Corporate Headquarters
3222 South Vance Street, Suite 200, Lakewood, CO 80227
T: 303.980.5200 F: 303.980.0089
www.pinyon-env.com

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Air Quality Impact Analysis

Crusoe Energy Systems Inc.
Charging Eagle 21-25 Pad
Dunn County, North Dakota

Pinyon Project No.:
1/19-1347-01

1. Current Environment

Crusoe Energy Systems Inc. has prepared a true minor source air permit application for a maximum of three (3) Waukesha 9394 GSI generators to be located on the Fort Berthold Indian Reservation (FBIR) at the RimRock Oil & Gas (RimRock) Charging Eagle 21-25 Pad (the Facility) in Dunn County, North Dakota. The purpose of the generators is to take gas from the wells that would otherwise be flared to use as fuel in to power small data centers. Each generator is built with a non-selective catalyst reduction (NSCR) device. Since the engines will yield emissions of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) and these were determined to be pollutants of concern by the U.S. Environmental Protection Agency (EPA), modeling was performed to demonstrate compliance with the 1-hour and annual nitrogen dioxide (NO_2), 1-hour and 8-hour CO, 1-hour SO_2 as well as 24-hour and annual $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS).

1.1 National Ambient Air Quality Standards

The Clean Air Act of 1970 and its amendments led to the U.S. Environmental Protection Agency (EPA) establishing National Ambient Air Quality Standards (NAAQS) for criteria air pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ground level ozone (O_3), particulate matter less than 10 microns (PM_{10}) and less than 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$). Multiple revisions to the NAAQS have occurred over time and the current NAAQS are provided in Table 1-1. There were previous standards for 24-hour SO_2 and annual SO_2 that are no longer in effect.

The generators are a contributor of NO_2, CO, $PM_{2.5}$, SO_2 and O_3 precursors, so only these criteria pollutants will be discussed in detail in subsequent sections. Currently all counties in North Dakota, including the Project location, are in attainment with NAAQS. Since ozone is a regional pollutant, it is not evaluated as part of the NAAQS screening process. Ozone and secondary $PM_{2.5}$ are discussed in the results section of this report through Modeled Emission Rates for Precursors (MERPs).

Table 1-1 National Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard	Form of Standard
Carbon Monoxide	8 hours	10,000 µg/m³ (9 ppm)	Not to be exceeded more than once per year
	1 hour	40,000 µg/m³ (35 ppm)	
Lead	Rolling three-month average	0.15 µg/m³	Not to be exceeded
Nitrogen Dioxide	1 hour	188 µg/m³ (100 ppb)	98th percentile of 1-hour daily maximum, averaged over 3 years
	Annual	100 µg/m³ (53 ppb)	Annual mean
Ozone	8 hours	140 µg/m³ (0.070 ppm)	Annual 4th highest 8-hour daily maximum, averaged over 3 years
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual (primary)	12 µg/m³	Annual mean, averaged over 3 years

Pollutant	Averaging Time	Primary Standard	Form of Standard
	Annual (secondary)	15 µg/m³	Annual mean, averaged over 3 years
	24 hours (primary and secondary)	35 µg/m³	98th percentile, averaged over 3 years
Particulate Matter < 10µm (PM_{10})	24 hours	150 µg/m³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide	1 hour	75 ppb (196 ug/m³)	99th percentile of 1-hour daily maximum, averaged over 3 years
	3 hour (secondary)	0.5 ppm (1,309 ug/m³)	Not to be exceeded more than once per year

Source: *EPA 2016*
ppm *parts per million*
ppb *parts per billion*
µm *microns*
µg/m³ *micrograms per cubic meter*

1.2 Background Concentrations

The facility is located within the Fort Berthold Indian Reservation in Dunn County, North Dakota. Upon review of EPA's AirData Air Quality Monitors database, the two nearest air quality monitors nearest to the Crusoe project area are Lake Ilo (38-025-0004) and 6493 First Street SW (38-057-0124). There are no nearby air quality monitoring data for CO, and therefore no CO values are included in the table below. The background values used in the cumulative analysis (discussed in Section 2), are an average of the Lake Ilo and First Street SW monitored values in the form of the standard (shown in Table 1-1) from 2018 to 2020 including exceptional events data, to be conservative (https://www.epa.gov/outdoor-air-quality-data/monitor-values-report). 2021 annual data is not finalized until May of 2022 and therefore was not included.

