Air Quality Impact Analysis Review

United State Department of Homeland Security
National Bio and Agro Defense Facility
Air Quality Construction Permit Application

Source ID No. 1610038
C-10107

Kansas Department of Health and Environment
Bureau of Air
Permitting Section

DRAFT

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I. Introduction

The United States Department of Homeland Security and National Bio and Agro Defense Facility (NBAF) submitted an air quality construction permit application to install and operate a research, diagnostics, training and evaluation facility with the capability to address threats from high-consequence disease agents and foreign animal disease agents. The facility will be located in Manhattan, Kansas.

An Air Quality Impact Analysis (AQIA) was requested as part of the construction permit application to show the impact of the proposed project on the National Ambient Air Quality Standards (NAAQS). This document summarizes the Kansas Department of Health and Environment (KDHE) review and evaluation of NBAF's AQIA.

The original air quality construction permit was issued by KDHE on January 24, 2011. New federal regulations required the facility to comply with additional requirements or apply for additional permit limits. The application for a modified permit was submitted on November 16, 2011. The original modeling protocol was submitted on August 30, 2011. An updated modeling protocol was submitted on November 14, 2011. The AQIA was submitted on December 29, 2011, and the final modeling files were submitted on January 3, 2012.

Dispersion modeling for this project includes a demonstration of compliance with NAAQS published recently by the Environmental Protection Agency (EPA). The NAAQS for 1-hour NO_2 was published on February 9, 2010, with an effective date of April 12, 2010. EPA did not issue significant impact levels (SILs), significant monitoring concentrations (SMCs), increment and other implementation guidance and tools that are needed for a dispersion modeling analysis for the 1-hour NO_2 NAAQS. Thus, KDHE has developed an interim SIL for the 1-hour NO_2 NAAQS. The KDHE-established interim SIL is to be valid until an EPA promulgated SIL is effective and adopted in the Kansas air quality regulations. Guidance was issued by EPA for an NO_2 1-hour interim SIL on June 29, 2010. In this analysis, the KDHE SIL was used.

II. Facility Description

The United States Department of Homeland Security and NBAF are proposing to construct and operate a biosafety level-3 (BSL-3) and BSL-4 research facility in Manhattan, Kansas. The facility would allow basic and advanced research, diagnostic testing and validation, countermeasure development, and diagnostic training for addressing high-consequence livestock diseases to U.S. agriculture and public health.

NBAF is proposing to install seven (7) boilers (each with maximum design heat-input rating of 33.475 MMBtu/hr) and seven (7) emergency generator diesel engines (each with maximum horsepower rating of 2,709 bhp) in the Central Utility Plant (CUP) of the proposed facility. NBAF is also proposing to install two (2) medical waste incinerators (with two (2) combustion chambers consisting of a primary chamber and a secondary chamber in series; each incinerator has a maximum design combustion capacity of 400 pounds per hour of waste) in the animal research laboratories of the proposed facility.

The seven (7) boilers will use natural gas as the primary fuel and No. 2 ultra low sulfur diesel (ULSD) fuel as the secondary fuel with a sulfur content not to exceed 15 ppm (0.0015 percent) by weight. Each boiler is equipped with low NO_x burners and flue gas recirculation (FGR) technology rated at 30 ppm NO_x. One (1) out of the seven (7) boilers will serve as a redundant unit and is not required to operate for meeting the design steam loads of the facility. Six (6) boilers were considered in the modeling since NBAF will operate six (6) boilers or fewer at a time.

The primary fuel for the generators will be ULSD fuel with a sulfur content not to exceed 15 ppm (0.0015 percent) by weight. Seven (7) generators were considered in the modeling since NBAF will operate up to seven (7) generators at a time during emergency situations and during maintenance checks and readiness testing of the engines. For comparison to the annual NO_2 NAAQS, the generators were modeled only for 12 hours per day of operation during daytime hours (from 6:00 AM to 6:00 PM).

One (1) incinerator is being installed as a redundancy unit in the event of failure of the other incinerator. Only one (1) incinerator was considered in the modeling since NBAF will operate only one (1) incinerator at a time. The incinerators are natural gas fired.

The 1-hour NO_2 and annual NO_2 emissions of the proposed facility were modeled using eight (8) different emission scenarios. The first four (4) emission scenarios, Scenarios 1, 2, 3, and 4, were modeled for the 1-hour NO_2 NAAQS, and the other four (4) emission scenarios, Scenarios 5, 6, 7, and 8, were modeled for the annual NO_2 NAAQS.

Scenarios 1 though 4 as modeled by KDHE and NBAF for the 1-hour NO_2 emissions are as follows:

- Scenario 1 assumes that six (6) boilers will operate 8,760 hours per year on natural gas at 100 % load and one (1) incinerator operates 8,760 hours per year at 100 % load.

- Scenario 2 assumes that six (6) boilers will operate 8,760 hours per year on natural gas at 85 % load and one (1) incinerator operates 8,760 hours per year at 100 % load.

