group	Modeled Impact (μg/m^3)	Background (μg/m^3)	Total Impact (μg/m^3)
D40	MAIN	153.1	9.6	162.7

[1] - The ALL source group represents the impacts from all modeled sources.

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.

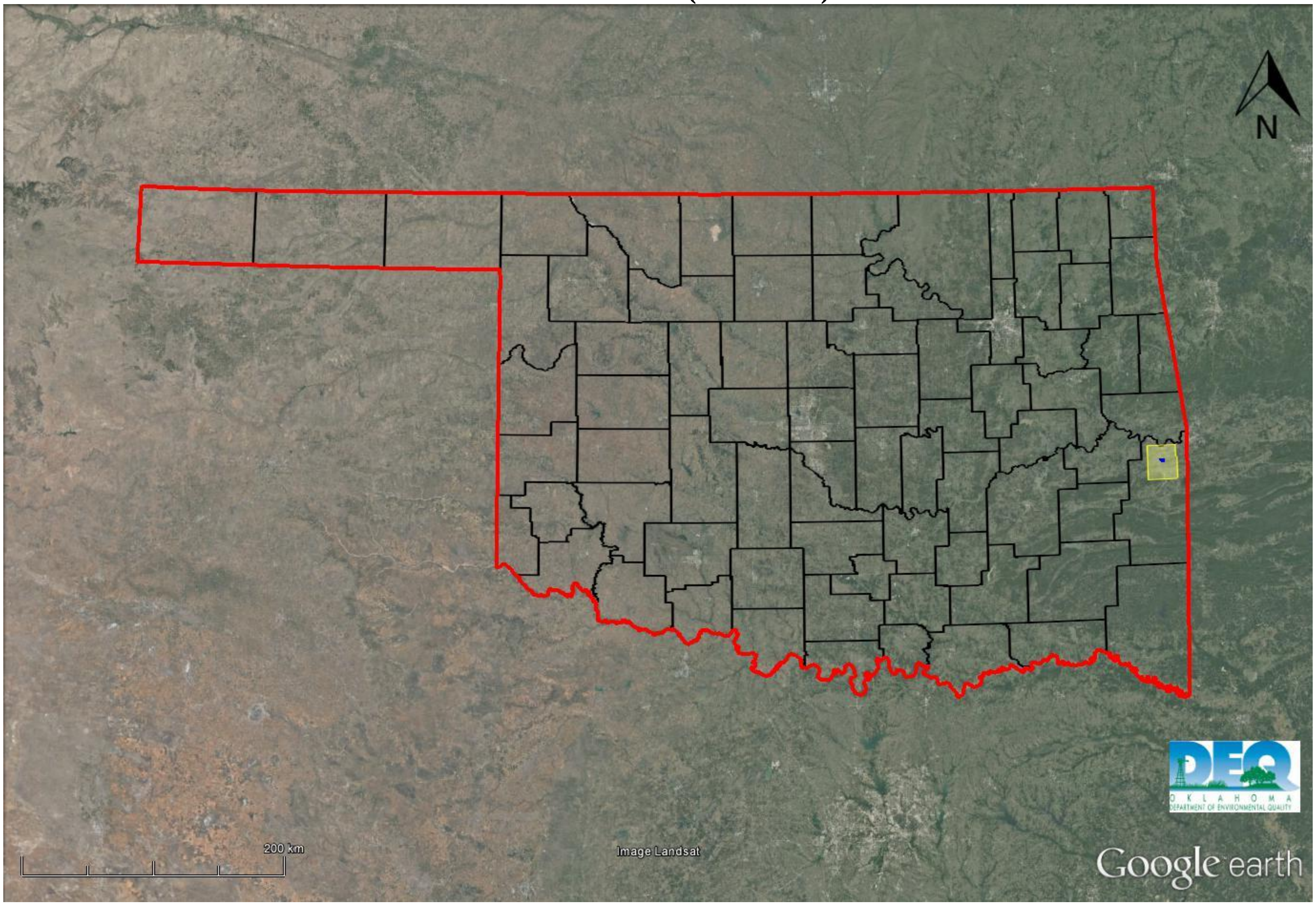
- User's Guide for the AERMOD Meteorological Data Preprocessor (AERMET)
    - http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.zip.

