ALASKA LNG

Alaska LNG Liquefaction Plant Construction Permit Application

Project Information Form Attachment 8:

AERMOD Sensitivity Liquefaction Plant

March 2018

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Since the submittal of the Liquefaction Facility Air Quality Modeling Report Supporting Resource Report No. 9 (Resource Report No. 9 Appendix D), dated October 11, 2016[1], USEPA promulgated new versions of AERMINUTE (updated from v.14337 to v. 15272), AERMET (updated from v. 15181 to v. 16216) and AERMOD (updated from version 15181 to version 16216r). This analysis describes a study conducted to demonstrate that assessments conducted with the superseded versions of AERMET and AERMOD yield the same results as those conducted with the current versions, obviating the need to revise all analyses conducted with the previous versions of AERMINUTE, AERMET and AERMOD.

To conduct this study, meteorology data was reprocessed using v15272 of AERMINUTE and v16216 of AERMET. This new meteorological dataset was used in conjunction with v16216r of AERMOD to perform sensitivity tests on the cumulative LNG NAAQS/AAAQS Air Quality Compliance Normal Operations modeling found in Table 7-3 of Resource Report No. 9 Appendix D. For this study impacts were predicted with the latest model versions for two pollutants and averaging periods: 1-hour NO_2 and 24-hour $PM_{2.5}$. These pollutants and averaging periods were selected because 1) both generally result in the smallest compliance margins, and 2) together they demonstrate potential sensitivities associated with modeling inert and reactive pollutants.

Results from this study are shown in Table 1 and compared to respective results found in Resource Report No. 9 Appendix D. These results indicate there are virtually no differences to the AERMOD predicted 1-hour NO_2 and 24-hour $PM_{2.5}$ impacts when the latest AERMOD modeling system model versions are used provided modeling is conducted with the same in-stack ratio (ISR) assumptions. Given that AERMOD treats all reactive and inert pollutants the same, the differences shown in Table 1 will be typical of all pollutants and averaging periods.

Table 1: Sensitivity of the Cumulative LNG Impacts for Normal Operations to the most recent version of AERMOD and AERMET

Pollutant and Averaging Period	Modeled Period	Model Predicted Impacts from Resource Report No. 9 Appendix D Table 7-3 Using AERMOD Version 15181[1,3]	Modeled Impact Using AERMOD Version 16216r[1,2]
1-Hour NO_2 (Highest-8th-High Rank)	2011-2015	149.47826	149.49961
24-Hour $PM_{2.5}$ (Highest-8th-High Rank)	2011-2015	6.38954	6.38955

[1] Meteorology data utilized in AERMOD run was processed using AERMINUTE v 14337 and AERMET v. 15181.
[2] Meteorology data utilized in AERMOD run was processed using AERMINUTE v 15272 and AERMET v. 16216.
[3] For this analysis, the In-Stack Ratios (ISRs) in v1616r were manually set to match the default ISR of 0.2 utilized in the v15181 runs found in Resource Report No. 9 Appendix D.

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[1] Alaska LNG. 2016. Liquefaction Facility Air Quality Modeling Report Supporting Resource Report No. 9. Appendix D. Document No. USAL-P1-SRZZZ-00-000001-000. October 11, 2016.

There is one significant difference between AERMOD model version v16216r and v15121 that deserves additional discussion and is not apparent in the 1-hour NO_2 results presented in Table 1 because they were obtained by manually setting the minimum ambient ratio to 0.2 in both versions. The minimum ambient ratio is set on a source-wide basis and is equivalent to the minimum in-stack ratio (ISR) representative of sources dominating impacts. AERMOD v16216r utilizes a default source wide ISR of 0.5, and v15121 utilizes a default ISR of 0.2. As a result, if a comparison were done using default settings with these two versions, differences in NO_2 predictions would occur solely due to the ISR defaults. Results predicted with default settings (i.e., difference ISR values) show a difference in predicted 1-hour NO_2 concentrations of approximately 7%. Therefore, in order to justify the 1-hour NO_2 comparisons found in Table 1 the same ISR must be used with each model version and:

1. a case must be made to justify a source-wide ISR of 0.2 when running AERMOD version v16216r; or

2. a demonstration must be made showing that impacts do not change when the source-wide ISR is increased to 0.5 when running v15121; or

3. a case must be made to justify a source-wide ISR somewhere between 0.2 and 0.5 to use with both versions that still demonstrates compliance with AERMOD v15121.

Neither 1 nor 2 can be done easily leaving option 3. To make this demonstration, modeling was performed at source-wide ISRs of 0.2, 0.3 and 0.5 using AERMOD v15121. The results of this ISR sensitivity modeling are shown in Table 2 and show results predicted are virtually the same and show compliance using an ISR of 0.3 and an ISR of 0.2. It is not until the source-wide ISR is increased to above 0.3 do modeled concentrations increase. With this demonstration made, all that is required is justifying the use of a source-wide ISR of 0.3 with AERMOD v16216r.

Table 3 shows ISRs by source category for the types of sources present in the LNG facility modeling. This table shows that with the exception of flares, on-site and offsite sources do have ISRs of 0.3 or less. Justifications of these ISRs were determined primarily though research of USEPA and/or ADEC databases and are found in Attachment A. While the flares have an ISR of 0.5, the dispersion properties of this source group are so different from the rest that the flares do not contribute to maximum impacts in the modeled domain. A culpability analysis of several modeled maximum impact locations showed that only a small number sources contribute significantly to the increases in pollutant concentrations which occur when the ISR is increased above 0.3. These sources include:

- Tesoro Refinery Tanker Hoteling Engines

- Agrium Kenai Nitrogen Operations Ammonia Vessel Hoteling Engines (900 kW)

- Agrium Kenai Nitrogen Operations Urea Vessel Hoteling Engines (240 kW)

- Kenai Liquefaction Facility Tanker Hoteling Engines

- Alaska LNG LNG Carriers

- Agrium Kenai Nitrogen Operations Turbines

Table 3 shows that all of these sources are expected to have ISRs of 0.3 or less. The culpability analysis showed that altering the ISR of sources other than these had little or no effect on maximum impacts.