Table 1-2 Background Concentrations for Cumulative Analysis

Pollutant	Averaging Time	Lake Ilo			First Street SW			Background Concentration
		2018	2019	2020	2018	2019	2020	
NO_2	1 hour	12 ppb	17 ppb	10 ppb	15 ppb	16 ppb	18 ppb	14.7 ppb (27.6 µg/m³)
	Annual	1.99 ppb	2.42 ppb	1.86 ppb	1.95 ppb	1.75 ppb	1.84 ppb	2.0 ppb (3.7 µg/m³)
O_3	8 hours	59 ppb	63 ppb	54 ppb	NA	NA	NA	59 ppb
$PM_{2.5}$	24 hours	20 µg/m³	11 µg/m³	10 µg/m³	NA	NA	NA	13.7 µg/m³
	Annual	5.0 µg/m³	4.1 µg/m³	3.6 µg/m³	NA	NA	NA	4.1 µg/m³
SO_2	1 hour	7 ppb	6 ppb	5 ppb	51 ppb	20 ppb	24 ppb	18.8 ppb (49.3 µg/m³)

2. Model Selection Justification and Settings

To demonstrate compliance with ambient air quality standards, the most recent version of the AERSCREEN air dispersion model (version no. 21112) was chosen to assess the potential air quality impacts of NO_2, CO, SO_2, and $PM_{2.5}$ from the Facility. AERSCREEN is the USEPA approved screening tool that analyzes one source and is based on AERMOD that produces worst-case 1-hour concentrations. AERSCREEN does not utilize hourly meteorological data but does use default meteorological data sets based on land type and average weather through the use of MAKEMET (version no. 21112).

Since this is a screening of the Facility's impacts conservative inputs were used as described in the following sections to demonstrate no exceedances of NAAQS are anticipated.

2.1 Terrain Options

AERSCREEN, as a screening tool, does not necessarily require location-specific or representative terrain data. Due to the relatively flat nature of the site, the terrain heights were not included with a source elevation of 0 meters in a rural setting. Because the majority of the land surrounding the Facility is not developed and has a low population density, rural dispersion was chosen. As described further in the AERMET processing, the surrounding location is considered grassland.

2.2 Meteorology

No onsite meteorological data were available for the Facility. AERSCREEN does not require any meteorological data and instead uses MAKEMET to generate basic meteorological parameters based on surface characteristics, wind speed, and temperature. Based on the site location, known data, and default parameters within AERSCREEN, the following was used for each of the AERSCREEN runs. Note that the worst-case meteorology wind speed, wind direction, and temperature were used making the modeling of emission sources conservative.

- Minimum Temperature: - 10 degrees Fahrenheit (default)
- Maximum Temperature: 100 degrees Fahrenheit (default)
- Minimum Wind Speed: 0.5 meters per second (default)
- Anemometer Height: 10 meters (default)
- AERMET seasonal tables: option 2
- Dominant Surface Profile: Grassland (6)
- Dominant Climate Profile: Average Moisture (1)
- Non-adjusted (default)

2.3 Receptors

Since AERSCREEN models only one source at a time, a receptor grid is generated by AERSCREEN based on the minimum distance to ambient air, set receptor spacing, and radius length of a receptor grid. Receptors were set as along and off of the fenceline to estimate worst-case impacts surrounding the source. Based on known data and default parameters within AERSCREEN, the following was used for each of the AERSCREEN runs.

- Distance to Ambient Air: 1 meter (default)
- Maximum Distance to probe: 5,000 meters (default)
- Receptor spacing: 25 meters (default)
- Discrete receptors: none
- Flagpole receptors: none

2.4 Source Location

For a cumulative analysis, nearby sources not owned or operated by Crusoe are also modeled. Tables 2-1 and 2-2 list each modeled source under Crusoe ownership and operatorship and each modeled source under RimRock ownership and operatorship. The nearby RimRock sources include those that will be included in the RimRock Charging Eagle 21-25 FIP registration application. The modeled distances to ambient air were assumed to be 1 meter (3.3 feet). Each of the sources is more than 1 meter from ambient air making this assumption conservative. Figure 1 provides a graphic representation of the sources and ambient air boundaries.

Table 2-1 Modeled Crusoe Sources

Source	Description
Generators (ENG01 through ENG03)	Three (3) 2,500 horsepower Waukesha 9394GSI generators[1]

1 Stack parameters across ENG01 through ENG03 are identical, so the units are modeled as a merged stack.

Table 2-2 Modeled RimRock Sources

Source	Description
Rimrock Heater Treaters	Three (3) 0.5 MMBtu/hr heater treaters[1]
RimRock Tank Flare	One (1) flare for control of storage tank emissions
RimRock Gas Flare	One (1) flare for control of stranded gas
RimRock Microturbines	Seven (7) 333 kW microturbines[1]
RimRock Compressor	One (1) 400 horsepower Caterpillar G3408 compressor engine

1 Stack parameters across the heater treaters and turbines are identical, so each of the grouped units are modeled as a merged stack.