- 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

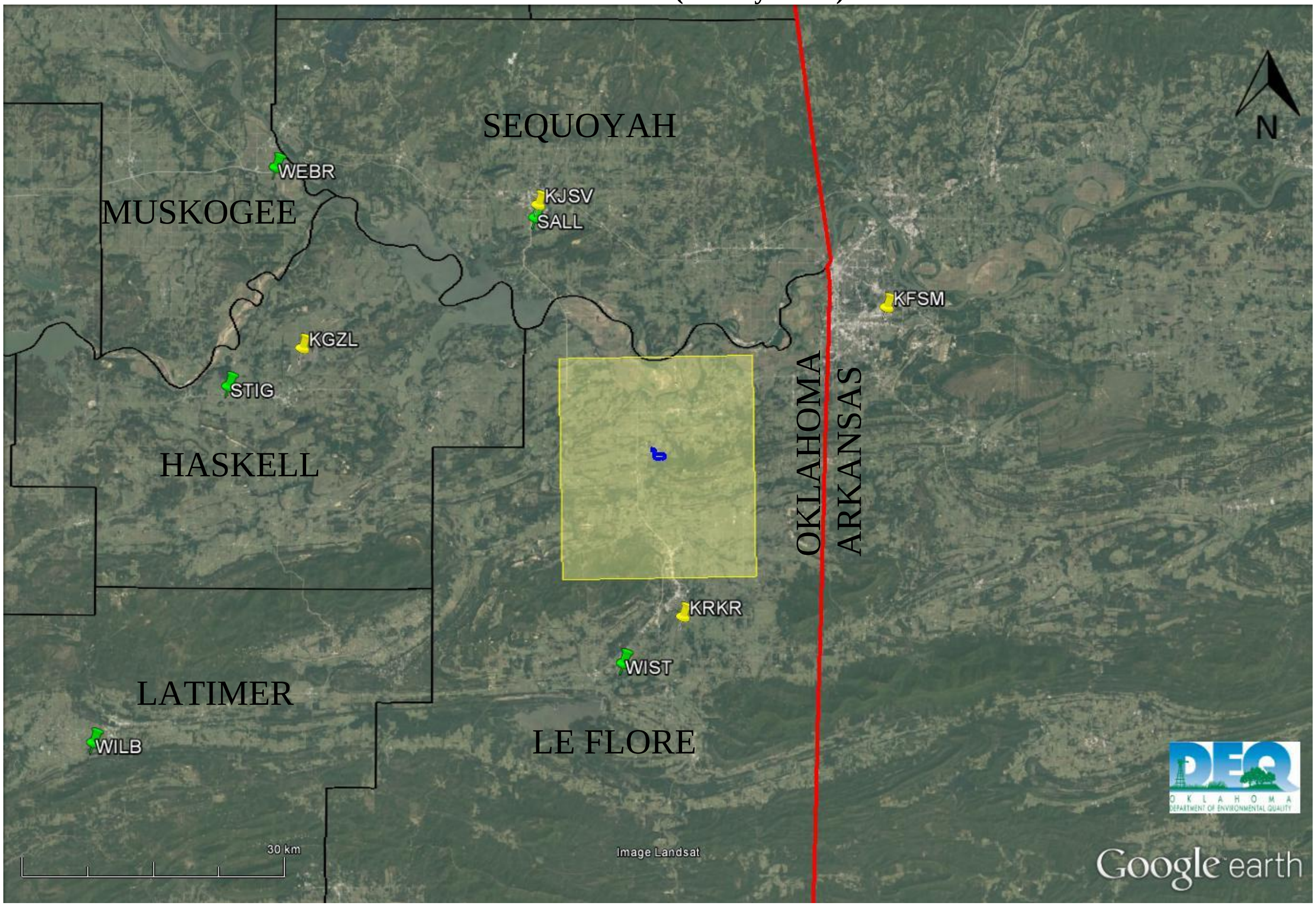
APPENDIX A DOMAIN LOCATION

Domain Location (State Level)