- Scenario 3 assumes that six (6) boilers will operate 8,760 hours per year on natural gas at 75 % load and one (1) incinerator operates 8,760 hours per year at 100 % load.

- Scenario 4 assumes that six (6) boilers will operate 8,760 hours per year on natural gas at 50 % load and one (1) incinerator operates 8,760 hours per year at 100 % load.

For the annual NO_2 NAAQS evaluation, NBAF and KDHE used different emissions scenarios. NBAF's emission scenarios were based on limited hours of operation per year of each boiler on natural gas. KDHE's emission scenarios were based on potential maximum hours of operation (no limit) each year for each boiler.

Scenarios 5 though 8 used by KDHE assume that six (6) boilers will operate 8,260 hours per year on natural gas and 500 hours on fuel oil, seven (7) generators will operate 500 hours per year on fuel oil, and one (1) incinerator operates 8,760 hours per year. The operational levels of the boilers and generators in Scenarios 5, 6, 7, and 8 used by KDHE are 100 %, 85 %, 75 %, and 50 % load, respectively. The incinerator is assumed to be operated at 100% load in Scenarios 5, 6, 7, and 8.

For a detailed description of Scenarios 5 through 8 used by NBAF with boiler operating hours limited, refer to the AQIA, Appendix A.

III. Air Quality Impact Analysis (AQIA) Applicability

The proposed facility intends to accept a permit limit to avoid being defined as a major source under K.A.R. 28-19-350, Prevention of Significant Deterioration. KDHE requested the facility submit modeling to demonstrate that allowable emission increases from the proposed facility would not cause or contribute to air pollution in violation of a NAAQS.

Emissions from the proposed project and significant emission thresholds are listed in Table 1 below. Major sources with pollutant emissions exceeding significant emission rates must undergo PSD review.

Table 1. Emissions from the Proposed Project and PSD Significant Emission Rates

Pollutant	Project Emissions with controls (tpy)	Significant Emission Rate (tpy)	Exceeds Significant Emission Rate?
NO_x	89.69	40	Yes
SO_2	0.40	40	No
PM	7.48	25	No
PM_{10}	7.48	15	No
$PM_{2.5}$	7.48	10	No
CO	57.19	100	No
VOC	10.16	40	No

IV. Model Selection

A dispersion model is a computer simulation that uses mathematical equations to predict air pollution concentrations based on weather, topography, and emissions data. AERMOD is the current model preferred by EPA for use in nearfield regulatory applications, per 40 CFR Part 51 Appendix W, Section 3.1.2, and Appendix A to Appendix W:

> *"AERMOD is a steady-state plume dispersion model for assessment of pollutant concentrations from a variety of sources. AERMOD simulates transport and dispersion from multiple sources based on an up-to-date characterization of the atmospheric boundary layer. AERMOD is appropriate for: point, volume, and area sources; surface, near-surface, and elevated releases; rural or urban areas; simple and complex terrain; transport distances over which steady-state assumptions are appropriate, up to 50 km; 1-hour to annual averaging times; and continuous toxic air emissions."*

The AERMOD modeling system, Version 11353 (using Lake Environmental software version 7.4.0), was used by KDHE to evaluate the impacts of the following emissions that will result from the proposed facility:

- 1-hour NO_2; and
- annual NO_2;

The AERMOD modeling system, Version 11103 (using Lake Environmental software version 7.1.0), was used by NBAF to evaluate the impacts of the following emissions that will result from the proposed facility:

- 1-hour NO_2; and
- annual NO_2;

AERMET Version 11059 was used to prepare meteorological data, which was provided by KDHE to NBAF for the years 2006-2010. AERMINUTE Version 11059 was used to process 1-minute ASOS wind data to generate hourly average winds for input to AERMET.

Regulatory default options in the AERMOD model were utilized for this air quality impact analysis. For the SIL preliminary modeling analysis, a Tier I analysis assuming 100 percent conversion of NO_x to NO_2 was used. For the refined modeling where a NAAQS is exceeded with the Tier I analysis, a Tier II analysis with 0.80 as a default ambient ratio was used.[1]

[1] Tier I and Tier II modeling analyses are discussed in more detail 40 CFR Part 51, Appendix W Guideline on Air Quality Models, §5.2.4.

V. Model Inputs

A. Source Data

The emission rates, point locations, and stack parameters for the emission sources used in the model were based on the data presented in the permit application updates submitted November 16, 2011 and March 22, 2012, the modeling protocol Appendix A submitted November 15, 2011, and the AQIA pages 11-18 submitted December 29, 2011 by the facility. For scenarios 5-8, the facility's modeling for boilers 1-6 assumed limited hours of use. For scenarios 5-8, KDHE's verification modeling for boilers 1-6 did not assume limited hours of use. Boilers 1-6 were modeled operating 8760 hours per year (500 hours on ULSD, 8260 hours on natural gas).

B. Urban or Rural

A review of United States Geological Survey (USGS) National Land Cover Data (NLCD) for 2006 for the site and a surrounding three (3) kilometer radius was reviewed to determine if rural or urban site classification should be used for modeling. The area was deemed "urban" for air modeling purposes. A population of 50,000 was used for the urban option.