Based on the results shown in Table 2, AERMOD v16216r and v15121 both yield the same results using an ISR of 0.3. Furthermore, an ISR of 0.3 is justified for use with AERMOD v16216r and using an ISR of 0.3 with AERMOD v15121 demonstrates compliance with roughly the same compliance margin as those documented in Resource Report No. 9 Appendix D. Therefore, this analysis shows that the results documented in Resource Report No. 9 Appendix D are not sensitive to recent changes in the AERMOD modeling system.

Table 2: In-Stack Ratio Sensitivity Analysis

Pollutant and Averaging Period	Year	ISR = 0.5		ISR = 0.2 or 0.3	
		15181[1]	16216r[2]	15181[1]	16216r[2]
1-Hour NO_2 (Highest-8th-High Rank)	2011-2015	159.96962	159.96962	149.47826	149.49961
24-Hour $PM_{2.5}$ (Highest-8th-High Rank)	2010[3]	12.53668	12.53107	12.53668	12.53107

[1] Meteorology data utilized in AERMOD run was processed using AERMINUTE v 14337 and AERMET v. 15181.
[2] Meteorology data utilized in AERMOD run was processed using AERMINUTE v 15272 and AERMET v. 16216.
[3] Sensitivity analysis was performed in the year which was shown to have maximum impact in the five individual years run in Resource Report No. 9 Appendix D.

Table 3: In-Stack Ratio by Source Category according to Attachment A

Source Category	ISR	Examples of Sources from the Alaska LNG Liquefaction Facility Modeling
Diesel-Fired Heaters/Boilers	<0.1	Package boiler, waste heat boiler, recycle gas heater, crude heater and glycol heater
Natural Gas-Fired Heaters/Boilers	<0.1	
Small Diesel-Fired Internal Combustion Engines (<600 hp)	<0.1	Firewater pump, auxiliary air compressor, LNG carrier engines, Tesoro tanker engines, Agrium Kenai Nitrogen Operations ammonia vessel engines[1] and Urea Vessel engines[1]
Diesel-Fired Internal Combustion Engines (>600 hp)	<0.2	
Gas-Fired Turbine Engines	<0.3	Compression turbines and power generator turbines
Gas-Fired Reciprocating Internal Combustion Engines (RICE)	<0.3	No modeled sources
Diesel-Fired Nonroad Engines Associated with Construction Equipment	<0.2	No modeled sources
Onroad Mobile Sources	<0.2	No modeled sources
Flares[2]	0.5	High pressure and low pressure flares at all facilities

[1] In the September 2014 Dispersion Modeling Analysis - Agrium Kenai Nitrogen Operations Facility Report, these sources were modeled with an ISR of 0.22.
[2] Not included in Appendix A. Based on USEPA Default.

ATTACHMENT A

Survey of Typical Emission Unit In-Stack NO_2 to NO_x Ratios

INTRODUCTION

Representative emission unit exhaust in-stack NO_2/NO_x Ratios selected for refined 1-hour NO_2 dispersion modeling were determined based on a survey of data available from the following:

- USEPA Technology Transfer Network (TTN) Support Center for Regulatory Atmospheric Modeling (SCRAM) database (http://www.epa.gov/ttn/scram/no2_isr_database.htm). The data used is contained in the spreadsheet named NO2_ISR_alpha_database.xlsx (herein referred to as "USEPA Database") and available on that web site. This data represents values collected by various Regional, State, and Local air permitting offices prior to the formal collection which has been initiated by the Office of Air Quality Planning and Standards (OAQPS) and represents the largest database available at this time.

- Alaska Department of Environmental Conservation (ADEC) Air Dispersion Modeling data base publically available at (http://dec.alaska.gov/air/ap/modeling.htm). This data represents values collected by ADEC from source tests conducted on emission units within the state. The following presents a review of available data and justification for the NO_2/NO_x Ratios selected for modeling based on emission unit type.

For onroad mobile sources, the following peer-reviewed papers were used:

- P G Boulter, I S McCrae, and J Green, Transportation research Laboratory, "Primary NO_2 Emissions From Road Vehicles in the Hatfield and Bell Commons Tunnels", July 2007.

- X Yao, N T Lau, C K Chan, and M Fang, Atmospheric Chemistry and Physics Discussions, "The use of tunnel concentration profile data to determine the ratio of NO2/NOx directly emitted from vehicles", December 2005.

- G A Bishop and D H Stedman, Air Pollution XVI 247, Department of Chemistry and Biochemistry, University of Denver, WIT Transactions on Ecology and the Environment, Vol 116, "Emissions of Nitrogen Dioxide from Modern Diesel Vehicles".

The following presents a review of available data and justification for the NO_2/NO_x Ratios selected for modeling based on emission unit type.

Diesel-Fired Heaters/Boilers

Entries of exhaust NO_2/NO_X ratio data from the USEPA database were summarized for diesel fired "small" heaters and boilers, i.e., units less than 10 MMBtu/hour heat input. Only units for which the heat input information was available were taken into consideration. The results are summarized in Table A-1. As shown in the table, only two data points were found for NO_x and NO_2 emissions test data collected from small, diesel-fired, uncontrolled boilers. Both the boilers were tested at a 100% load only, and therefore, NO_2/NO_x ratios across various load cases could not be determined.

A similar database developed by the Alaska Department of Environmental Conservation (ADEC) was also referenced. The search returned one 29.3 MMBtu/hour Cleaver-Brooks Fire Tube Boiler at the Dutch

Harbor Seafood Processing Facility - Captain's Bay Plant. Four tests were run on this boiler at 4 load points between 20% and 100% load. These tests all yielded a NO_2/NO_x in-stack ratio of less than 0.01.

Based on this analysis, an NO_2/NO_x in-stack ratio lower than 0.05 is justifiable for modeling small diesel fired boilers.

Table A-1:   **NO_2/NO_x In-Stack Ratios for Uncontrolled Diesel Boilers from USEPA Database**

Load	No. of Data Points	Average	Maximum	Minimum
100%	2	0.0409	0.0476	0.0341

Natural Gas-Fired Heaters/Boilers

Exhaust NO_2/NO_x in-stack ratio data were summarized for natural gas-fired heaters and boilers. Entries of exhaust NO_2/NO_x in-stack ratio data from the USEPA database were summarized for natural gas fired heaters and boilers in Table A-2. As shown in the table, two natural gas-fired boilers with no controls with NO_x and NO_2 emissions test data from the John Bean Tech Corporation Facility were found. The heat input information was not available for these boilers in the database. Both the boilers were tested at four different loads, and therefore, NO_2/NO_x ratios across various load cases were determined. Test results for zero load were assumed erroneous and ignored.