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

Domain Location (County Level)

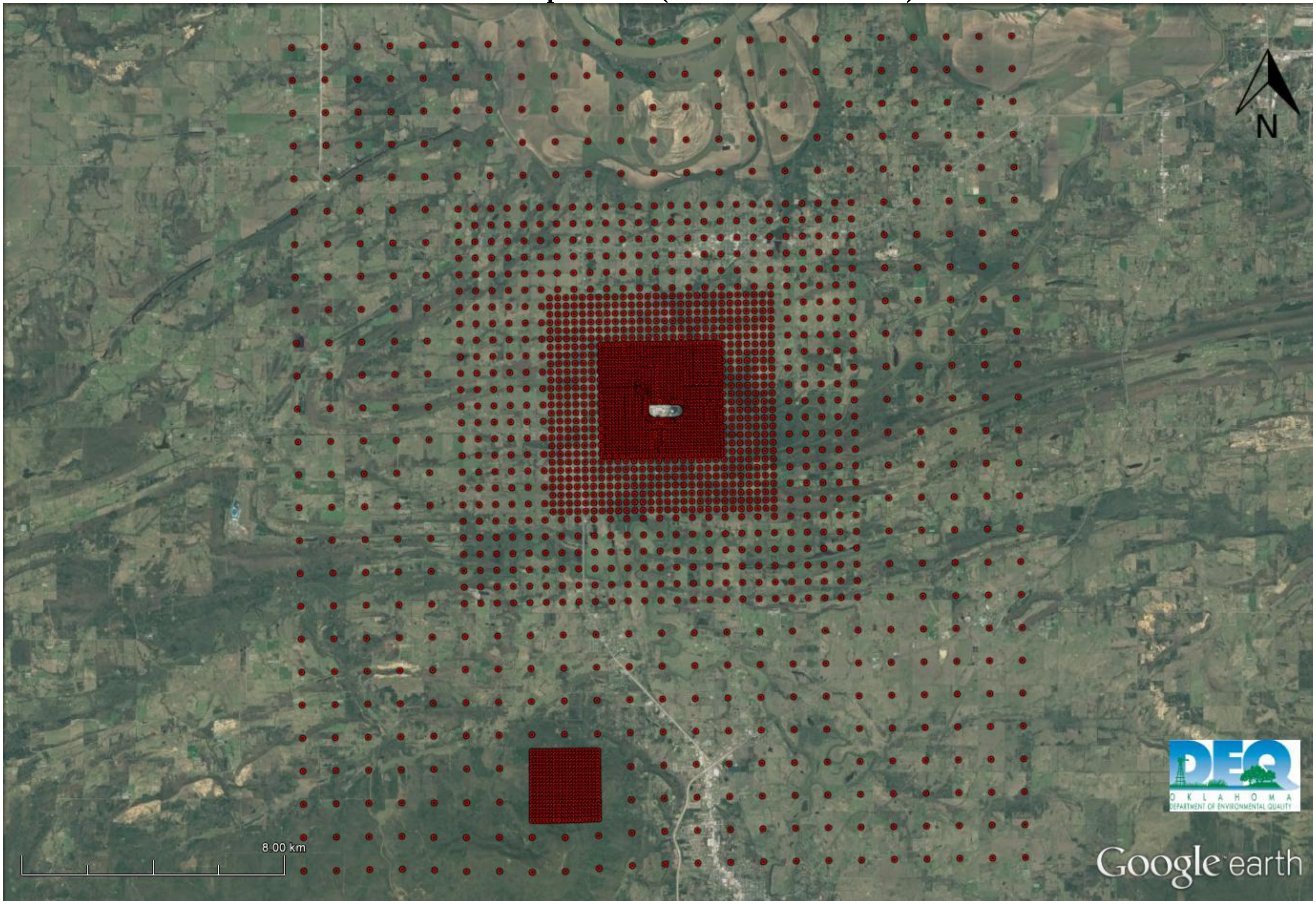


* Red – Oklahoma/Arkansas Boarder; Black - Oklahoma County Lines; Yellow Area – Modeling Domain; Green Push-Pin – Mesonet Stations; Yellow Push Pins – ISH Stations.