Two approaches to determining cumulative model results against the NAAQS were taken: (1) assume that all of the sources originate at the same central point where dispersion plumes overlap completely and (2) evaluate the maximum 1st high through 8th high results (see Section 2.5) of each individual source additively regardless of location (i.e., one sources' maximum 1st high at 200 meters added to another sources' maximum 1st high at

1 meter). Both approaches are conservative in that they do not account for realistic conditions such as the space between sources and gaps that would occur between individual source dispersion plumes.

2.5 Standards

Based on how AERSCREEN operates, and the NAAQS shown in Table 1-1, the form of the standard is not considered in the model output. Instead, the maximum potential 1-hour concentration is modeled and, if applicable, persistence factors are applied to the maximum 1-hour result for longer averaging times. Based on AERSCREEN guidance, the maximum 1-hour result is multiplied by 1 for 3-hour standards, multiplied by 0.9 for 8-hour standards, multiplied by 0.6 for 24-hour standards, and multiplied by 0.1 for annual standards. The results summary in the OUT file for AERSCREEN applies these persistence factors when presenting the scaled longer average time period results.

Because the form of the standard for 1-hour NO_2 and 24-hour $PM_{2.5}$ are both 98th percentile, or the highest 8th high, and averaged over 3 years, utilizing the maximum 1-hour value result to determine concerns with the NAAQS is a conservative approach. Similarly, the form of the standard for 1-hour SO_2 is the 99th percentile or the highest 4th high, and averaged over 3 years resulting in the maximum 1-hour value result to determine concerns with the NAAQS is a conservative approach. The form of the standard for the 1-hour and 8-hour CO NAAQS is not to be exceeded more than once per year, or the highest 2nd high. Therefore, comparing the highest 1st high to the NAAQS is also conservative. As discussed further in the results sections, the 2nd through 8th maximum values of the 1-hour NO_2 and 24-hour $PM_{2.5}$ cumulative model results and the 2nd through 4th maximum values of the 1-hour SO_2 cumulative model results are tabulated to demonstrate the model results more accurately in the form of the standard.

3. Emission Sources and Modeled Emission Rates

Detailed emission calculations for the three (3) Crusoe generator engines are provided in the permit application. A summary of the modeled emission rates for the proposed Crusoe sources are summarized in Tables 3-1 and 3-2. Since the generators have identical stack parameters and emissions rates, a merged stack was modeled assuming all emissions from one stack. For the cumulative analysis, nearby sources not owned or operated by Crusoe are also modeled. The modeled emissions rates for the RimRock sources that have the potential to emit the same pollutants are summarized in Tables 3-3 and 3-4. Note, CO and SO_2 emissions from RimRock sources are not included in Table 3-4 as a cumulative analysis was not required (see Sections 4 and 6).

To estimate NO_2 concentrations, the ozone limiting method (OLM) was used in AERSCREEN (Option 2). With OLM, the background ozone concentration from Table 1-2 was used in conjunction with in-stack ratios for each emission unit type (e.g., reciprocating engine, turbine, heater, flare, etc.). The in-stack ratios were retrieved from the most recent version of the EPA NO_2 In-Stack Ratio (ISR) database released in October of 2020. Non-zero values were not included when determining the average ISR used in the AERSCREEN model. The ISR are included in Tables 3-1 through 3-4 below. The "No Chemistry" option was used for all CO, SO_2, and $PM_{2.5}$ model runs.

Table 3-1 NO_2 Modeled Emission Rates of Crusoe Sources

Source	NOx Emissions (lb/hr)	Emission Unit Classification	NO_2/NOx In-Stack Ratio
Generators (ENG01 – ENG03)	2.48	Reciprocating IC engine	0.17

Table 3-2 CO, SO_2, and $PM_{2.5}$ Modeled Emission Rates of Crusoe Sources

Source	CO Emissions (lb/hr)	SO_2 Emissions (lb/hr)	$PM_{2.5}$ Emissions (lb/hr)
Generators (ENG01 – ENG03)	4.96	0.24	1.14

Table 3-3 NO_2 Modeled Emission Rates of RimRock Sources

Source	NOx Emissions (lb/hr)	Emission Unit Classification	NO_2/NOx In-Stack Ratio
Heater Treaters	0.17	Boiler/Heater	0.1
Tank Flare	0.42	Flare	0.5
Gas Flare	0.59	Flare	0.5
Microturbines	0.86	Turbine – natural gas	0.14
Compressor	0.88	Reciprocating IC engine	0.17