Table A-2:   **NO_2/NO_x In-Stack Ratios for Natural Gas-Fired Boilers from USEPA Database**

Load	No. of Data Points	Average	Maximum	Minimum
25%	2	0.017	0.020	0.015
50%	2	0.016	0.018	0.014
75%	2	0.031	0.035	0.027
100%	3	0.030	0.034	0.026
Overall Maximum			0.034	

A similar database developed by the Alaska Department of Environmental Conservation (ADEC) was also reviewed. The search returned one 30 MMBtu/hr Zeeco boiler (Model GLSFWB12) equipped with a low NO_x burner installed at BP's Milne Point Unit (MPU) facility in Alaska. The results are summarized in Table A-3. As shown in the table, the boiler was tested at two load conditions: 40% load and 60% load.

Table A-3:   **NO_2/NO_x In-Stack Ratios for Natural Gas-Fired Boilers from USEPA Database**

Load	No. of Data Points	Average	Maximum	Minimum
60%	1	0.05	0.05	0.05
40%	1	0.34	0.34	0.34
Overall Maximum			0.34	

The size of the boilers for the USEPA database was not provided. However, an internet search of the boiler models (KEWANEE BOILER KF15-1562-6 and CLAYTON BOILER EO-200-3FM) reveals that these boilers are sized less than 30 MMBtu/hour. The USEPA database contains multiple data points at various loads with good continuity among the test data. The ADEC data for the 30 MMBtu/hour Zeeco boiler at 40% load seems to be an outlier in comparison to all other available data points.

The maximum in-stack ratio based on the USEPA data is 0.035 and 0.05 for the ADEC data (excluding the outlier point at 40% load). As such, a 0.10 in-stack ratio upper limit is justifiable. This value is conservative as it is a factor of 2 higher than the highest non-outlier in-stack ratio between the USEPA and ADEC database.

Small Diesel-Fired Internal Combustion Engines

Exhaust NO_2/NO_x in-stack ratio data were summarized from the USEPA database for small (less than or equal to 600 hp), uncontrolled diesel-fired reciprocating, internal-combustion engines (RICE). Data was available from the Harvey Explorer facility containing values for three (3) different load categories for a 540 hp Caterpillar/3412EDITA RICE and values at 90-100% load for three (3) 320 kW Caterpillar/3406CDITA RICE. NO_2/NO_x in-stack ratio values ranged between 0.05 and 0.08. These data are summarized in Table A-4.

An examination of the ADEC data did not reveal differences in the average NO_2/NO_x in-stack ratio (data not shown). The average in-stack ratio value was 0.05, with only one data point within the subset of ADEC data for small diesel reciprocating engines.

Based on this analysis, an upper limit NO_2/NO_x in-stack ratio of 0.10 for the purposes of modeling small (<600 hp) diesel-fired RICE is justifiable. The maximum observed value across all loads is less than that, at 0.08.

Table A-4: NO_2/NO_x In-Stack Ratios by Load for Uncontrolled Small Diesel RICE Emission Test Results from USEPA Database

Load	No. of Data Points	Average	Maximum	Minimum
90-100%	3	0.06	0.07	0.06
80%	1	0.08	0.08	0.08
60%	1	0.05	0.05	0.05
30%	1	0.08	0.08	0.08
Overall Maximum			0.08	

Diesel-Fired Internal Combustion Engines Associated with Power Generation

Exhaust stack NO_2/NO_x in-stack ratio data were summarized for emissions test data for large (greater than 600 hp), diesel-fired reciprocating, internal-combustion engines (RICE) for which load information was available. Data for the one or more Caterpillar 3406B RICE associated with the City of LeMoore were eliminated from consideration due to lack of information concerning equipment size and load. Removal of these data resulted in the loss of 41 data points. Data from the AEL&P Lemon Creek facility appeared to contain emission results for three runs; therefore, data were reduced to one average value for each load category presented contributing three data points for the data analysis. This reduced the total number of available data points by six (6). Average NO_2/NO_x in-stack ratio values ranged between 0.06 and 0.10, ranging between 0.05 and 0.11 when taking into consideration information such as the standard deviation and number of data points (i.e. generating confidence intervals based on 95th percentile). These data are summarized in Table A-5.

Table A-5:   **Average NO_2/NO_x In-Stack Ratios by Load for Uncontrolled Diesel RICE Emission Test Results from USEPA Database**

Load Class	No. of data Points	Upper Confidence Limit	Average	Lower Confidence Limit
90-100%	7	0.08	0.06	0.05
70-89%	10	0.11	0.08	0.05
50-69%	13	0.11	0.10	0.08
Less than 50%	8	0.11	0.10	0.08
All	**38**	**0.09**	**0.09**	**0.08**

An examination of the ADEC data did not reveal differences in the average NO_2/NO_x in-stack ratio by load class. The average ratio value was 0.04 across all load classes. The maximum and minimum values observed for the uncontrolled ADEC NO_2/NO_x Ratio data were 0.05 and 0.03, respectively. The total number of data points within the subset of ADEC data in which emission controls were not installed was six (6).

In addition to generating average values, the maximum and minimum values observed by load class and for all data points combined were examined as well. Based on this analysis, the maximum NO_2/NO_x in-stack ratio observed was 0.19 and the minimum ratio value observed was 0.01 (See Table A-6).

Table A-6:   **Range of NO_2/NO_x In-Stack Ratios by Load for Uncontrolled Diesel RICE Emission Test Results from USEPA Database**

Load Class	No. of data Points	Maximum	Minimum
90-100%	7	0.10	0.02
70-89%	10	0.15	0.01
50-69%	13	0.19	0.06
Less than 50%	8	0.14	0.08
All	**38**	**0.19**	**0.01**

Based on the above analysis, an NO_2/NO_x in-stack ratio of 0.2 or above for the purposes of modeling diesel fired RICE is both conservative and justifiable. This is particularly the case when the maximum and minimum observed values are taken into consideration. Clearly the maximum observed value across the 38 data points demonstrates that 0.20 is just above the range of values expected for the NO_2/NO_x in-stack ratio of diesel-fired RICE engines.