** Blue property boundary identifies the AES Cogeneration Plant.

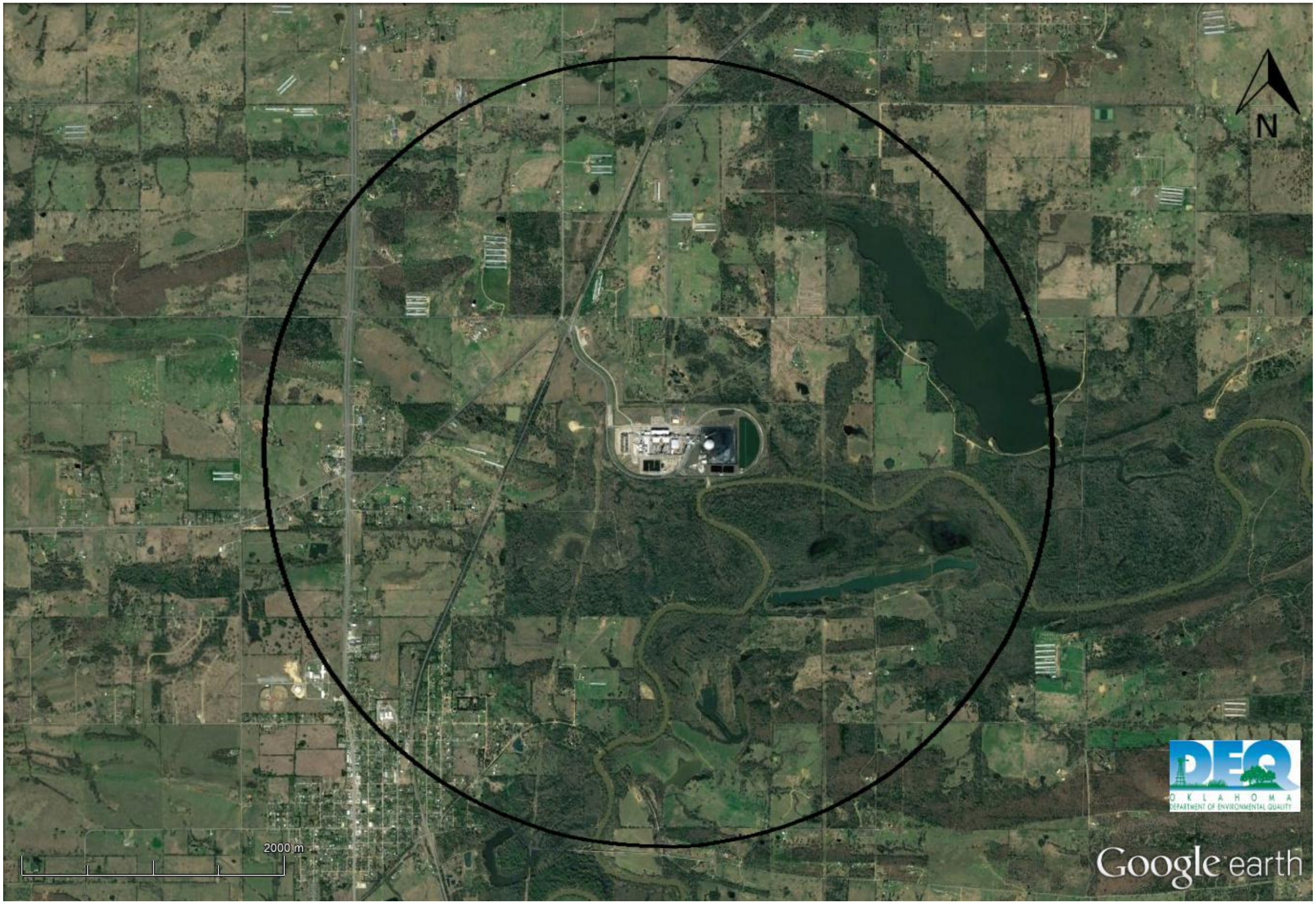
APPENDIX B DOMAIN RECEPTOR GRID