Table 3-4 $PM_{2.5}$ Modeled Emission Rates of RimRock Sources

Source	$PM_{2.5}$ Emissions (lb/hr)
Heater Treaters	0.014
Tank Flare	--
Gas Flare	--
Microturbines	0.16
Compressor	0.061

[1] There are no potential $PM_{2.5}$ emissions from the RimRock Tank Flare and Gas Flare

3.1 Source Parameters

The modeled stack parameters are summarized in Tables 3-5 and 3-6. All stack flows and temperatures were determined from manufacturer specifications of the specific make/model equipment or default values, where appropriate. These parameters will be installed and operational upon Crusoe's installation and operation of their equipment.

Table 3-5 Stack Parameters for Crusoe Sources

Source	Source Type	Stack Height (ft)	Stack Diameter (in)	Stack Flow Rate (acfm)	Stack Temp (°F)
Generators (ENG01 – ENG03)	Point	25	13	10,544	1,084

Table 3-6. Stack Parameters for RimRock Sources

Source	Source Type	Stack Height (ft)	Stack Diameter (in)	Stack Flow Rate (acfm)	Stack Temp (°F)	Heat Release Rate (cal/s)
Heater Treaters	Point	23	24	3,770[2]	1,100	NA
Tank Flare	Flare	14	See footnote 1	See footnote 1	See footnote 1	276,417.1 (3.95 MMBtu/hr)
Gas Flare	Flare	11	See footnote 1	See footnote 1	See footnote 1	458,362.5 (6.55 MMBtu/hr)
Microturbines	Point	13	12	3,990	507	NA
Compressor	Point	14	8	1,613	931	NA

[1] Flare heat release rates determined from reported waste gas flow rates and heating values in FIP registration. Flare default parameters of 20 m/s effective exhaust velocity, 0.55 heat loss fraction, and 1273 K for effective exit temperature were used.

[2] Exhaust flow for heater based on similar sources (20 feet per second).

3.2 Building Downwash and Fumigation

Per EPA guidance, building downwash and fumigation were not included in the AERSCREEN runs.

4. CO AERSCREEN Modeling Results

CO was modeled only for the Crusoe sources to first determine if a cumulative analysis is required. Should a new source by itself demonstrate modeled impacts below the pollutant's significant impact level (SIL), then a cumulative analysis is not required. CO's 1-hour SIL is 2,000 μg/m^3 and 8-hour SIL is 500 μg/m^3 (40 CFR Part 51.165 (b)(2)). Below are the 1-hour and 8-hour model results of Crusoe's generators.

Table 4-1 AERSCREEN Model Results of 1st high 1-hour CO

Source	1st High 1-hour CO	Distance (meters)
Crusoe Generators	55.16	96

Table 4-2 AERSCREEN Model Results of 1st high 8-hour CO

Source	1st High 8-hour CO	Distance (meters)
Crusoe Generators	49.64	96

Since both highest 1st high results of the Crusoe generators model below the SIL for the respective averaging times, the Charging Eagle 21-25 project is not expected to cause or contribute to a violation of the NAAQS and no further analysis is required.

5. NO_2 AERSCREEN Model Results

NO_2 was modeled for each source to determine the maximum 1-hour result using the OLM method for NOx to NO_2 conversion in AERSCREEN. The results of the AERSCREEN models of each individual source are in Table 5-1 for 1st high through 8th high 1-hour NO_2 regardless of impact location, Table 5-2 for the 1-hour NO_2 model results assuming the same origin point, Table 5-4 for maximum annual NO_2, and Table 5-5 for the annual NO_2 model results assuming the same origin point. As described in Section 2.5, a persistence factor of 0.1 was applied to 1-hour results to determine annual impacts.

Table 5-1 AERSCREEN Model Results of 1st high through 8th high 1-Hour NO_2

Source	1st High 1-hour NO_2	2nd High 1-hour NO_2	3rd High 1-hour NO_2	4th High 1-hour NO_2	5th High 1-hour NO_2	6th High 1-hour NO_2	7th High 1-hour NO_2	8th High 1-hour NO_2
RimRock Heaters	3.85	3.56	3.56	3.09	2.68	2.49	2.20	1.91
RimRock Tank Flare	8.51	8.17	7.49	7.07	5.97	5.52	5.02	4.43
RimRock Gas Flare	11.32	11.25	10.70	9.07	7.73	7.18	6.59	5.86
RimRock Microturbines	41.07	40.88	33.70	32.10	28.02	22.51	20.64	18.95
RimRock Compressor	48.55	47.62	38.26	30.67	30.54	27.33	24.58	21.76
Crusoe Generators	24.82	24.73	23.34	22.14	20.01	17.72	15.91	15.38
Background	27.60	27.60	27.60	27.60	27.60	27.60	27.60	27.60
Total	165.7	163.8	144.65	131.74	122.6	110.4	102.5	95.9