Gas-Fired Turbine Engines

Exhaust stack NO_2/NO_x in-stack ratio data were summarized for emissions test data for natural gas-fired turbines for which load information was available. Only one set of data was available for a dual-fired unit, while combusting diesel fuel. Therefore, this analysis is limited to the gas turbine engine emission test results. There were a total of 16 different emission units and 42 data points. USEPA data were screened for quality and completeness and only four data points from one unit could be used. The one viable turbine test run from the USEPA average ratio values ranged between 0.06 and 0.10, ranging between 0.06 and 0.49 when taking into consideration information such as the standard deviation and number of data points (i.e. generating confidence intervals). These data are summarized in Table A-7.

Based on this analysis, an NO_2/NO_x in-stack ratio of 0.3 for the purposes of modeling the natural gas fired turbines is both conservative and justifiable. This is particularly the case when the maximum and minimum observed values are taken into consideration. Clearly, the maximum observed value across the 42 data points demonstrates that 0.3 is within the range of values expected for the NO_2/NO_x in-stack ratio of gas-fired turbines.

Table A-7: **Average NO_2/NO_x In-Stack Ratios by Load for Uncontrolled Natural Gas Turbine Emission Test Results from USEPA Database**

Load Class	Number of Data Points	Upper Confidence Limit	Average	Lower Confidence Limit
90-100%	13	0.15	0.11	0.06
70-89%	11	0.26	0.18	0.10
50-69%	9	0.16	0.14	0.12
Less than 50%	9	0.49	0.35	0.21
All	**42**	**0.24**	**0.19**	**0.14**

Gas-Fired Reciprocating Internal Combustion Engines (RICE) by Control

Exhaust stack NO_2/NO_x in-stack ratio data were summarized for emissions test data for gas-fired RICE for which input rating information was available. Data for the natural gas-fired RICE that lacked information on the engine input rating were eliminated from consideration. Removal of these data resulted in the loss of 595 data points. A majority of the remaining data did not have load information associated with it; therefore, a comparison of NO_2/NO_x in-stack ratios across loads was not determined. The only other data field that could provide a distinction across data points was the primary control field. For this reason, ratios were compared across primary control equipment type installed on the engines. Average ratio values ranged between 0.14 and 0.26 across all control classes. These data are summarized in Table A-8.

Table A-8: **Average NO_2/NO_x In-Stack Ratios by Load for Uncontrolled Natural Gas RICE Emission Test Results from USEPA Database**

Control Equipment Class	Number of Data Points	Upper Confidence Limit	Average	Lower Confidence Limit
No Controls	3	0.26	0.22	0.18
SCR Only	238	0.20	0.19	0.19
All	**241**	**0.20**	**0.19**	**0.19**

Natural Gas-Fired Internal Combustion Engines by Load

Exhaust NO_2/NO_x in-stack ratio data were summarized from the USEPA database for natural gas-fired reciprocating, internal-combustion engines (RICE) for which size and load information was available. Data from the CenterPoint Energy facility containing three tests, two for a 4,000 hp Cooper-Bessemer RICE and one test for a 1,500 hp Cooper-Bessemer RICE, was the only data available. NO_2/NO_x in-stack ratio values ranged between 0.18 and 0.24. These data are summarized in Table A-9. As can be seen, a NO_2/NO_x in-stack ratio between 0.2 and 0.3 is justifiable for dispersion modeling purposes.

An examination of the ADEC data revealed only one data point within the subset of ADEC data for natural gas reciprocating engines, a 740 hp Waukesha F3514GSI engine. This emission unit had an average NO_2/NO_x in stack ratio of 0.05. However, note that this was a controlled engine and this low value was not included in the analysis.

Table A-9: **Average NO_2/NO_x In-Stack Ratios by Load for Uncontrolled Natural Gas RICE Emission Test Results from USEPA Database**

Load	No. of Data Points	Average	Maximum	Minimum
100%	1	0.24	0.24	0.24
95%	1	0.24	0.24	0.24
90%	1	0.18	0.18	0.18
Overall Maximum			**0.24**	

Diesel-Fired Nonroad Engines Associated with Construction Equipment

The USEPA database was researched to evaluate instances of diesel-fired RICE specifically used in construction service. Engines serving equipment such as cranes, bulldozers, excavators, front-end loaders, winches etc. would fall under this category. Two entries for nonroad construction engines were found in the USEPA database. Two 250 hp Caterpillar C7 diesel engine powered logging winches were each tested at 50% load and 80% load. A 365 hp Caterpillar D343 diesel engine powered crane was also tested at 60% load and 80% load. The test data are summarized in Table A-10.

Based on this analysis, a NO_2/NO_x in-stack ratio of 0.20 is justifiable for the purposes of modeling diesel fired engines used in construction service.

Table A-10: **Range of NO_2/NO_x In-Stack Ratios by Load for Uncontrolled Construction Equipment Diesel RICE Emission Test Results from USEPA Database**

Load Class	No. of data Points	Average	Maximum	Minimum
70-89%	3	0.1354	0.1811	0.0965
50-69%	3	0.1496	0.1669	0.1209
Overall Maximum			**0.1811**	

Onroad Mobile Sources

The USEPA and ADEC databases contained test information for stationary and nonroad sources only. Therefore, a web search was conducted to research NO_2/NO_x in-stack ratios for light/medium duty and heavy duty diesel vehicles. The findings are presented in Table A-11. The maximum NO_2/NO_x in-stack ratio for light and medium duty diesel and gasoline vehicles is 0.25; whereas, that for heavy duty diesel vehicles is 0.11. Based on Table A-11, a proposed NO_2/NO_x in-stack ratio of 0.01 or more for heavy duty diesel vehicles and 0.20 or more for light and medium duty diesel vehicles for the purposes of modeling is conservative. For a mixed fleet, a value of 0.15 should be conservative assuming that most of the fuel consumed will be in the larger engines.

