Air Quality Impacts Analysis (AQIA)
for
Crusoe Energy Systems, Inc.

Located in Williams, ND 58830
Lat. 48.52778 Long. -103.47409

Permit No.: ACP- 18228 v1.0
Report Date: June 11, 2024

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North Dakota Department of Environmental Quality
Division of Air Quality

Report By:

Sankalp Kumar
Environmental Engineer, NDDEQ
Division of Air Quality

Contents

1 Executive Summary

Crusoe Energy Systems, Inc. (Crusoe Energy) conducted air dispersion modeling for Hulk Central Delivery Point (CDP) in Williams County, ND. The modeling efforts were conducted to demonstrate compliance with both state and federal Ambient Air Quality Standards (AAQS).

Based on the data provided in the Permit to Construct (PTC) application submitted on March 15, 2024[1], and the Department's independent review and modeling analysis, it is expected that the proposed facility (Project) will comply with the applicable AAQS. The Department results of the modeled impacts for the AAQS are outlined in Table 1 and Table 2, respectively.

Table 1- Ambient Air Quality Standards (AAQS) Results Summary[2]

POLLUTANT	AVERAGING TIME	MODELED IMPACT ($\mu g/m^3$)	BACKGROUND ($\mu g/m^3$)	TOTAL IMPACT ($\mu g/m^3$)	NDAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	PASSED (Y/N)
NO_2	Annual	8.63	5	13.63	100	100	Y
	1-HR	93.40	35	128.40	-	188	Y

2 Introduction

On March 15, 2024, the North Dakota Department of Environmental Quality, Division of Air Quality (Department) received an application for a Permit to Construct from Hulk CDP for the construction of a new data center in Williams County, North Dakota. The application included a modeling analysis to confirm compliance with the North Dakota Ambient Air Quality Standards (NDAAQS), and the National Ambient Air Quality Standards (NAAQS). Modeling efforts were carried out for NO_2. This Air Quality Impacts Analysis (AQIA) summarizes the Department's findings based on a thorough review and independent modeling analysis of the Project.

3 Project Background

Crusoe Energy is proposing a new data center located approximately 42 km northeast of Williston, North Dakota in Williams County. The facility will be utilizing natural gas to operate compressor and generator engines to power a set of data centers at the site.

[1] Air Quality Impacts analysis submitted on April 2, 2024.
[2] See Table 154 for AAQS averaging times.

4 Model Requirements

Hulk CDP qualifies as a minor source according to the PSD rules[3,4] and consequently is not subject to PSD review requirements. Per the Department Memo[5] dated October 6, 2014, sources that are not subject to the PSD rules require dispersion modeling for criteria pollutants prior to the issuance of a PTC if the projected emissions exceed significant emission rates (SERs) (Table 2).

Furthermore, any new source subject to non-PSD review that is situated within 50 kilometers (km) of a Class I area is required to include a Class I increment analysis. Table 3 provides a list of the Class I areas in closest proximity to Hulk CDP. Hulk CDP is located approximately 63 km from the nearest Class I area; therefore, a Class I increment analysis is not required. All other areas within North Dakota are designated Class II areas and Class II increment analysis applies.

Table 2 - Significant Emission Rates (SERs) in Tons per Year for non-PSD sources[6]

POLLUTANT	NON-PSD SER (<1.5 stack)	PROJECT PTE (TPY)	MODELING REQUIRED (Y/N)
NO_x	40	95.8	Y
PM_{10}	15	6.44	N
$PM_{2.5}$	10	6.44	N
SO_2	40	10.51	N

Table 3 - Class I Areas Near Source

CLASS I AREA	DISTANCE FROM PROJECT (km)	MODELING REQUIRED (Y/N)
Medicine Lake Wilderness Area (MT)	63	N
Lostwood Wilderness Area (ND)	73	N
Theodore Roosevelt National Park-North Unit (ND)	100	N
Theodore Roosevelt National Park-Elkhorn Ranch Unit (ND)	142	N

[3] *NDAC 33.1-15-15*. Available at: https://www.ndlegis.gov/information/acdata/pdf/33.1-15-15.pdf (Last visited October 24, 2023)
[4] *40 CFR §52.21*. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-52/subpart-A/section-52.21 (Last visited October 24, 2023)
[5] *Criteria Pollutant Modeling Requirements for a Permit to Construct.* Available at: https://deq.nd.gov/publications/AQ/policy/Modeling/Criteria_Modeling_Memo.pdf (Last visited October 24, 2023)

Theodore Roosevelt National Park-South Unit (ND)	167	N
Voyageurs National Park (MN)	757	N
Boundary Waters Canoe Area (MN)	897	N

Hulk CDP is subject to the requirements of NDAC 33.1-15-02[6] and Ambient Air Quality Standards. Cumulative modeling was conducted to demonstrate compliance with applicable state and federal standards.

5 Model Input Values

5.1 Model Version

The U.S. Environmental Protection Agency (EPA) has developed the *Guideline on Air Quality Models*[7] (40 CFR 51 Appendix W) wherein they list preferred models for pre-construction permitting reviews. At the time of the application submittal, Appendix W (2017) was the most current revision in use.

EPA's preferred model is AERMOD, which Hulk CDP and the Department used for the analysis and review, in accordance with Appendix W. In accordance with Appendix W, Crusoe Hulk utilizes the default Tier 2 NO_x-to-NO_2 conversion method (Ambient Ratio Method 2 (ARM2)).