C. Terrain

The proposed project was modeled using the Elevated Terrain Mode. AERMAP processor was used by the applicant to process the National Elevation Data (NED) files from the USGS to interpolate elevations at each receptor. The AERMAP processor was used to process the NED files and generate source, building, and receptor heights and hill height scales as applicable.

D. Meteorological Data

Five (5) consecutive years of meteorological data considered representative of the climatology and topography for the proposed facility location was used in the AQIA. AERMET, the meteorological data pre-processor for the AERMOD modeling system, extracts and processes data in order to calculate the boundary layer parameters that are necessary for the calculation of pollutant concentrations within the atmosphere. The surface and upper air measurements used for this analysis were for the years from 2006 to 2010. The upper air data was from the Topeka station, WBAN# 13996, and the surface air data was from the Manhattan airport, WBAN #03936. Information on these stations is shown in Table 2 below and a wind rose for the cumulative five-year period is provided in Figure 1. Figure 2 shows a map that includes the proposed NBAF site, the Topeka station, and the Manhattan airport.

Table 2. Meteorological Data Sites					
Station Type	**Station Name**	**WBAN #**	**Latitude/Longitude**	**Elevation [m]**	**Years of Data**
Surface Air Station	Manhattan	03936	39.135 / -96.678	322.2	2006-2010
Upper Air Station	Topeka	13996	39.072 /-95.626	267.0	2006-2010