Domain Receptor Grid (10 km from fence line)



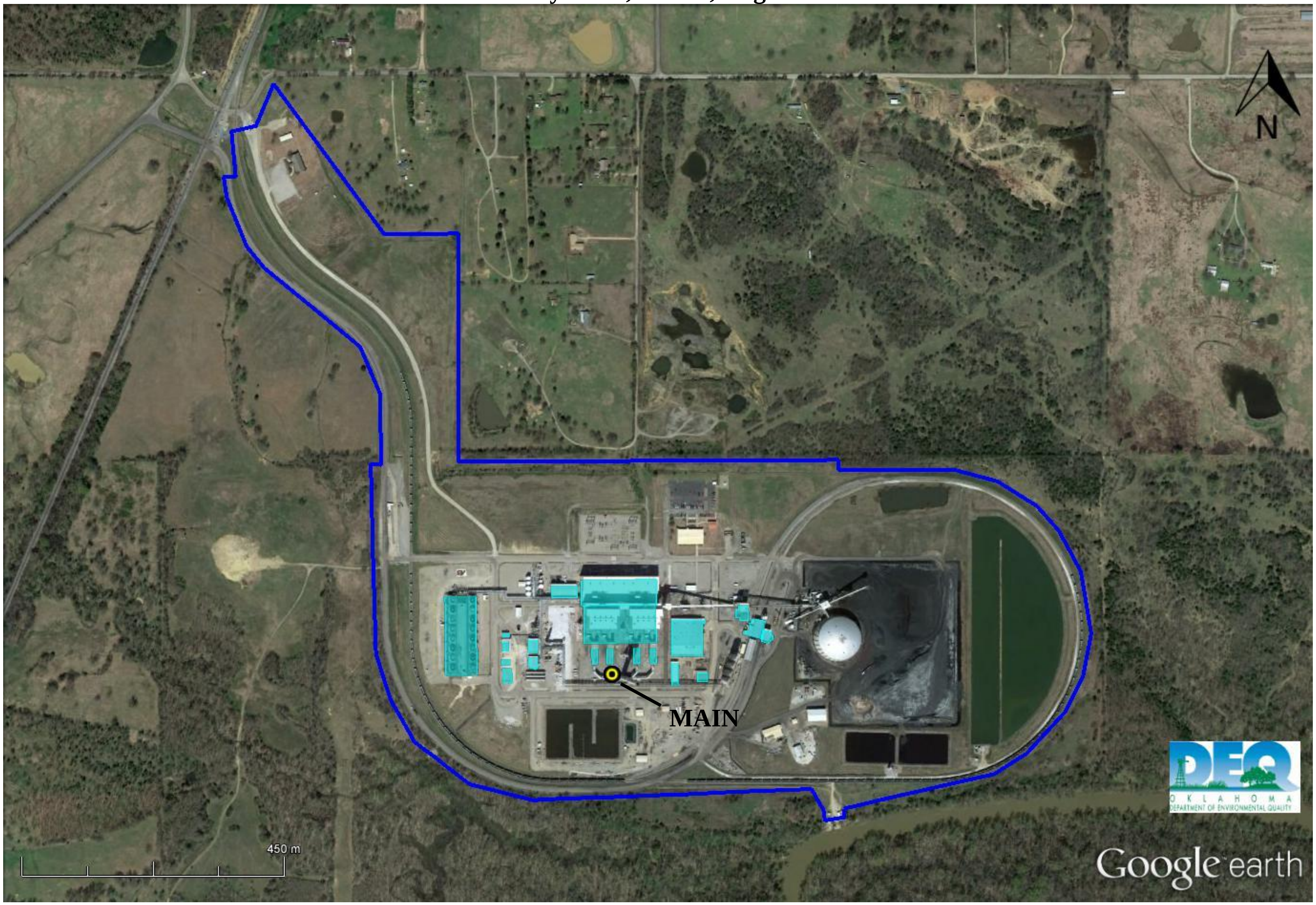
APPENDIX C LAND USE/LAND COVER AREAL PHOTO