Table 5-2 AERSCREEN Model Results of Maximum 1-Hour NO_2 from Same Origin Point

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
RimRock Heaters	0.05	0.66	3.56	3.56	3.09	2.68	2.49	2.20
RimRock Tank Flare	0.15	1.26	7.49	8.17	7.07	5.97	5.52	5.02
RimRock Gas Flare	0.23	1.70	11.25	10.70	9.07	7.73	7.18	6.59
RimRock Microturbines	0.51	33.70	40.88	32.10	28.02	22.51	20.64	18.95
RimRock Compressor	0.49	30.67	47.62	38.26	30.54	27.33	24.58	21.76

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
Crusoe Generators	0.68	3.55	15.91	23.34	24.73	22.14	20.01	17.72
Background	27.60	27.60	27.60	27.60	27.60	27.60	27.60	27.60
Total	29.71	99.14	154.3	143.7	130.1	116.0	108.0	99.84

The distance from each source to its maximum impact is tabulated below. These distances are referenced from the AERSCREEN out files.

Table 5-3 Distance to Maximum Impact

Source	Distance to Maximum Impact (meters)
RimRock Heaters	60
RimRock Tank Flare	64
RimRock Gas Flare	47
RimRock Microturbines	48
RimRock Compressor	45
Crusoe Generators	96

The rankings of the 1st through 8th high (98th percentile) can be found in the model summary tables included with the modeling files included with this report. As depicted in the tables above and the model results, the maximum impact for each source occurs beyond the minimum assumed distance to ambient air (1 meter). In Table 5-1, with the inclusion of background 1-hour NO_2 value, no 1-hour NO_2 values show potential exceedances of the NAAQS. It is important to note that the results in Table 5-1 do not account for location of the 1st high through 8th high and therefore adding them together is conservative as it does not account for the locations of the sources. The 8th highest impact value from each of the sources added together plus background, again regardless of location, demonstrates a value of 95.89 µg/m^3 which is below the NAAQS standard of 188 µg/m^3. Assuming all of the sources originate from the same point and have plumes completely overlapping one another, shows a maximum 1-hour value plus background of 154.3 µg/m^3 at a distance of 50 meters from the source in Table 5-2 which is also below the NAAQS standard of 188 µg/m^3. The individual source AERSCREEN model runs and analyses are submitted with this report.

Table 5-4 AERSCREEN Model Results of 1st high Annual NO_2

Source	1st High Annual NO_2
RimRock Heaters	0.39
RimRock Tank Flare	0.85
RimRock Gas Flare	1.13
RimRock Microturbines	4.11

Source	1^{st} High Annual NO_2
RimRock Compressor	4.86
Crusoe Generators	2.48
Background	3.70
Total	17.51

Table 5-5 AERSCREEN Model Results of Maximum Annual NO_2 from Same Origin Point

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
RimRock Heaters	0.005	0.07	0.36	0.36	0.31	0.27	0.25	0.22
RimRock Tank Flare	0.02	0.13	0.75	0.82	0.71	0.60	0.55	0.50
RimRock Gas Flare	0.02	0.17	1.13	1.07	0.91	0.77	0.72	0.66
RimRock Microturbines	0.05	3.37	4.09	3.21	12.80	2.25	2.06	1.90
RimRock Compressor	0.05	3.07	4.76	3.83	3.05	2.73	2.46	2.18
Crusoe Generators	0.07	0.36	1.59	2.33	2.47	2.21	2.00	1.78
Background	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Total	3.91	10.85	16.37	15.31	13.95	12.54	11.74	10.92

As depicted in the tables above and the model results, the maximum impact for each individual source occurs beyond the minimum assumed distance to ambient air (1 meter). In Table 5-4, with the inclusion of background annual NO_2 value, the cumulative 1^{st} high annual NO_2 value of 17.51 μg/m^3 is below the NAAQS standard of 100 μg/m^3. Assuming all of the sources originate from the same point and have plumes completely overlapping one another, shows a maximum annual value plus background of 16.37 μg/m^3 at a distance of 50 meters from the source in Table 5-5 which is also below the NAAQS standard of 100 μg/m^3. The individual source AERSCREEN model runs and analyses are submitted with this report.