Table A-11:   Range of NO$_2$/NO$_x$ In-Stack Ratios for Onroad Source

Vehicle Class	Average	Maximum	Minimum
Light and Medium Duty Gasoline / Diesel Vehicles [1]	0.18	0.25	0.16
Heavy Duty Diesel Vehicles [1]	0.085	0.11	0.06

[1] Ranges of NO$_2$/NO$_x$ in-stack ratios obtained from - P G Boulter, I S McCrae, and J Green, Transportation research Laboratory, "Primary NO$_2$ Emissions From Road Vehicles in the Hatfield and Bell Commons Tunnels", July 2007.

Alaska LNG Liquefaction Plant Construction Permit Application

Project Information Form Attachment 9:

Pre-Construction Monitoring

March 2018

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In Table 1, the Alaska LNG Project (Project) has compared modeled maximum impacts of its Liquefaction Plant to Significant Monitoring Concentrations (SMCs) provided in the PSD rules at 40 CFR 52.21(i)(5), and adopted by reference into 18 AAC 50.

Table 1. Alaska LNG Liquefaction Plant Pre-Construction Monitoring per 40 CFR 52.21(m)

Air Pollutant	Averaging Period	Maximum AERMOD Predicted Concentration ($\mu g/m^3$)	52.21 (i)(5) Significant Monitoring Concentration (SMC) ($\mu g/m^3$)	Pre-Construction Monitoring Required?	Source of Monitoring Information?
SO_2	24-hour	19.0	13	Yes	Alaska LNG monitoring
CO	8-hour	1132	575	Yes	Alaska LNG monitoring
NO_2	Annual	8.4	14	No	n/a
PM_{10}	24-hour	6.0	10	No	n/a
$PM_{2.5}$	24-hour	SMC is effectively 0 $\mu g/m^3$ [a]		Yes	Agrium Monitoring
O_3		SMC does not apply		Yes	Agrium Monitoring

$\mu g/m^3$ = micrograms per cubic meter

a   In its final rule, the EPA adopted and set values for an SMC for PM2.5. See 75 Fed. Reg. at 64,864. However, In Sierra Club v. EPA, decided on January 22, 2013, The Court of Appeals for the District of Columbia rejected EPA's rules governing SMC for determining PSD permitting requirements for new sources of PM2.5. Therefore, PM2.5 pre-construction monitoring is always required for projects triggering PM2.5 PSD review.

From the Table above, the Project believes it **does not have** 52.21(m) pre-construction monitoring requirements for:
- Oxides of Nitrogen (NOx), based on the SMC for nitrogen dioxide (NO_2)
- Particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10})

From the Table above, the Project believes it **does have** 52.21(m) pre-construction monitoring requirements for:
- Sulfur dioxide (SO_2)
- Carbon monoxide (CO)
- Particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$)
- Ozone (O_3) note: per 52.21(i)(5), there is no SMC for Ozone, the Project has emissions greater than 100 tons per year of NOx, creating a monitoring requirement for O_3.

In Figure 1, the Alaska Department of Environmental Conservation (ADEC) approved use of existing (Agrium) data for the following parameters having a pre-construction monitoring requirement:
- Particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$)
- Ozone (O_3)

Existing (Agrium) pre-construction monitoring information is provided in the folder *NOx_PM_PreConstruction Data*, associated with the attachment 7 electronic format modeling files.

The Department did not approve the use of existing data for the following parameters having a pre-construction requirement:

- Sulfur dioxide (SO_2)
- Carbon monoxide (CO)

The Project has initiated a program to collect pre-construction monitoring data for SO2 and CO, at a site approved by ADEC. This additional information will be provided to the Department in a supplement to this application, when available.

Figure 1. ADEC Approval for Use of Certain Existing Pre-Construction Monitoring

From: Schuler, Alan E (DEC) <alan.schuler@alaska.gov>
Sent: Tuesday, June 13, 2017 4:33 PM
To: Jim Pfeiffer (jpfeiffer@agdc.us); Kalb Stevenson (KStevenson@agdc.us)
Cc: Schuler, Alan E (DEC); Trost, Barbara E (DEC); Renovatio, James J (DEC); Pfeiffer, Jim A
Subject: ADEC Response Re Nikiski Pre-Construction Monitoring
Attachments: Is an LNG plant a fuel conversion plant under the Clean Air Act?; FW: trailers

Follow Up Flag: Follow up
Flag Status: Flagged

Jim and Kalb,

The Department is providing the following response to Alaska LNG's 6/7/17 request to use Agrium and Swanson River ambient monitoring data to meet the Prevention of Significant Deterioration (PSD) pre-construction monitoring requirements for the Kenai Liquefaction Facility. We agree that the 2013 – 2014 Agrium coarse particulate (PM-10), fine particulate (PM-2.5), and ozone (O3) data would meet the PSD pre-construction monitoring requirements for the proposed project. The 2008 – 2009 Swanson River nitrogen dioxide (NO2) and carbon monoxide (CO) data does not meet PSD pre-construction monitoring requirements due to its age. (The data is supposed to be "current" per Section 2.4.3 of the U.S. Environmental Protection Agency's (EPA's) *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* guidance, which the Department has adopted by reference in 18 AAC 50.035(a)(5).)

We believe AK LNG has the following three options as to how they could meet the pre-construction monitoring requirements for NO2 and CO:

1) Demonstrate that the project impacts are below the Significant Monitoring Concentration (SMC) for the given pollutant;
2) Propose some other surrogate data set; or
3) Collect at least 12-months of PSD-quality pre-construction data.

We're available to discuss these options in greater detail if that would help. I'm also attaching an email train regarding a possible source of monitoring equipment as a FYI (See FW: trailers).

Staff also recently received the attached email regarding LNG conversion plants, which I'm forwarding as an additional FYI.

Feel free to contact us if you have any questions.