Aerial Photo with 3 km Radius Circle



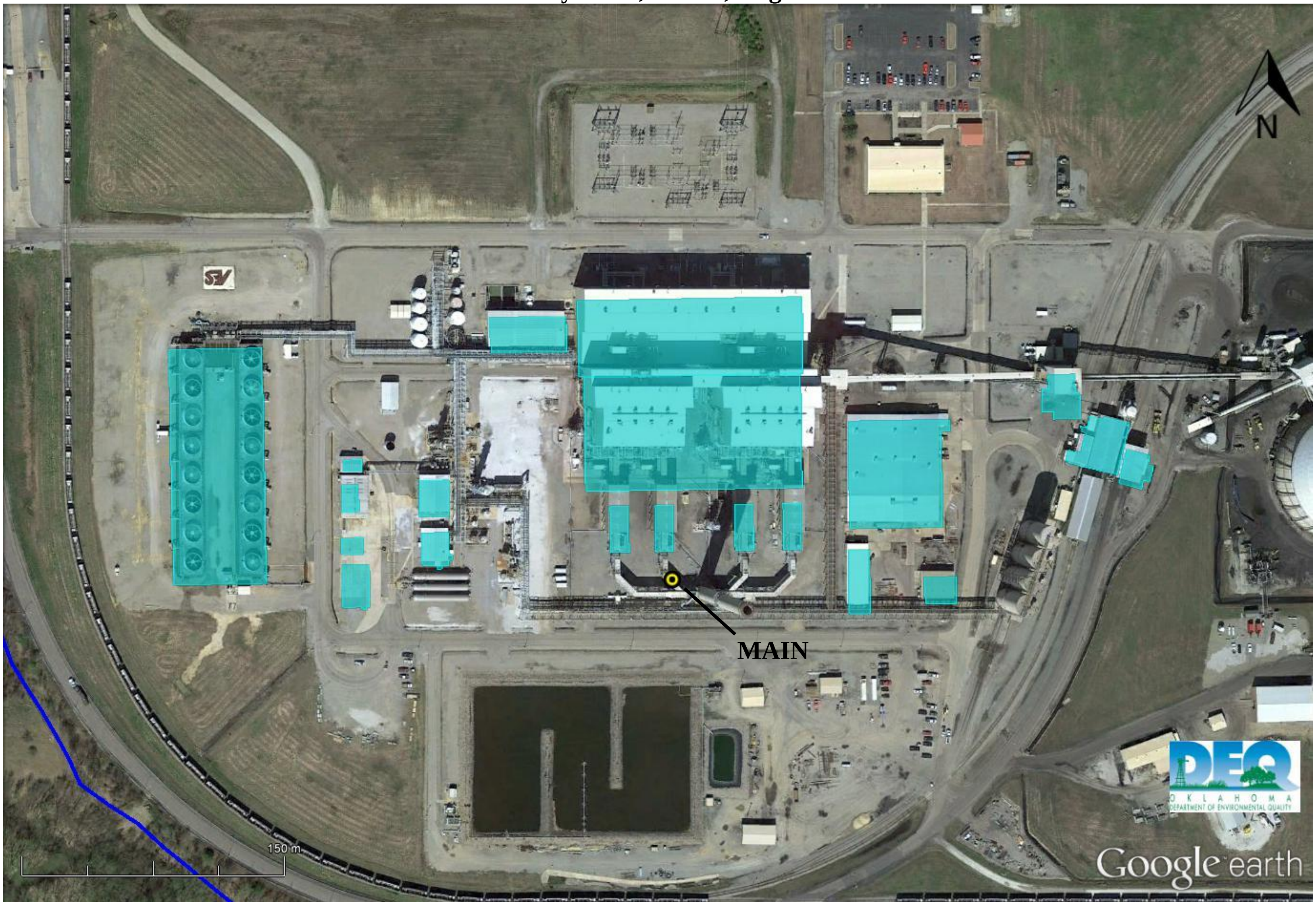
APPENDIX D AERIAL PHOTO OVERLAID WITH FACILITY DATA