Table 4 - Model Versions

MODEL	VERSION	MODEL	VERSION
AERMOD	23132	BPIP-PRIME	4274
AERMET	23132	AERMINUTE	15272
AERMAP	18081	AERSURFACE	20060

5.2 Meteorological Data (MET)

In the modeling process, both surface and upper-air meteorological (met) data are pre-processed through AERMET. This pre-processing generates the boundary layer parameters required by AERMOD to estimate plume dispersion. AERMET processes hourly meteorological data to determine plume transport and dispersion downwind from a source.

Per Appendix W (2017) 8.4.2.e, the choice of meteorological data should be based on ensuring a sufficiently conservative and representative result, considering hourly and seasonal variations in meteorological conditions throughout the year, which directly influence plume movement due to atmospheric conditions. The options for selecting meteorological data include:

1. One year of site-specific data: This involves using data collected onsite from a monitoring station.

[6] Available at: https://www.ndlegis.gov/information/acdata/pdf/33.1-15-02.pdf (Last visited October 24, 2023)
[7] Available at: https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf (Last visited October 24, 2023)

2. Five years of representative National Weather Service (NWS) data: This data source typically provides long-term, historical weather information.
3. At least 3 years of prognostic meteorological data: This type of data involves using predictive meteorological models to estimate future conditions.

The specific MET stations used for input in AERMET for this analysis are listed in Table 5. AERMET processes hourly surface observations, including parameters such as wind speed and direction, ambient temperature, sky cover (opacity), and local air pressure (optionally). It combines these observations with the pre-processed AERSURFACE output values (Table 8) to compile the necessary surface met inputs for AERMOD.

Table 5 - MET Data Used

MET DATA	LOCATION	STATION NO.	YEARS	DISTANCE FROM SOURCE* (km)	SOURCE OF DATA
Surface Air	Tioga, ND	720863	2019-2023	42	NWS
Upper Air	Bismarck, ND	24011	2019-2023	278	NWS

* Approximate distances using ArcGIS Earth's measuring tool.

5.3 Surface Inputs

AERMET relies on certain key values, including surface roughness length, albedo, and Bowen ratio when pre-processing met data for use in AERMOD.

AERSURFACE allows users to generate these values based on inputs related to seasonal variation in the vegetative landscape (e.g., landcover). The Input values recommended by the Department for AERSURFACE are outlined in the document titled *"Recommended AERSURFACE Inputs North Dakota* (March 2017)".[8]

Table 6 - AERSURFACE Input Values

PARAMETER	VALUE USED
Radius of study area used for surface roughness:	1.0 km
Define the surface roughness length for multiple sectors?	Yes
Number of sectors:	12

[8] Available at: https://deq.nd.gov/publications/AQ/policy/Modeling/AERSURFACE_InputsND.pdf (Last visited October 24, 2023)

Temporal resolution of surface characteristics	Monthly
Continuous snow cover for at least one month?	Yes
Reassign the months to different seasons?	Yes
Specify months for each season:	Yes
Late autumn after frost and harvest, or winter with no snow	Oct, Nov, Dec, Mar
Winter with continuous snow cover	Jan, Feb
Transitional spring	Apr, May
Midsummer with lush vegetation	Jun, Jul, Aug
Autumn with unharvested cropland	Sep
Is this site at an airport?	Yes
Is the site in an arid region?	No
Surface moisture condition at the site:	Average

5.4 Receptor Grid

Receptors serve as the designated locations where the air quality model calculates ground-level pollutant concentrations. These receptors are strategically placed within a receptor grid, and their distribution is determined by factors such as terrain characteristics and pollutant emission rates. While the exact configuration may vary, it typically forms a rectangular pattern radiating outward from the emission source. The goal is to ensure that the receptor grid effectively captures the dispersion and distribution of pollutants in the vicinity of the facility.

For further specifics on the receptor grid, including intervals and locations used (Table 7).

Table 7 - Receptor Grid Spacing

DISTANCE OUT FROM SOURCE	DISTANCE BETWEEN RECEPTORS
Fence line	25 meters
0 to 1000 meters (0 to 1.0 km)	50 meters
1,001 to 2,000 (1 to 2 km)	100 meters

2,001 to 5,000 meters (2 to 5 km)	250 meters
5,001 to 10,000 meters (5 to 10 km)	500 meters
Total Number of Receptors	5,587
Terrain Data	NED 2017, 1/3 arcsecond (10-meter)

The receptor points are placed at ground level, and their elevation is determined using the United States Geological Survey (USGS) National Elevation Dataset (NED) terrain and land-use data. The Universal Transverse Mercator (UTM) map projection with the North American Datum of 1983 (NAD83) is used for both the source input locations and the receptor grid location. To ensure accurate placement at ground level, the USGS NED 2017 data at a 1/3 arcsecond (10-meter) resolution is processed through the AERMAP pre-processor. This pre-processor adjusts the receptor points' elevations based on terrain data, aligning them with the actual topography of the area.

Receptor points located within the plant boundary are not modeled, as they do not represent ambient air.[9] Ambient air is defined as air situated outside of a boundary (e.g., a fence), which restricts general public access to a facility or source. Hulk CDP will utilize a fence around the plant boundary, and signage to preclude access to the general public. This exclusion ensures that the modeling analysis focuses on assessing the impact of emissions on the air quality in areas accessible to the public.

5.5 Background

Hulk CDP used fixed background concentrations when predicting the total ambient effect on AAQ. These fixed background concentrations are not included as inputs in the modeling process, and as a result, they are not included in the values output for concentrations (i.e. not included in MODELED IMPACT, but added in after under the TOTAL IMPACT in Table 1 and Table 10). Fixed background concentrations shown in Table 8 are considered reasonably representative of the entire state, and while they are conservative, they play a significant role in ensuring a comprehensive and conservative assessment of the total ambient effect on AAQS due to emissions from the facility.