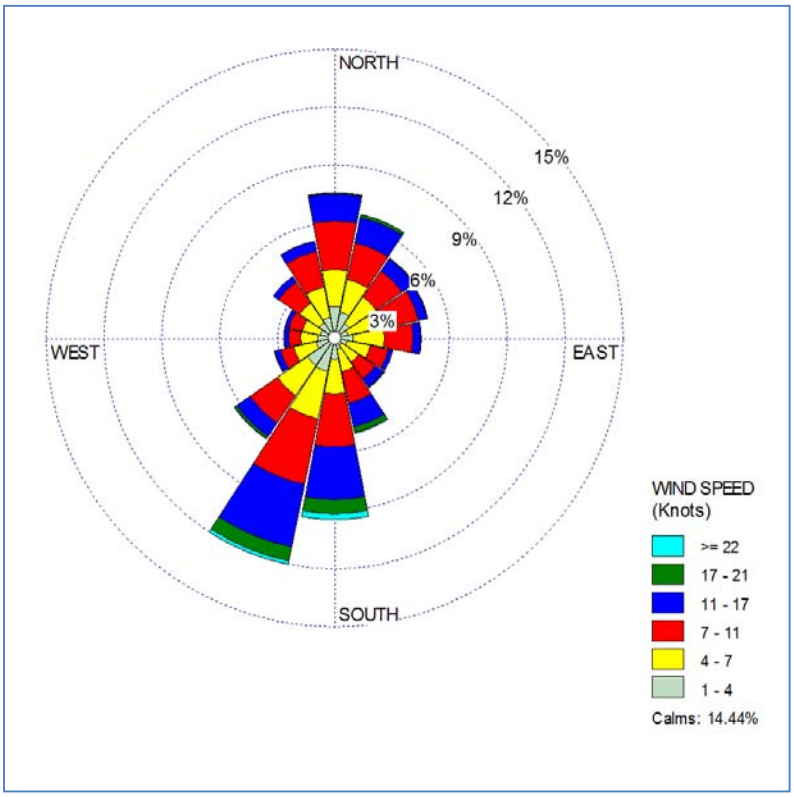

Figure 1. Wind Rose for Years 2006 to 2010

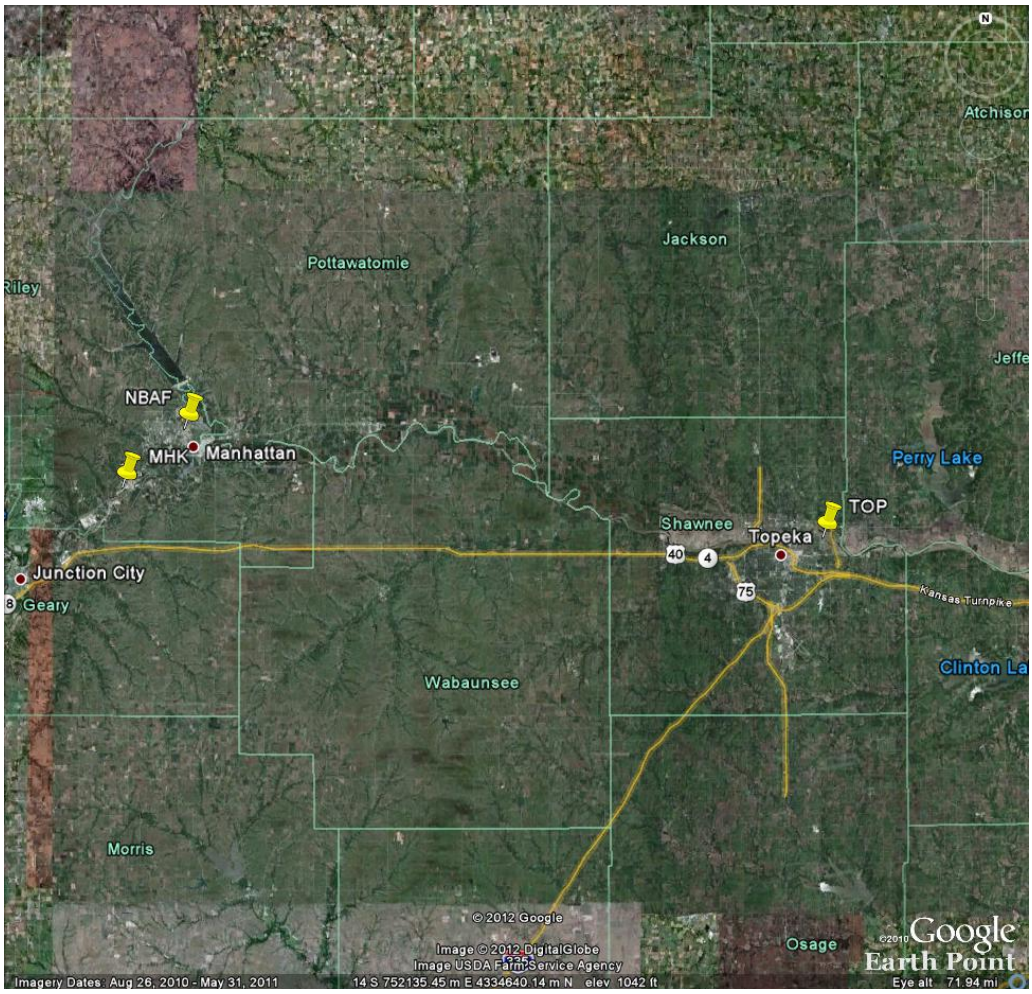

Figure 2. Map of National Bio and Agro Defense Facility and the Manhattan (MHK) and Topeka (TOP) Meteorological Stations

The surface characteristics for use with the AERMET program were determined using AERSURFACE. Evaluation of a comparison of the surface characteristics surrounding the Manhattan Airport and the NBAF site indicates that the Manhattan Airport data are representative of the application site.

E. Building Downwash

Good Engineering Practice (GEP) stack height for stacks constructed after January 12, 1979 is defined as the greater of

- 65 meters, measured from the base of the stack and
- Stack height calculated from the following formula:

  $Hg = H + 1.5L$

Where
Hg = the GEP stack height
H = the height of the nearby structure
L = the lesser of the building height or the greatest crosswind distance of the building also known as maximum projected width.

Emissions released at heights greater than GEP are modeled at GEP stack height. Emissions released at or below GEP are modeled at their true release height. Building downwash was calculated using the Building Profile Input Program (BPIP) with plume rise model enhancements (PRIME).

F. Receptors

AERMOD estimates ambient concentrations using a network of points, called receptors, throughout the region of interest. The model uses emissions and weather information to estimate ambient pollutant concentrations at each receptor location. Model receptors are typically placed at locations that reflect the public's exposure to the pollutant. Receptors were placed at 50 meter spacing along the proposed facility's fenceline. The minimum receptors for significant impact modeling for the proposed facility consisted of a multi-tiered grid as shown in Table 3.

Table 3. Receptor Spacing for Significant Impact Modeling for the Proposed Facility

Distance From Facility Boundary (meters)	Receptor Spacing (meters)
Facility Center to 1,000	50
1,000 to 2,000	100
2,000 to 10,000	250
10,000 to 50,000	1000

Screening modeling resulting in a significant impact for any receptors at or beyond the facility fenceline requires a full impact analysis. The screening model radius of impact (ROI) was determined by first finding the distance from the center of the facility to the farthest receptor showing a concentration greater than the SIL. This distance is then added to 50 kilometers and the area within this radius from the center of the facility is considered to be the ROI.

VI. Significance Determination

In order to determine if a full impact modeling analysis and/or ambient air monitoring is necessary, a preliminary modeling analysis was first conducted. The preliminary analysis included only the proposed NBAF sources to determine if a modeled impact will exceed the SIL thresholds for 1-hour and annual NO_2.

The preliminary modeling results, the SILs, and the pre-application monitoring thresholds for NO_2 are shown in Table 4. Table 4 shows that the modeled impacts for the proposed facility exceed the SILs for both the 1-hour NO_2 and the annual NO_2 averaging periods.

Table 4. Significance Determination Table for NO_2

Averaging Period	Scenario Number	Maximum Predicted Concentration for each Scenario ($\mu g/m^3$)	Modeling Significant Impact Level (SIL) ($\mu g/m^3$)	Exceeds SIL?	Maximum Radius of Impact (m)	Pre-application Monitoring Threshold Concentration ($\mu g/m^3$)	Exceeds Monitoring Threshold?
1-hour	1	**127.8**	10	Yes	3020.8	NA	No
	2	117.3					
	3	109.7					
	4	9.4					
Annual	5	**7.0**	1	Yes	1208.3	14	No
	6	6.6					
	7	6.3					
	8	5.4					

The SIL modeling significant impact area for 1-hour NO_2 and for annual NO_2 are shown in Figures 3 and 4, respectively.