AES Shady Point, L.L.C., Cogeneration Plant



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

AES Shady Point, L.L.C., Cogeneration Plant



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

APPENDIX E SOURCE DATA

AES Cogeneration Plant 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)
MAIN	Hourly File Boiler	350040	3895687	131	350	350	92.67	17	1,582.33
UNIT1A	Only 1 Boiler Running	350040	3895687	131	350	350	23.17	17	398.53
UNIT1A2A	Two Boilers Running	350040	3895687	131	350	350	46.33	17	794.50
UNIT1AB2	Three Boilers Running	350040	3895687	131	350	350	69.50	17	1,193.03
MAINA	All Four Boilers	350040	3895687	131	350	350	92.67	17	1,582.33

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

Mesonet Station

ID	Station #	Name/City	County	State	Latitude	Longitude	Elev. (m)	Commissioned
SALL	82	Sallisaw	Sequoyah	OK	35.43815	-94.79805	157	01/01/1994
WIST	106	Wister	LeFlore	OK	34.98426	-94.68778	143	01/01/1994

ISHD Stations

Call Sign	USAF #	WBAN #	Name	County	State	Latitude	Longitude	Elev. (m)
KRKR	722178	53953	Robert S. Kerr Airport	LeFlore	OK	35.0187	-94.6202	136.2
KSFM	723440	13964	Ft. Smith Regional Airport	Sebastian	AR	35.3334	-94.3653	133.8

ESRL Station

Call Sign	WMO #	WBAN #	Name	County	State	Latitude	Longitude	Elev. (m)
LZK	72340	03952	North Little Rock Municipal Airport	Pulaski	AR	34.83	-92.27	172