Table 8 - Fixed Background Concentrations[10]

POLLUTANT	AVERAGING TIME	BACKGROUND ($\mu g/m^3$)
NO_2	Annual	5
	1-HR	35

[9] *§40 CFR 50.1(e).* Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50/section-50.1 (Last visited October 24, 2023)

[10] Available at: https://deq.nd.gov/publications/AQ/policy/Modeling/ND_Air_Dispersion_Modeling_Guide.pdf

5.5.1 Nearby Sources

Per Appendix W, the Department examined records pertaining to sources that might potentially share a significant concentration gradient with the proposed Hulk CDP facility. After the review, it was determined that no sources were interacting with or significantly impacting the air dispersion model for Hulk CDP.

5.6 Emission Source Modeling Parameters

AERMOD requires specific source data to model air pollutant dispersion accurately. This data includes:

1. Type and location of each emission point
2. Base elevation of each stack
3. Emission height and rate
4. Gas exit velocity and temperature
5. Other stack/emission parameters depending upon source type

To ensure the accuracy of model input values, a comparison was made between the emission rates and stack parameters provided in the application and the corresponding information for each emission unit.

Source modeling parameters are shown in *Table 9*.

Table 9 - **Point Source Parameters** lists the model input parameters for location (UTM X-Y coordinates), elevation, height (i.e. release height), exit temperature, exit velocity, stack exit diameter, and stack exit orientation

EMISSION POINT	EMISSION POINT DESCRIPTION	UTM X (m)	UTM Y (m)	ELEV. (m)	HEIGHT (m)	TEMP (°F)	FLOW (acfm)	VELOCITY (m/s)	EXIT DIA. (m)	Orient. (vert/horiz)	NO_x (g/s)
EP1	Compressor Engine #1	612627.8	5376082.1	655.81	7.62	1,265	2,871	15.82	0.33	Vertical	0.02
EP2	Compressor Engine #2	612639.7	5376082.1	655.88	7.62	1,265	2,871	15.82	0.33	Vertical	0.02
EP3	Generator Engine #1	612598.0	5375973.6	655.20	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP4	Generator Engine #2	612617.2	5375973.6	655.24	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP5	Generator Engine #3	612636.4	5375973.6	655.29	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP6	Generator Engine #4	612655.2	5375973.6	655.36	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP7	Generator Engine #5	612673.4	5375973.6	655.43	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP8	Generator Engine #6	612597.6	5376031.2	655.46	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP9	Generator Engine #7	612616.2	5376031.2	655.52	7.62	1,084	10,544	58.11	0.33	Vertical	0.10

EP10	Generator Engine #8	612634.4	5376031.2	655.55	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP11	Generator Engine #9	612653.2	5376031.2	655.56	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP12	Generator Engine #10	612672.1	5376031.2	655.55	7.62	1,084	10,544	58.11	0.33	Vertical	0.10
EP13	Turbine	612619.8	5376087.1	655.77	12.19	910	268,030	48.15	1.83	Vertical	1.64

6 Model Execution and Results

6.1 Ambient Air Quality Standards (AAQS)

State[11] and federal[12] AAQS were modeled per the parameters listed in Section 5.6. The model analysis results are shown in Table 10.

Table 10 – AAQS Results Summary

POLLUTANT	AVERAGING TIME	MODELED IMPACT ($\mu g/m^3$)	BACKGROUND ($\mu g/m^3$)	TOTAL IMPACT ($\mu g/m^3$)	NDAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	PASSED (Y/N)
NO2	Annual[A] (2022)	8.63	5.00	13.63	100	100	Y
	1-HR[B]	93.40	35.00	128.40	-	188	Y

[A] Modeled concentration is the annual average concentration of five modeled years of meteorological data.

[B] Modeled concentration is the 98th percentile (eighth-high) of the annual distribution of daily maximum 1-hr concentrations averaged across five years of meteorological data.

7 Summary & Conclusions

Upon the Department's review and independent analysis of the modeling submitted by Crusoe Energy Systems, the following is concluded:

Crusoe Energy Systems followed all applicable State and Federal guidance in their modeling protocol.

Hulk CDP's dispersion modeling was conducted to demonstrate that emissions from the Project are expected to comply with state and federal Ambient Air Quality Standards (AAQS). Emissions associated with operating the facility with the proposed emission units and limits are not expected to cause or contribute to a violation of the NAAQS and NDAAQS as listed in NDAC 33.1-15-02-04. Results of the modeled impacts for the AAQS are displayed in Table 1 and Table 15.

[11] *NDAC 33.1-15-02*. Available at: https://www.ndlegis.gov/information/acdata/pdf/33.1-15-02.pdf?20150602082326 (Last visited October 24, 2023)

[12] *§40 CFR 50.* Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50?toc=1 (Last visited October 24, 2023)