Based on the results in Section 5, possible scenarios where the cumulative impacts between Crusoe sources and RimRock sources result in maximum 1-hour NO_2 impacts less than the NAAQS threshold of 188 μg/m^3 and maximum annual NO_2 impacts less than the NAAQS threshold of 100 μg/m^3. Therefore, there are no NO_2 NAAQS concerns from this Project.

6. SO_2 AERSCREEN Model Results

SO_2 was modeled only for the Crusoe sources to first determine if a cumulative analysis is required. Should a new source by itself demonstrate modeled impacts below the pollutant's SIL, then a cumulative analysis is not required. SO_2's 1-hour SIL is 3 ppb (7.8 µg/m^3) as reasoned in the August 23, 2010 EPA memorandum "Guidance Concerning the 1-hour SO_2 NAAQS for the Prevention of Significant Deterioration Program". Below is the 1-hour model result of Crusoe's generators.

Table 6-1 AERSCREEN Model Results of 1st high 1-hour SO_2

Source	1st High 1-hour SO_2	Distance (meters)
Crusoe Generators	2.67	96

Since the highest 1st high result of the Crusoe generators model is below the SIL, the Charging Eagle 21-25 project is not expected to cause or contribute to a violation of the NAAQS and no further analysis is required.

7. $PM_{2.5}$ AERSCREEN Model Results

$PM_{2.5}$ was modeled for each source to determine the maximum 24-hour result in AERSCREEN. The results of the AERSCREEN models of each individual source are in Table 7-1 for 1st high through 8th high 24-hour $PM_{2.5}$ regardless of impact location, Table 7-2 for the 24-hour $PM_{2.5}$ model results assuming the same origin point, Table 7-4 for maximum annual $PM_{2.5}$, and Table 7-5 for the annual $PM_{2.5}$ model results assuming the same origin point. As described in Section 2.5, a persistence factor of 0.6 was applied to the 1-hour result to determine 24-hour impacts and a persistence factor of 0.1 was applied to the 1-hour results to determine annual impacts.

Table 7-1 AERSCREEN Model Results of 1st high through 8th high 24-Hour $PM_{2.5}$

Source	1st High 24-hour $PM_{2.5}$	2nd High 24-hour $PM_{2.5}$	3rd High 24-hour $PM_{2.5}$	4th High 24-hour $PM_{2.5}$	5th High 24-hour $PM_{2.5}$	6th High 24-hour $PM_{2.5}$	7th High 24-hour $PM_{2.5}$	8th High 24-hour $PM_{2.5}$
RimRock Heaters	0.21	0.20	0.20	0.17	0.15	0.14	0.12	0.10
RimRock Microturbines	5.09	5.07	4.18	3.98	3.47	2.79	2.56	2.35
RimRock Compressor	2.24	2.20	1.77	1.42	1.41	1.26	1.14	1.01
Crusoe Generators	7.60	7.58	7.15	6.79	6.13	5.43	4.87	4.71
Background	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Total	28.84	28.75	27.00	26.06	24.86	23.32	22.39	21.87

Table 7-2 AERSCREEN Model Results of Maximum 24-hour $PM_{2.5}$ from Same Origin Point

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
RimRock Heaters	0.002	0.04	0.20	0.20	0.17	0.15	0.14	0.12
RimRock Microturbines	0.06	4.18	5.07	3.98	3.47	2.79	2.56	2.35
RimRock Compressor	0.02	1.41	2.20	1.77	1.41	1.26	1.14	1.01
Crusoe Generators	0.21	1.09	4.87	7.15	7.58	6.79	6.13	5.43
Background	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Total	13.99	20.42	26.04	26.80	26.33	24.69	23.67	22.61

The distance from each source to its maximum impact is tabulated below. These distances are referenced from the AERSCREEN out files.

Table 7-3 Distance to Maximum Impact

Source	Distance to Maximum Impact (meters)
RimRock Heaters	60
RimRock Microturbines	48
RimRock Compressor	45
Crusoe Generators	96

The rankings of the 1st through 8th high (98th percentile) can be found in the model summary tables included with the modeling files included with this report. As depicted in the tables above and the model results, the maximum impact for each source occurs beyond the minimum assumed distance to ambient air (1 meter). In Table 7-1, with the inclusion of background 24-hour $PM_{2.5}$ value, the 1st high through 8th high 24-hour $PM_{2.5}$ values show a cumulative impact below the NAAQS of 35 µg/m³. It is important to note that the results in Table 7-1 do not account for location of the 1st high through 8th high and therefore adding them together is conservative as it does not account for the locations of the sources. Assuming all of the sources originate from the same point and have plumes completely overlapping one another, shows a maximum 24-hour value plus background of 26.80 µg/m³ at a distance of 75 meters from the source in Table 7-2 which is also below the NAAQS standard of 35 µg/m³. The individual source AERSCREEN model runs and analyses are submitted with this report.