Based on the results of the preliminary modeling, refined modeling was conducted to demonstrate compliance with the NAAQS for 1-hour NO_2 and annual NO_2. The refined modeling includes the combined impact of the proposed project, nearby sources, and background concentrations.

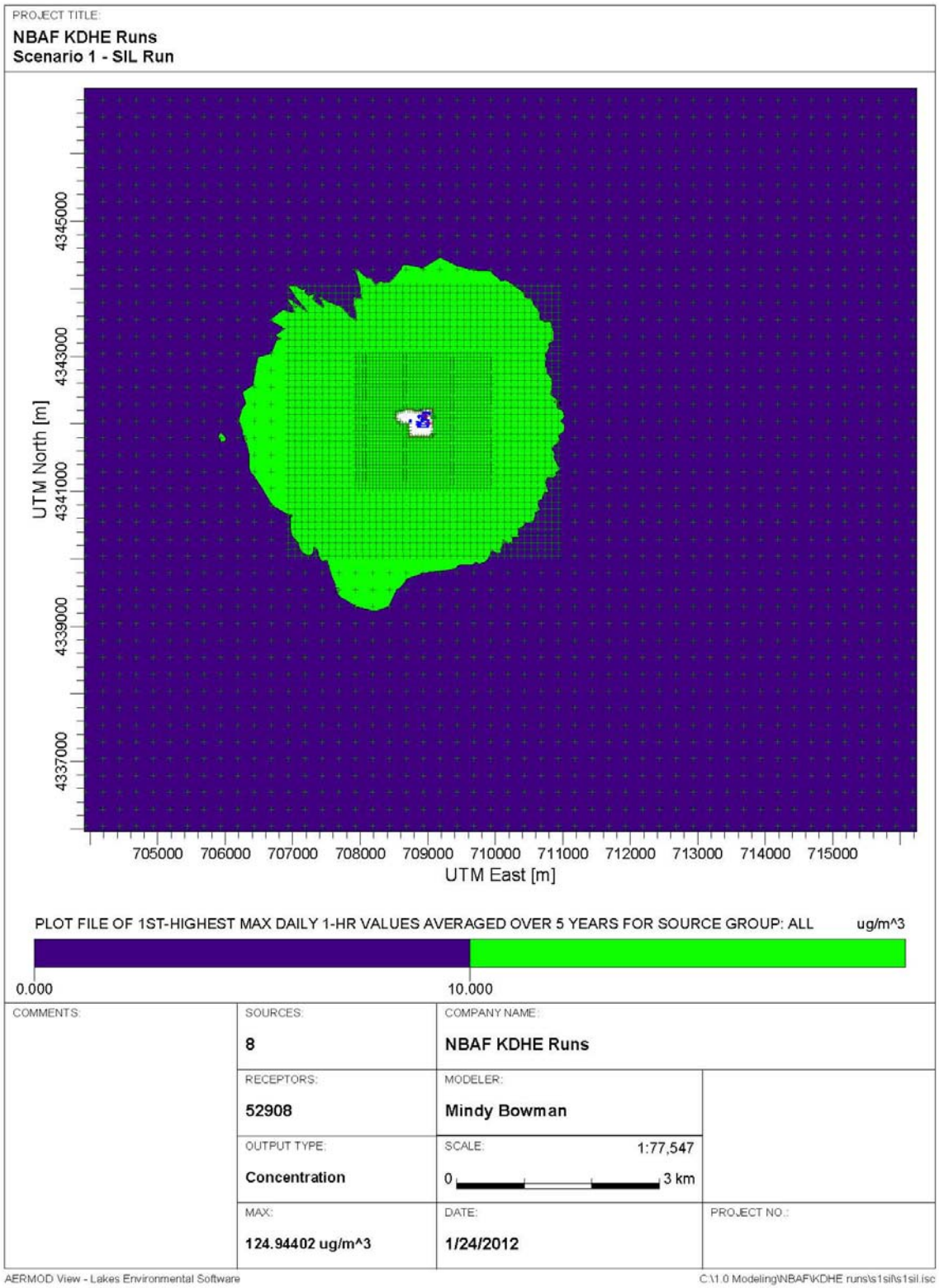

Figure 3. SIL Modeling Significant Impact Area for 1 Hour NO_2

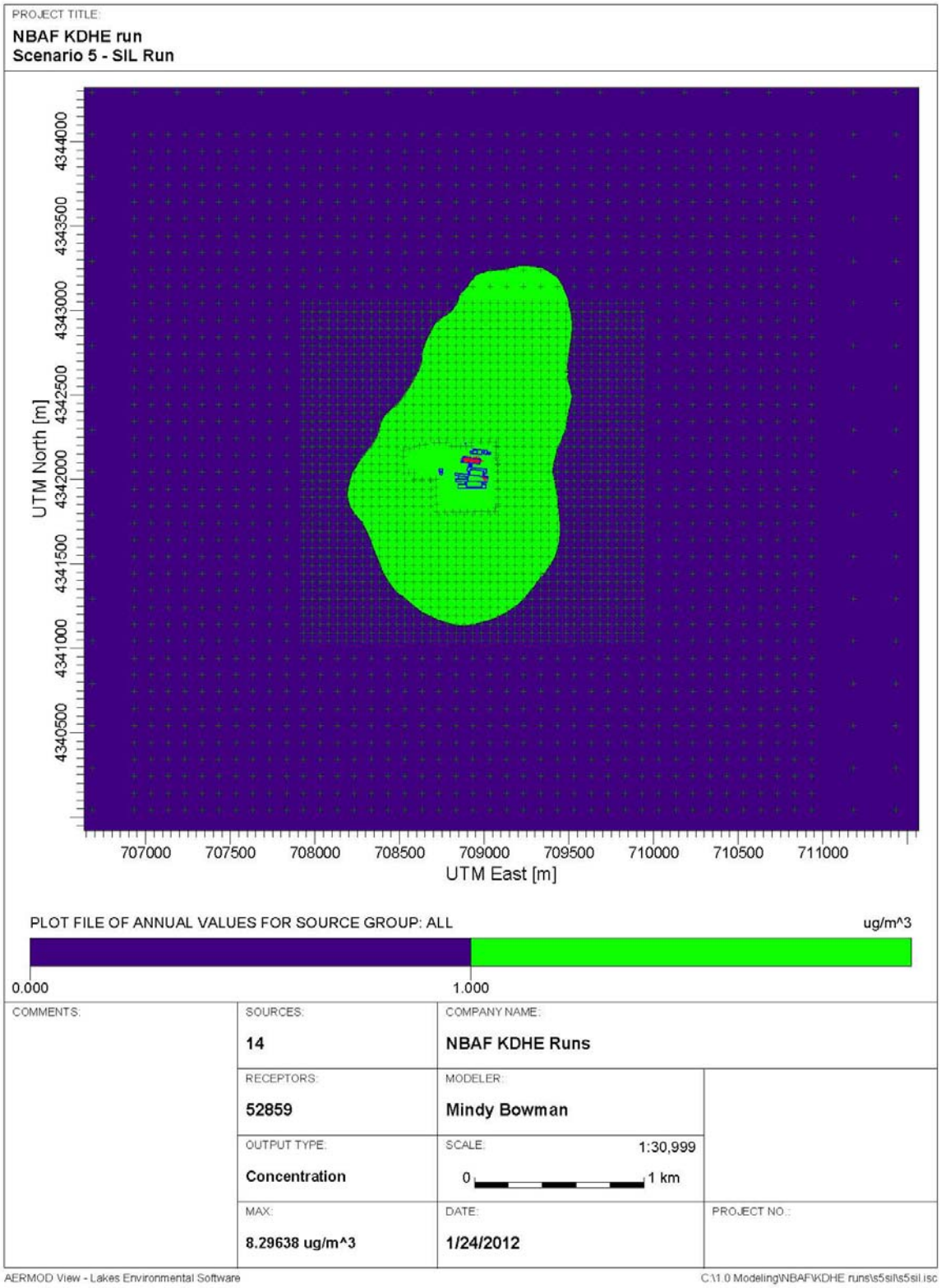

Figure 4. SIL Modeling Significant Impact Area for Annual NO_2

VII. Refined Analysis Results

Refined modeling was conducted to demonstrate compliance with the 1-hour and annual NO_2 NAAQS. Evaluation of compliance with the NAAQS requires that the refined modeling accounts for the combined impact of the proposed project, nearby sources, and background concentrations.

KDHE supplied emission sources within 20 kilometers from facility to the center of NBAF for the full impact analysis. KDHE prepared the nearby source inventories using information available through the KDHE emission inventory database and the facility files. 40 CFR Part 51 Appendix W procedures were followed. The list of nearby sources with source parameters and emission rates can be found in Table 7 on page 23 of the AQIA.

The background concentrations were provided by KDHE. Background concentrations prepared by KDHE can be found in Table 8a on pages 26-27 of the AQIA.

Table 5 summarizes the results from the refined analysis and includes the total concentration compared to the NAAQS for each pollutant for which a refined analysis was conducted. For scenarios 5-8, the KDHE analysis did not limit hours of operation of the NBAF boilers, and therefore yielded higher maximum predicted impacts than the facility's modeling. Maximum impacts as predicted by the facility's modeling can be found in Table 8a on pages 26-27 of the AQIA.