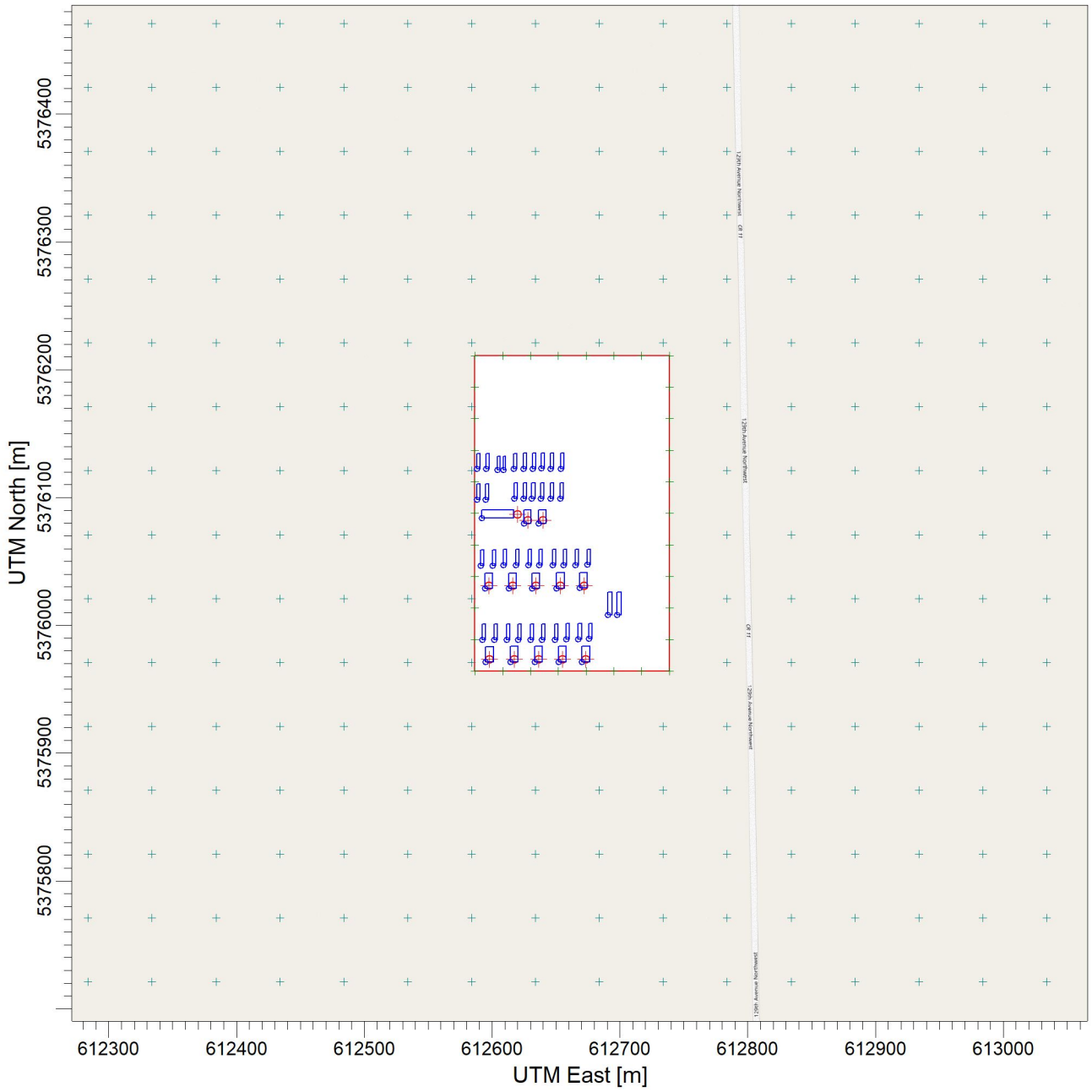
8 Plots

Model Set-Up

AAQS Analysis

PROJECT TITLE:

Crusoe Energy Systems, Inc. - Hulk CDP
Plot 1 - Site



COMMENTS:	SOURCES: **13**	COMPANY NAME: **North Dakota Department of Environmental Quality**	
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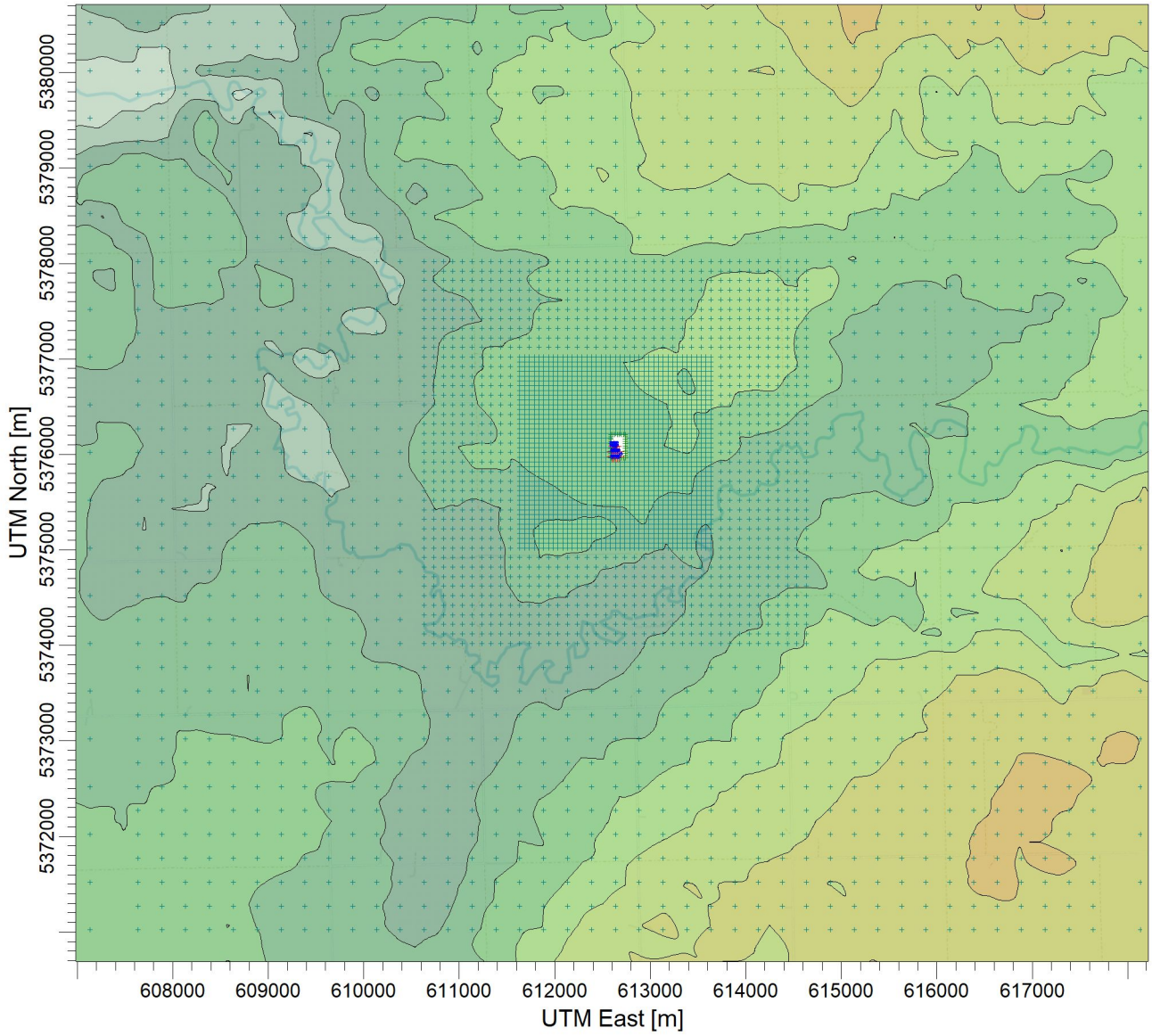
		SCALE: 1:5,000 0 0.1 km	
		DATE: **5/23/2024**	PROJECT NO.: **ACP- 18228 v1.0**