Alan

Alaska LNG Liquefaction Plant Construction Permit Application

Project Information Form Attachment 10:

Liquefaction Plant Additional Impacts Analysis

March 2018

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As part of Prevention of Significant Deterioration (PSD) rules promulgated under 40 Code of Federal Regulations (CFR) 52.21 and adopted by reference in 18 Alaska Administrative Code (AAC) 50.040 with the changes indicated in 18 AAC 50.306, additional impacts analyses must be submitted to reviewing authorities as part of a PSD permit application. The Alaska Gasline Development Corporation (AGDC) provided the Alaska Department of Environmental Conservation (ADEC) with a protocol for the air quality and additional impact analyses required for the Alaska LNG Liquefaction Plant PSD permit application in *Liquefaction Facility Air Quality Modeling Report Supporting Resource Report No. 9* (Resource Report No. 9 Appendix D), dated October 11, 2016. The information in this document is being provided to supplement the information in Resource Report No. 9 Appendix D (Alaska LNG 2016) and to satisfy the requirements in 40 CFR 52.21(o). The following sections outline the results of the required analyses.

1. ADDITIONAL IMPACT ANALYSIS

This document describes the PSD analyses that assess potential impacts on soils, vegetation, and visibility in the project area caused by Liquefaction Plant emissions in combination with emissions from growth in the area due to the project. The additional impact analysis required in 40 CFR 52.21(o) consists of the following components:

- Growth Analysis: an analysis of the air quality impact predicted for the area as a result of general commercial, residential, industrial and other growth associated with the source or modification (40 CFR 52.21(o)(2));

- Soil and Vegetation Impact Analysis: a discussion of predicted ambient air quality impacts relative to soils and vegetation in the project impact area having significant commercial or recreational value (40 CFR 52.21(o)(1));

- Visibility Impairment Analysis: an estimate of the impacts due to source emissions on the visual quality in the area. This analysis is typically an assessment of plume blight and not regional haze (40 CFR 52.21(o)(1)).

1.1. Growth Analysis

The growth analysis consists of a projection of the associated industrial, commercial, and residential growth that is likely to occur in the area due to the Liquefaction Plant and an estimate of the emissions generated by that associated growth.

No industrial or commercial growth is likely to occur as the requirements for the project are expected to fit within the current infrastructure in the area. However, when fully operational, the Liquefaction Plant would employ approximately 300 people. Therefore, it is possible that the Project could lead to some residential growth in the area. However, this would be quite small considering the 2010 population in the project area was 12,612 (U.S. Census Bureau for Nikiski, Salamatof, and Kenai combined). Conservatively assuming that all 300 employees would be new residents to the area and the population of the area has not grown since 2010, the population would only increase about 2%. As such, emissions generated by

associated residential growth would be equally low, and any additional air quality impacts due to residential growth in the area would be inconsequential. Therefore, additional impacts on air quality, soils, vegetation, and visibility due to growth associated with the project are described by the project and cumulative modeling and analyses described in this document and in Resource Report No. 9 Appendix D (Alaska LNG 2016).

1.2. Soils and Vegetation Impact Analysis

This analysis involves an assessment of the ambient air quality impacts on the soil and vegetation types found in the project area. South-Central Alaska region is diverse, including an area from the peaks of the Alaska Range to the coastal marshes of the Kenai Peninsula resulting in a wide range of soil and vegetation types. The project is located in the upper Kenai Peninsula, which is located in a transition zone between the maritime and continental zones with little to no permafrost. The area is characterized as a glaciated lowland containing areas of ground moraine and stagnant ice topography, drumlin fields, eskers, and outwash plains with rugged mountains located to the east. Soils consist of marine, glacial, alluvial, and volcanic ash deposits that have been altered by glacial action and erosion. The surface soils and features in the area have been created by several major glacial events, which included the deposition of marine sandy clay. Vegetation in the region includes over 19 forest types, 7 herbaceous types, and 6 shrub types growing from barren alpine regions to coastal salt marshes (Gallant et al. 1995).

1.2.1   Vegetation Impact

To assess if a project has the potential to cause deleterious effects to vegetation in the project area, a comparison of project impacts can be made to threshold screening values developed by the USEPA from available laboratory and field studies (USEPA 1980). These thresholds "represent the minimum concentrations at which adverse growth effects or tissue injury in exposed vegetation were reported" to occur for sensitive plant species.

However, because it is more convenient and more protective, for most vegetation, ADEC recommends that the Secondary NAAQS are protective of vegetation species in Alaska (ADEC 2016). Secondary NAAQS set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation and buildings. In the case of carbon monoxide (CO), the National Ambient Air Quality Standards (NAAQS) are significantly more stringent than these threshold screening values. Therefore, a project that demonstrates compliance with the NAAQS easily demonstrates compliance with USEPA's threshold screening values and indicates the project will not cause deleterious effects to vegetation. However, lichen species are particularly sensitive to sulfur dioxide (SO_2) since they lack roots and derive all growth requirements from the atmosphere (Treshow and Anderson 1989). A U.S. Forest Service study conducted in the Tongass National Forest in southeast Alaska suggests 13 micrograms per cubic meter ($\mu g/m^3$) as a worst-case sensitivity threshold for lichen species found there. While it is not known whether species of lichens found in the project impact area have the same sensitivity as those in the Tongass National Forest, the sensitivity threshold still provides a reasonable surrogate measure. Therefore, based on ADEC recommendations, the Secondary NAAQS will be supplemented with an annual SO_2 limit of 13

$\mu g/m^3$. For CO, Primary NAAQS will be used for comparison and considered protective of vegetation in the absence of Secondary NAAQS.

Table 1 summarizes the vegetation impact analysis, which presents the totals of the cumulative modeled impact (project plus offsite sources) and background concentration at near-field locations as determined in Resource Report No. 9 Appendix D (Alaska LNG 2016). The results in Table 1 indicate that the total impact for all pollutants is below appropriate vegetation exposure levels for project area plant species. Similar to other cumulative analyses, these impacts also included project emissions that would not be required for modeling supporting PSD permitting. Therefore, these ambient air quality impacts are overstated and they are still not expected to result in adverse growth effects or tissue injury to vegetation in the project area.