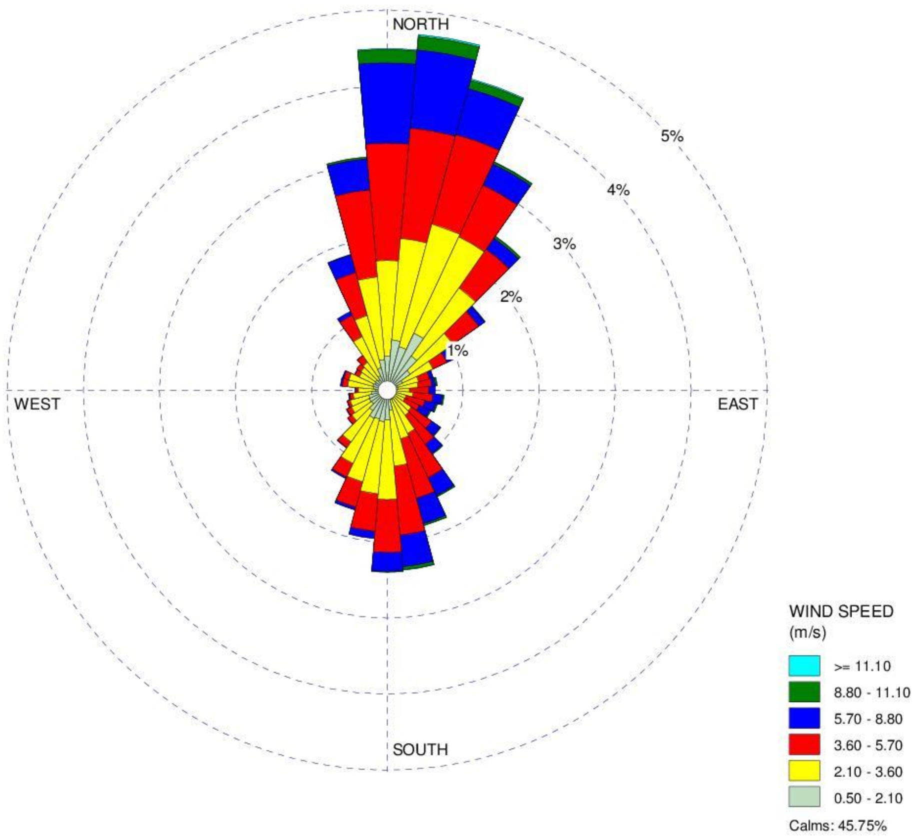
APPENDIX G WIND ROSE

WIND ROSE PLOT:

Station #53953

DISPLAY:

Wind Speed
Flow Vector (blowing to)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 1/1/2012 - 00:00 **End Date: 12/31/2014 - 23:59**		
		MODELER:	
	CALM WINDS: **45.75%**	TOTAL COUNT: **26009 hrs.**	
	AVG. WIND SPEED: **1.84 m/s**	DATE: **10/27/2016**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

APPENDIX H SURFACE CHARACTERISTICS

Facility Domain Surface Characteristics

AES	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.17	0.71	0.37	1.68	0.287
Spring	0.15	0.38	0.22	1.02	0.363
Summer	0.18	0.40	0.25	0.99	0.546
Fall	0.18	0.71	0.37	1.68	0.546

Modeling Domain Surface Characteristics

SALL	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.17	0.73	0.39	1.70	0.045
Spring	0.15	0.41	0.25	1.07	0.063
Summer	0.18	0.42	0.27	1.02	0.173
Fall	0.18	0.73	0.39	1.70	0.172

Modeling Domain Surface Characteristics

WIST	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.17	0.77	0.39	1.85	0.025
Spring	0.15	0.42	0.24	1.13	0.037
Summer	0.18	0.40	0.25	0.99	0.170
Fall	0.18	0.77	0.39	1.85	0.170

Modeling Domain Surface Characteristics

KRKR	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.17	0.77	0.39	1.89	0.032
Spring	0.15	0.41	0.24	1.14	0.048
Summer	0.18	0.42	0.27	1.07	0.195
Fall	0.18	0.77	0.39	1.89	0.195

Modeling Domain Surface Characteristics

KFSM	Albedo	Bowen Ratio (Average)	Bowen Ratio (Wet)	Bowen Ratio (Dry)	Surface Roughness
Winter	0.17	0.78	0.45	1.74	0.028
Spring	0.15	0.53	0.34	1.26	0.037
Summer	0.17	0.55	0.37	1.25	0.075
Fall	0.17	0.78	0.45	1.74	0.070

Modeling Domain Moisture Conditions[1]

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

[1] - Moisture conditions based on rainfall data from the SALL Oklahoma Mesonet station unless otherwise noted.
A - Average (precipitation in the middle 40th percentile);
D - Dry (precipitation in the lower 30th percentile);
W - Wet (precipitation in the upper 30th percentile).