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Crusoe Energy Systems, Inc. - Hulk CDP
Plot 2 - Terrain Contours



COMMENTS:	SOURCES: **13**	COMPANY NAME: **North Dakota Department of Environmental Quality**	
	RECEPTORS: **5587**	MODELER: **Sankalp Kumar**	
		SCALE: 1:70,646 0 2 km	
		DATE: **5/23/2024**	PROJECT NO.: **ACP- 18228 v1.0**

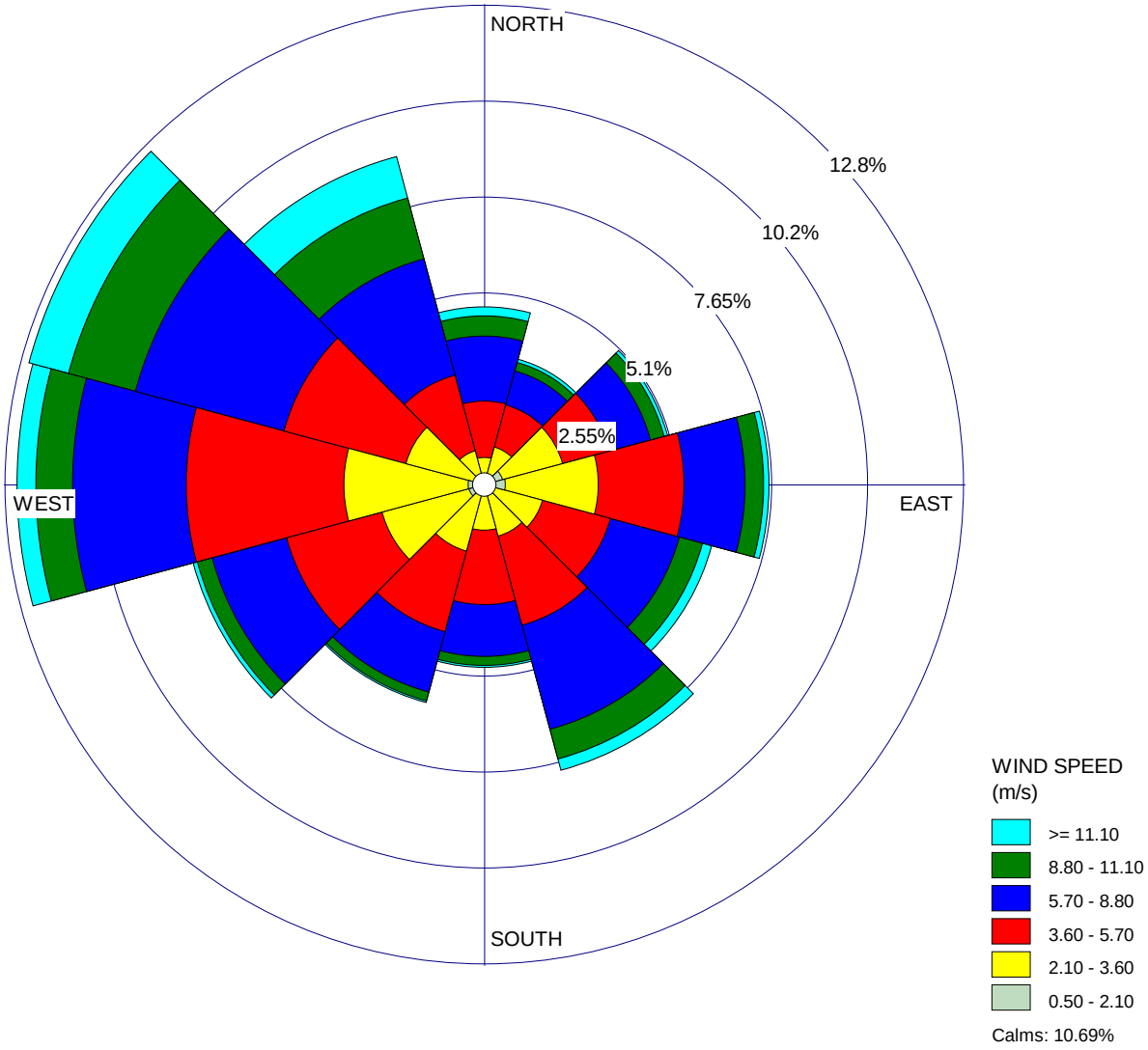
AERMOD View - Lakes Environmental Software