Table 1: Vegetation Impact Analysis

Air Pollutant	Averaging Period	Modeled Impact[1] ($\mu g/m^3$)	Maximum 1-Hour Fumigation Concentration ($\mu g/m^3$)	Ambient Background Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	Vegetation Exposure Threshold ($\mu g/m^3$)
Sulfur Dioxide	3-Hour[2]	50.6	5.7	5.0	61.3	1,300[6]
	Annual[3]	0.6	5.7	0.0	6.3	13[7]
Carbon Monoxide	1-Hour[2]	2,721	78.3	1,145	3,945	40,000[8]
	8-Hour[2]	1,071	78.3	1,145	2,294	10,000[8]
Nitrogen Dioxide	Annual[3]	20.4	34.1	2.60	57.1	100[6]
Particulate Matter less than 10 Microns	24-Hour[5]	23.9	5.0	40	68.9	150[6]
Particulate Matter less than 2.5 Microns	24-Hour[4]	6.4	5.0	12	23.4	35[6]
	Annual[3]	2.8	5.0	3.7	11.4	15[6]

Abbreviations:

$\mu g/m^3$ = micrograms per cubic meter

Notes:

[1] Value reported is the maximum AERMOD concentration found at near-field receptors and is equivalent to the impact shown in Resource Report No. 9 Appendix D (Alaska LNG 2016).

[2] Value reported is the highest, second highest concentration of the values determined for each of the 5 modeled years.

[3] Value reported is the maximum annual average concentration for the 5-year period.

[4] Value reported is the 98th percentile averaged over the 5-year period.

[5] Value reported is the highest, 6th highest concentration over the 5-year period.

[6] Secondary NAAQS – Recommended by ADEC as the appropriate limit to protect against damage to crops and vegetation.

[7] Threshold determined by ADEC to be applicable to lichens which may exist in the project area (ADEC 2016).

[8] Primary NAAQS are used for comparison in the absence of Secondary NAAQS.

1.2.2   Soils Impact

According to USEPA (1980), there is little information available on the effects of air pollutants on soils. Deposition of trace elements may have some effect on soils, but "secondary effects of the pollutant appear to impact the soil system more adversely than the addition of the pollutant itself to the soil. For instance, damaging or killing vegetative cover could lead to increased solar radiation, increased soil temperatures, and moisture stresses," in addition to increased runoff and erosion. Thus, impacts on nearby soils were evaluated by determining the potential effect of project emissions on vegetation. As discussed in the previous section, vegetation impacts were found to be below applicable vegetation exposure thresholds. Therefore, impacts to soils in the project area are expected to be insignificant.

1.3. Visibility

The visibility impairment assessment involves a plume blight analysis to determine the impacts of a proposed project's emissions on the visual quality of an area. Plume impairment is generally defined as the pollutant loading of a portion of the atmosphere such that it becomes visible, by contrast or color difference, against a viewed background such as a landscape feature or the sky. The evaluation criteria for plume impairment are the color difference index (ΔE) and plume contrast (C_p). This air quality related value is generally applied at near-field (approximately less than 50 kilometers [km]) locations and modeled using the Level 1 or Level 2 VISCREEN screening model or the PLUVUE II model, if more information is required.

This near-field plume visibility analysis was conducted to evaluate the extent of visibility of plumes associated with the Liquefaction Plant in Kenai National Wildlife Refuge (Kenai NWR) which is the nearest National Conservation Lands area close enough to be reasonably modeled with a near-field model. While there is no requirement to conduct the modeling on National Conservation Lands, it was done because it provides a convenient area for developing model inputs.

Impacts were predicted using USEPA's VISCREEN model. VISCREEN is a screening-level plume visibility model recommended in USEPA's Workbook for Plume Visual Impact Screening and Analysis (The Visibility Workbook, USEPA 1992). This model simulates the dispersion and optical characteristics of an elevated emission source plume. It incorporates the straight-line Gaussian dispersion of primary particulate as well as the transformation of primary pollutants (nitrogen oxides [NO_x]). It then computes the scattering of direct sunlight due to airborne pollutants. For a given time of day, wind speed, atmospheric stability, background visual range, and ozone concentration, the model computes light intensity at various visible wavelengths for lines-of-sight through the plume centerline. By comparing the light intensity reaching an observer both with and without the source present, the model computes visibility parameters that can be used to gauge whether or not a plume might be visible against a background sky or terrain.

Inputs required by VISCREEN include:

- Observer distance from source;
- Meteorological conditions (wind speed and atmospheric stability);
- Background visual range;

- Background ozone concentration; and

- Emission rates of NO_x and primary particulate (elemental carbon and primary sulfate are optional emission rates).

Observer locations chosen for the VISCREEN analysis included the closest boundary of the Kenai NWR (the most conservative observer location as suggested by the Visibility Workbook) and Skilak Lake (a popular visitor destination within the refuge). Kenai NWR is located approximately 10 km from the Liquefaction Plant, and Skilak Lake is located approximately 52 km from the Liquefaction Plant. As was done for Resource Report No. 9 Appendix D (Alaska LNG 2016), both were assessed using a Level 2 screening analysis, as described the Visibility Workbook. Unless otherwise mentioned, default VISCREEN settings were utilized.

The USEPA Visibility Workbook indicates that the highest modeled plume visibility impairment is associated with plume-observer geometry where the wind vector carries the plume centerline 11.25° on either side of the line between the plant and the observer. Thus, one wind vector to left and one to the right of the observer location were simulated. Following the methods described in the Visibility Workbook, the wind speed and atmospheric stability class for the 22.5° wind direction sector for each observer that corresponds to the one percent worst-case probability was applied. Wind speed and stability class categories and frequencies were based on the same meteorological data set used for the near-field modeling analyses described in Resource Report No. 9 Appendix D (Alaska LNG 2016): 2008-2012 meteorological data from the nearby Kenai NWS station. Table 2 summarizes the one percent worst-case meteorological conditions applied in the visibility analysis.

Background visual range was determined by averaging the 12 months of average monthly visual range values measured in nearby Tuxedni National Wildlife Refuge (Table 10, USDOI [2010]).