Table 5. NAAQS Compliance Demonstration

Pollutant	Averaging Period	Scenario	Modeled Concentration ($\mu g/m^3$)	Modeled Concentration x .80 per ARM[2]	Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
NO_2	1-hour (H8H, 5 yr average)	1	**161.4**	129.1	49.0	178.1	188
		2	161.3	129.0	49.0	178.0	188
		3	161.2	129.0	49.0	178.0	188
		4	160.9	128.7	49.0	177.7	188
	Annual (H1H)	5	**12.0**	NA	7.5	19.5	100
		6	11.6	NA	7.5	19.1	100
		7	11.2	NA	7.5	18.7	100
		8	10.4	NA	7.5	17.9	100

The predicted maximum impacts are shown in Figures 5 and 6 for 1-hour NO_2 and annual NO_2, respectively. Figure 5 shows only maximum impact, rather than design value for 1-hour NO_2.

[2] 40 CFR Part 51 Appendix W §5.2.4 discusses the use of Tier II, also known as the Ambient Ratio Method, for use with the NO_2 annual averaging period. Appendix W recommends following the Tier I approach, and if the predicted concentration exceeds the NAAQS, proceed with a Tier II analysis. In this case, none of the annual NO_2 modeled concentrations exceeded the NAAQS. Therefore, KDHE conservatively did not use the ARM to lower the modeled concentration for the annual averaging period. The facility did use the ARM for both 1-hour and annual NO_2 when adding the total modeled concentration to the background value.

No NAAQS exceedances were modeled. For 1-hour NO_2, the maximum predicted impact was for Scenario 1 at 129.1 μg/m^3, for a total concentration of 178.1 μg/m^3 when background is included. For annual NO_2, the maximum predicted impact was for Scenario 5 at 12.0 μg/m^3, for a total concentration of 19.5 μg/m^3 when background is included. The analyses indicated that concentration levels of all pollutants resulting from the proposed project, when combined with other sources, would not cause or contribute to an exceedance of the NAAQS.