WIND ROSE PLOT:

Epitome Energy
Plot 3 - Windrose

DISPLAY:

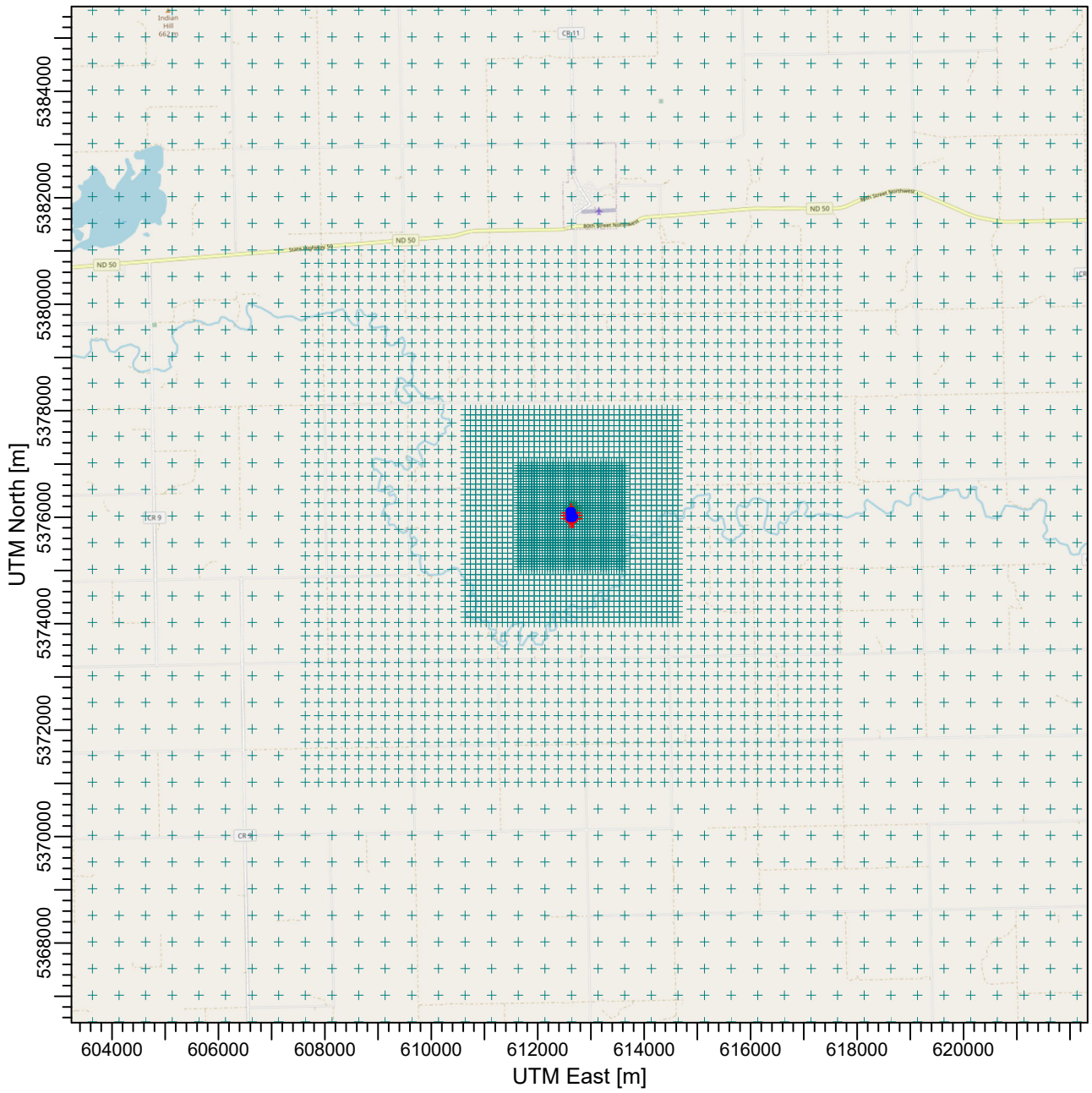
Wind Speed
Direction (blowing from)



COMMENTS: Tioga, ND Station No. 720863	DATA PERIOD: **Start Date: 1/1/2019 - 00:00** **End Date: 12/31/2023 - 23:59**	COMPANY NAME: **North Dakota Department of Environmental Quality**	
		MODELER: **Sankalp Kumar**	NORTH Dakota Be Legendary. | Environmental Quality
	CALM WINDS: **10.69%**	TOTAL COUNT: **43096 hrs.**	
	AVG. WIND SPEED: **5.09 m/s**	DATE: **5/23/2024**	PROJECT NO.: **ACP-18228 v1.0**

PROJECT TITLE:

Crusoe Energy Systems, Inc. - Hulk CDP
Plot 4 - Receptor Grid

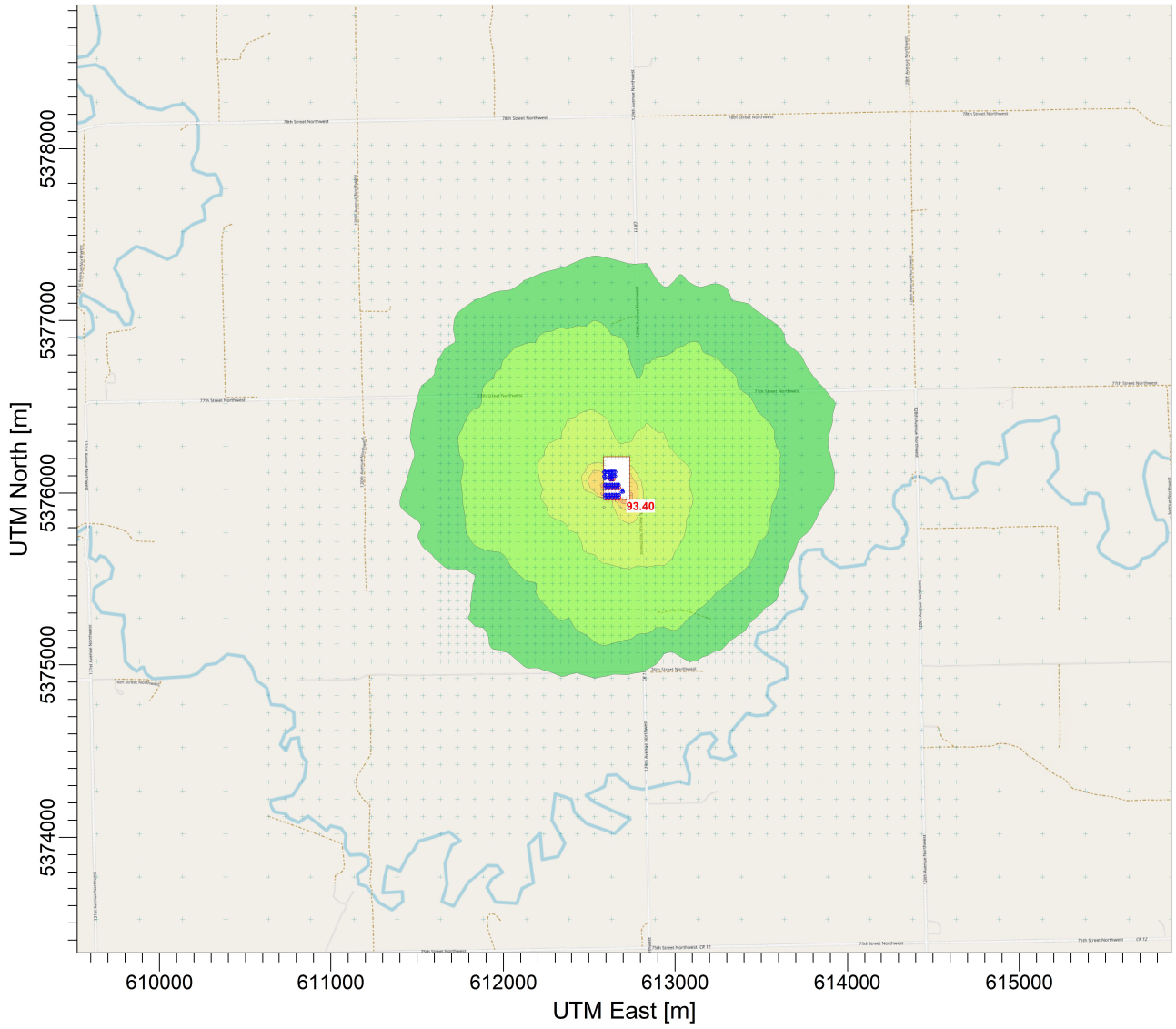


COMMENTS:	SOURCES: **13**	COMPANY NAME: **North Dakota Department of Environmental Quality**	
	RECEPTORS: **5587**	MODELER: **Sankalp Kumar**	NORTH Dakota Be Legendary. | Environmental Quality
		SCALE: 1:120,000 0 4 km	
		DATE: **5/30/2024**	PROJECT NO.: **ACP- 18228 v1.0**

AERMOD View - Lakes Environmental Software

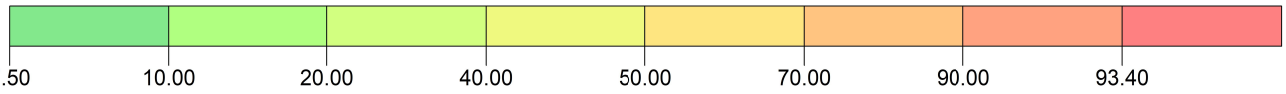
PROJECT TITLE:

Crusoe Energy Systems, Inc. - Hulk CDP
Plot 5 - NO2 1-HR AAQS



PLOT FILE OF 8TH-HIGHEST MAX DAILY 1-HR VALUES AVERAGED OVER 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

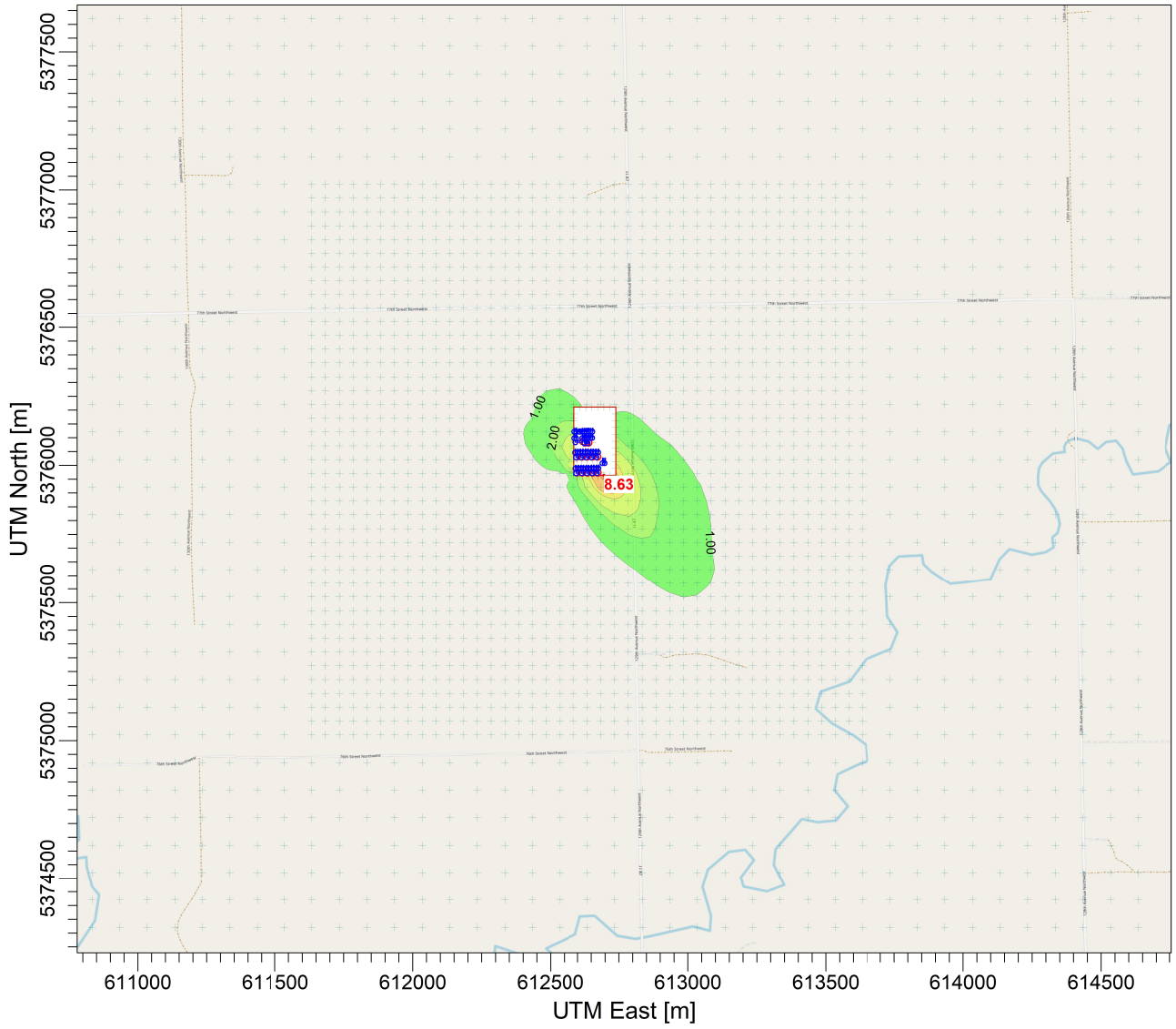
Max: 93.40 [ug/m^3] at (612717.04, 5375964.08)



COMMENTS: Background is 35 µg/m3. Total Impact is 128.4 µg/m3. AAQS is 188 µg/m3.	SOURCES: **13**	COMPANY NAME: **North Dakota Department of Environmental Quality**	
	RECEPTORS: **5587**	MODELER: **Sankalp Kumar**	NORTH Dakota Be Legendary. | Environmental Quality
	OUTPUT TYPE: **Concentration**	SCALE: 1:40,000 0 1 km	
	MAX: **93.40 ug/m^3**	DATE: **5/30/2024**	PROJECT NO.: **ACP- 18228 v1.0**

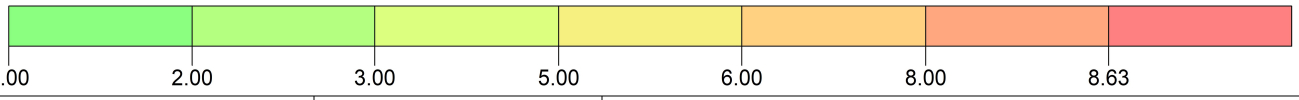
PROJECT TITLE:

Crusoe Energy Systems, Inc. - Hulk CDP
Plot 5 - NO2 Annual AAQS



POST/PLOT FILE OF ANNUAL VALUES FOR YEAR 1 FOR SOURCE GROUP: ALL ug/m^3

Max: 8.63 [ug/m^3] at (612695.29, 5375964.08)



COMMENTS: Background is 5 µg/m3. Total Impact is 13.63 µg/m3. AAQS is 100 µg/m3.	SOURCES: **13**	COMPANY NAME: **North Dakota Department of Environmental Quality**	
	RECEPTORS: **5587**	MODELER: **Sankalp Kumar**	NORTH Dakota Be Legendary. | Environmental Quality
	OUTPUT TYPE: **Concentration**	SCALE: 1:25,000 0 0.5 km	
	MAX: **8.63 ug/m^3**	DATE: **5/30/2024**	PROJECT NO.: **ACP- 18228 v1.0**