Table 7-4 AERSCREEN Model Results of 1st high Annual $PM_{2.5}$

Source	1st High Annual $PM_{2.5}$
RimRock Heaters	0.04
RimRock Microturbines	0.85
RimRock Compressor	0.37
Crusoe Generators	1.27
Background	4.1
Total	6.6

Table 7-5 AERSCREEN Model Results of Maximum Annual $PM_{2.5}$ from Same Origin Point

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
RimRock Heaters	0.0003	0.007	0.03	0.03	0.03	0.03	0.02	0.02
RimRock Microturbines	0.01	0.70	0.85	0.66	0.58	0.47	0.43	0.39
RimRock Compressor	0.003	0.24	0.37	0.30	0.24	0.21	0.19	0.17

Source	1 m from Source	25 m from Source	50 m from Source	75 m from Source	100 m from Source	125 m from Source	150 m from Source	175 m from Source
Crusoe Generators	0.04	0.18	0.81	1.19	1.26	1.13	1.02	0.91
Background	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Total	4.1	5.2	6.2	6.3	6.2	5.9	5.8	5.6

As depicted in the tables above and the model results, the maximum impact for each individual source occurs beyond the minimum assumed distance to ambient air (1 meter). In Table 7-4, with the inclusion of background annual $PM_{2.5}$ value, the cumulative 1st high annual $PM_{2.5}$ value of 6.6 $\mu g/m^3$ is below the NAAQS standard of 12 $\mu g/m^3$. Assuming all of the sources originate from the same point and have plumes completely overlapping one another, shows a maximum annual value plus background of 6.3 $\mu g/m^3$ at a distance of 75 meters from the source in Table 7-5 which is also below the NAAQS standard of 12 $\mu g/m^3$. The individual source AERSCREEN model runs and analyses are submitted with this report.

Based on the results in Section 7, possible scenarios where the cumulative impacts between Crusoe sources and RimRock sources result in maximum 24-hour $PM_{2.5}$ impacts less than the NAAQS threshold of 35 $\mu g/m^3$ and maximum annual $PM_{2.5}$ impacts less than the NAAQS threshold of 12 $\mu g/m^3$. Therefore, there are no $PM_{2.5}$ NAAQS concerns from this Project.

8. Ozone

Ozone is a regionally significant pollutant that is formed by chemical reactions in the atmosphere from the precursors of NOx and VOC. This Project is located in an area that is in attainment with the current ozone NAAQS and not in concern of exceeding the NAAQS. Additionally, the operation of the Crusoe Charging Eagle 21-25 units would lower NOx and VOC emissions compared to the business-as-usual case (i.e., flaring of gas).

Per recent April 2019 guidance, EPA released procedures for a Tier I demonstration for ozone and $PM_{2.5}$ under the PSD program called MERPs. This guidance has also been known to be used for minor sources as well, such as Crusoe's Charging Eagle 21-25 Project. The MERP guidance provides otherwise photochemically modeled impacts for secondary pollutants such as ozone and secondary $PM_{2.5}$ based on emissions rates to determine whether a project may have negative impacts on these pollutants. The following analysis was completed for the Crusoe Charging Eagle 21-25 Project based on the Tier I demonstration guidelines in Section 4.1.1.

The Project is not located in an area with complex terrain, proximity to very large NOx or VOC sources, or unusual meteorology. Based on the location in North Dakota, the results from the lowest 8-hour O_3 from NOx and lowest 8-hour O_3 from VOC of the Rockies/Plains can be used:

8-hour O_3 from NOx: 184 ton/yr

8-hour O_3 from VOC: 1,067 ton/yr

The Project has estimated emissions of the same pollutants of the following:

NOx: 10.86 ton/yr

VOC: 0.72 ton/yr

The MERP calculation is as follows:

(10.86 ton/yr NOx from Project / 184 ton/yr NOx 8-hr daily maximum O_3 MERP) + (0.72 ton/yr VOC from Project / 1,067 ton/yr VOC 8-hr daily maximum O_3 MERP) = 0.0984+ 0.001 = **0.060 = 6%**

A value less than 100% indicates that the O_3 SIL would not be exceeded when considering the combined impacts of the precursors. Therefore, the Crusoe Charging Eagle 21-25 Project is not expected to exceed the 8-hour O_3 SIL.