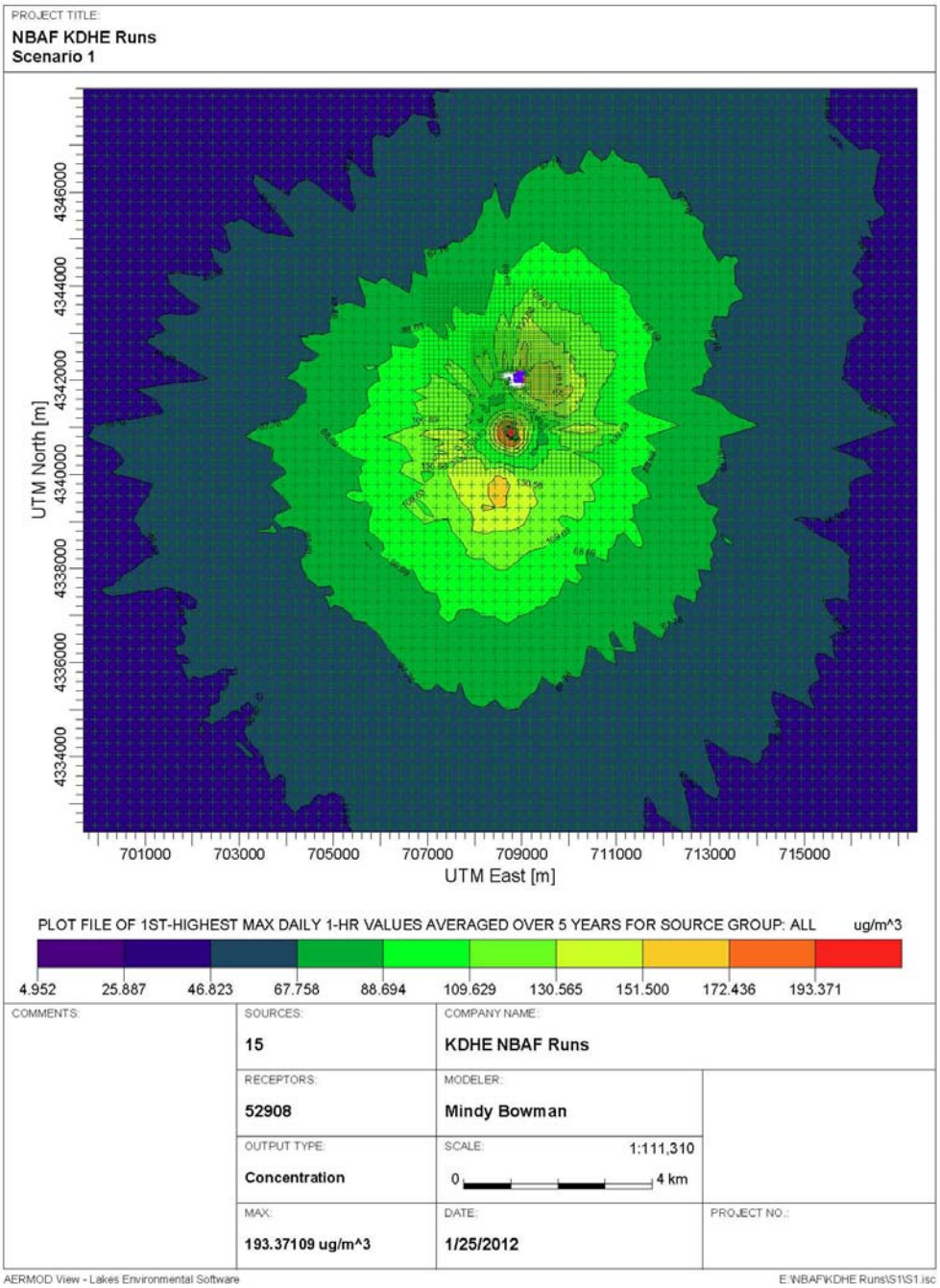

Figure 5. Refined Modeling Maximum Predicted 1-Hour NO_2 Concentrations

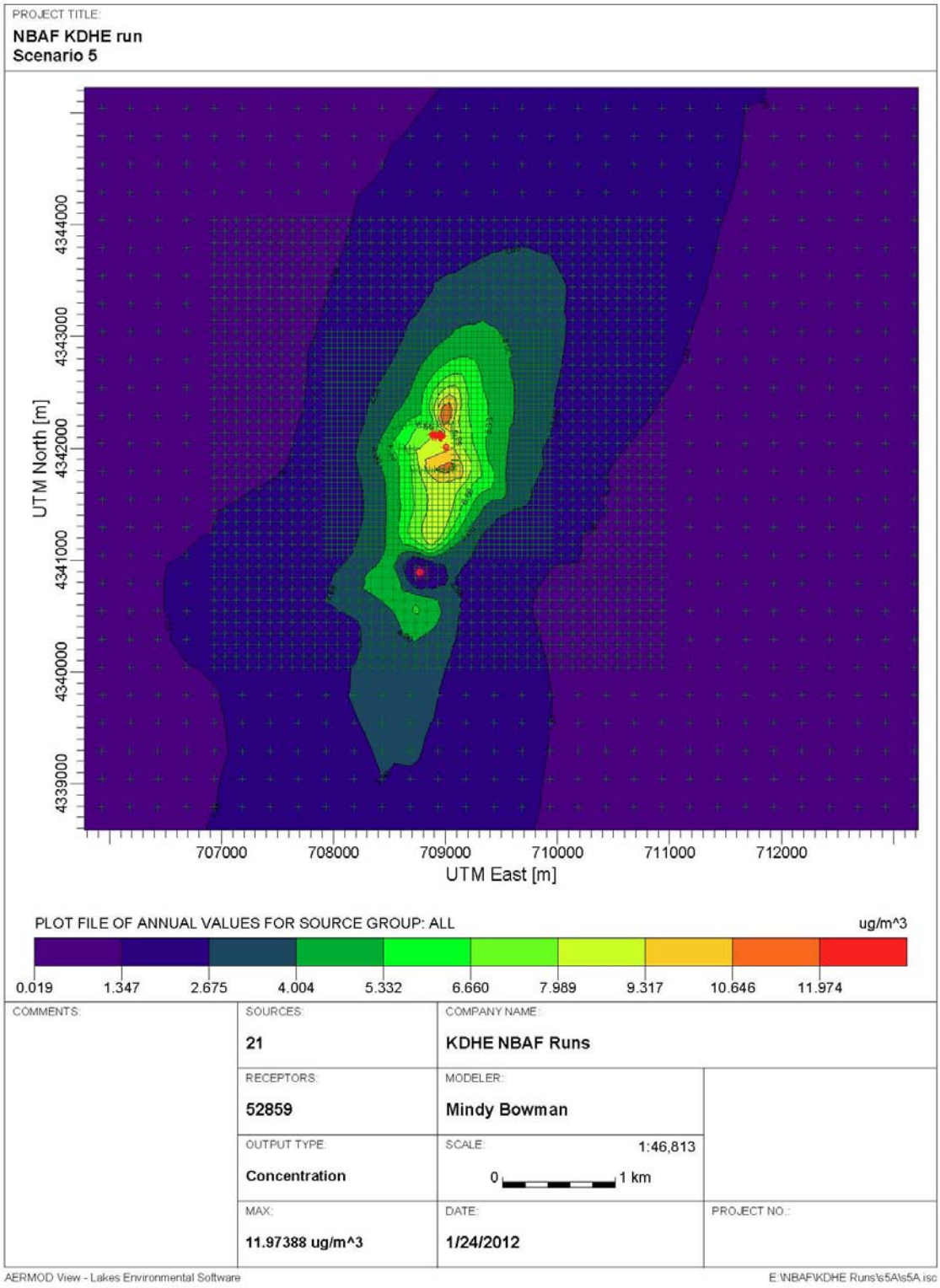

Figure 6. Refined Modeling Maximum Predicted Annual NO_2 Concentrations

VIII. Conclusions

The results of the modeling analysis are summarized in the AQIA submitted December 29, 2011. The AERMOD Modeling System was used to determine predicted ground level concentrations.

The results of the initial significant impact modeling indicated that refined modeling was required for 1-hour NO_2 and annual NO_2.

The refined analyses indicated that concentration levels of the pollutant resulting from the proposed project, when combined with other sources, would not significantly cause or contribute to an exceedance of the NAAQS.