8.1 Secondary $PM_{2.5}$

Secondary $PM_{2.5}$ is also a regionally significant pollutant that is formed by chemical reactions in the atmosphere from the precursors of a combination of SO_2, NOx, VOCs, and ammonia. This Project is located in an area that is in attainment with the current secondary $PM_{2.5}$ NAAQS and not in concern of exceeding the NAAQS. Additionally, the operation of Crusoe Charging Eagle 21-25 units would lower NOx and VOC emissions compared to the business-as-usual case (i.e., flaring of gas) and has minimal SO_2 emissions due to being fueled by sweet gas (i.e., low hydrogen sulfide content) and no ammonia content.

Per recent April 2019 guidance, EPA released procedures for a Tier I demonstration for ozone and $PM_{2.5}$ under the PSD program called MERPs. This guidance has also been known to be used for minor sources as well, such as Crusoe's Charging Eagle 21-25 Pad Project. The MERP guidance provides otherwise photochemically modeled impacts for secondary pollutants such as ozone and secondary $PM_{2.5}$ based on emissions rates to determine whether a project may have negative impacts on these pollutants. The follow analysis was completed for the Crusoe Charging Eagle 21-25 Project based on the Tier 1 demonstration guidelines in Section 4.1.1.

The Project is not located in an area with complex terrain, proximity to very large NOx, SO_2, or VOC sources, or unusual meteorology. Based on the location in North Dakota, the results from the lowest 8-hour O_3 from NOx and lowest 8-hour O_3 from VOC of the Rockies/Plains can be used:

Daily $PM_{2.5}$ from NOx: 1,740 ton/yr

Daily $PM_{2.5}$ from SO_2: 251 ton/yr

The Project has estimated emissions of the same pollutants of the following:

NOx: 10.86 ton/yr

SO_2: 1.04 ton/yr

Because there are direct daily and annual $PM_{2.5}$ impacts from the Crusoe Charging Eagle 21-25 Project, and those direct daily and annual $PM_{2.5}$ impacts were modeled higher than the SIL, a cumulative analysis is required. The hypothetical representative source used in the MERP guidance for cumulative analyses with direct $PM_{2.5}$ impacts was used based on location (Rockies region and elevated source). Conservatively, the 1st high daily $PM_{2.5}$ modeled concentration was used for the annual $PM_{2.5}$ analysis, though it is likely impacts are lower.

Daily

Source nitrate = 10.86 ton/yr x (0.047 μg/m^3 / 1,000 ton/yr) = 0.00051 μg/m^3

Source sulfate = 1.04 ton/yr x (0.094 μg/m^3 / 500 ton/yr) = 0.00020 μg/m^3

Crusoe Charging Eagle 21-25 Pad cumulative maximum direct daily $PM_{2.5}$ = 15.1 μg/m^3

Background daily $PM_{2.5}$ = 13.7 μg/m^3

Source nitrate + source sulfate + Crusoe Charging Eagle 21-25 Pad maximum direct daily $PM_{2.5}$ + Background daily $PM_{2.5}$ = 0.00051 + 0.00020 + 15.1 + 13.7 = **28.8 μg/m^3**

Annual

Source nitrate = 10.86 ton/yr x (0.047 μg/m^3 / 1,000 ton/yr) = 0.00051 μg/m^3

Source sulfate = 1.04 ton/yr x (0.094 μg/m^3 / 500 ton/yr) = 0.00020 μg/m^3

Crusoe Charging Eagle 21-25 Pad cumulative maximum direct annual $PM_{2.5}$ = 2.5 μg/m^3

Background annual $PM_{2.5}$ = 4.1 μg/m^3

Source nitrate + source sulfate + Crusoe Charging Eagle 21-25 maximum direct annual $PM_{2.5}$ + Background annual $PM_{2.5}$ = 0.00051 + 0.00020 + 2.5 + 4.1 = **6.6 μg/m^3**

The sum total of the four inputs above yields an estimate secondary $PM_{2.5}$ daily maximum impact less than the NAAQS value of 35 μg/m^3 and secondary $PM_{2.5}$ annual maximum impact less than the NAAQS value of 15 μg/m^3. Therefore, the Crusoe Charging Eagle 21-25 Pad Project is not expected to exceed the 24-hour nor annual secondary $PM_{2.5}$ NAAQS.

9. Conclusion

The modeling exercise for the Project was conducted with AERSCREEN to estimate conservative potential cumulative impacts of the Charging Eagle 21-25 Pad location. The results of the conservative AERSCREEN modeling show that the potential impacts of the project are not of concern due to maximum 1-hour, 8-hour, 24-hour, and annual results being less than the NAAQS thresholds. Additionally, since the sources are being utilized to reduce the amount of gas flaring compared to the business-as-usual operation for the site, operation of Crusoe's engines result in a lower-emissions scenario.

10. References

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