Table 2: Summary of Worst-Case Meteorological Conditions Applied In Visibility Analysis

VISCREEN Analysis	Observer Location	Wind Sectors Analyzed (degrees)	Stability Class	Wind Speed (m/s)
Compressor Turbines	Closest Park Boundary	258.75 to 281.25	D	3
	Skilak Lake	281.97 to 304.47	D	4
Power Generators	Closest Park Boundary	258.75 to 281.25	D	3
	Skilak Lake	281.75 to 304.25	D	4
Low Pressure (LP) Flare	Closest Park Boundary	259.05 to 281.55	D	3
	Skilak Lake	281.55 to 304.05	D	4
Wet/Dry Flares	Closest Park Boundary	258.75 to 281.25	D	3
	Skilak Lake	281.65 to 304.15	D	4
Marine Sources	Closest Park Boundary	258.75 to 281.25	D	3
	Skilak Lake	280.65 to 303.15	D	4

Emission rates used as inputs were based on the short-term primary NO_x, primary particulate matter (PM), and primary elemental carbon emissions estimated from the Liquefaction Plant. For the Low Pressure Flare and Wet and Dry Flares, maximum flaring events, which may occur during upset and startup

scenarios, will occur less than once per year. If one does occur, it should occur for less than 30 minutes. Therefore, modeled emissions associated with maximum relief events were based on 30 minutes per day every day of the year. Recognize that these are very short-lived events, and the probability is very low that these transient events will occur simultaneously with the modeled one percent worst-case probability meteorology conditions.

Also note that VISCREEN assumes that 10% of NO_x emissions are initially converted to NO_2, either within the source stack or within the first kilometer of plume transport. In addition, the default VISCREEN ozone background value of 40 ppbv was assumed and is consistent with measurements collected at Denali National Park and used for other long-range and near-field assessments described in Resource Report No. 9 Appendix D (Alaska LNG 2016).

There will be several emission source types at the Liquefaction Plant, and many would have different stack parameter characteristics. Furthermore, some sources would also be large distances apart. Rather than conservatively assume all of these emissions are emitted as a single plume, it was assumed that the plumes from many of these sources would not combine into a single plume and were assessed separately. Therefore, an assessment was conducted to determine which plumes would and would not likely combine. Stack velocities, heights, temperatures, and distances were considered in this analysis. A total of five separate plumes were conservatively identified. Table 3 summarizes the sources that were combined into each of these plumes with justifications. A specific VISCREEN analysis was performed on each of these plumes to obtain more representative visibility degradation estimations at the observer locations.

The results of the visibility impairment analysis are presented in Table 4 and Table 5. The nearest Class I area is Tuxedni NWR, located at 86 km from the Liquefaction Plant. Because there are no Class I areas located within the maximum range of the VISCREEN model (50 km), there are no criteria available to assess visibility impairment at the Liquefaction Plant. Therefore, these results are presented for informational purposes only to satisfy the requirement for a visibility impairment analysis in 40 CFR 52.21(o)(1).

Table 3: Summary Combined Plume Emission Sources

Source Plume	Source Emissions Included in Plume	Justification for Combining Sources
Compressor Turbines	6 Compressor Turbine	Identical source types. Distances apart range from approximately 0.1 to 0.5 kilometers.
Power Generators	4 Power Generators + Firewater Pump + Aux Compressor	The Power Generators are located in the same general vicinity of each other. The Firewater Pump and Aux Compressors are also nearby and have stack parameters which suggest potential for combining with Power Generator plumes.
Low Pressure (LP) Flare	2 LP Flares + Thermal Oxidizer	The two LP flares are nearby each other. The Thermal Oxidizer is also conservatively included with the LP flares as it is nearby source.
Wet/Dry Flares	2 Wet Flares + 2 Dry Flares	All four of these flares are nearby each other and have similar stack parameters.
Marine Sources	North Carrier + South Carrier + Support Tugs	Though exact locations of these sources is unknown, they were conservatively combined into a single plume.

Table 4: Viscreen-Predicted Impacts Inside Kenai NWR (Sky Background)

Source Plume	Observer Location	Scattering Angle (degrees)	Modeled Perceptibility (ΔE)	Modeled Contrast (Cp)
Forward Scatter				
Compressor Turbines	Closest Park Boundary	10	1.30	-0.02
	Skilak Lake	10	0.39	-0.01
Power Generators	Closest Park Boundary	10	0.38	-0.01
	Skilak Lake	10	0.12	0.00
LP Flare + Thermal Oxidizer	Closest Park Boundary	10	0.24	0.00
	Skilak Lake	10	0.12	0.00
Wet/Dry Flares	Closest Park Boundary	10	0.69	-0.01
	Skilak Lake	10	0.40	0.00
Marine Sources	Closest Park Boundary	10	0.91	-0.01
	Skilak Lake	10	0.33	-0.01
Backward Scatter				
Compressor Turbines	Closest Park Boundary	140	2.39	-0.07
	Skilak Lake	140	0.86	-0.03
Power Generators	Closest Park Boundary	140	0.66	-0.02
	Skilak Lake	140	0.24	-0.01
LP Flare + Thermal Oxidizer	Closest Park Boundary	140	1.04	-0.03
	Skilak Lake	140	0.45	-0.01
Wet/Dry Flares	Closest Park Boundary	140	2.23	-0.10
	Skilak Lake	140	1.40	-0.04
Marine Sources	Closest Park Boundary	140	0.78	-0.02
	Skilak Lake	140	0.24	-0.01

Table 5: Viscreen-Predicted Impacts Inside Kenai NWR (Terrain Background)

Source Plume	Observer Location	Scattering Angle (degrees)	Modeled Perceptibility (ΔE)	Modeled Contrast (Cp)
Forward Scatter				
Compressor Turbines	Closest Park Boundary	10	5.63	0.02
	Skilak Lake	10	2.15	0.03
Power Generators	Closest Park Boundary	10	1.61	0.01
	Skilak Lake	10	0.60	0.01
LP Flare + Thermal Oxidizer	Closest Park Boundary	10	3.27	0.01
	Skilak Lake	10	1.18	0.01
Wet/Dry Flares	Closest Park Boundary	10	9.80	0.04
	Skilak Lake	10	3.65	0.04
Marine Sources	Closest Park Boundary	10	0.68	0.00
	Skilak Lake	10	0.46	0.01
Backward Scatter				
Compressor Turbines	Closest Park Boundary	140	0.46	0.00
	Skilak Lake	140	0.75	0.02
Power Generators	Closest Park Boundary	140	0.12	0.00
	Skilak Lake	140	0.21	0.01
LP Flare + Thermal Oxidizer	Closest Park Boundary	140	0.23	0.00
	Skilak Lake	140	0.39	0.01
Wet/Dry Flares	Closest Park Boundary	140	0.76	0.01
	Skilak Lake	140	1.25	0.03
Marine Sources	Closest Park Boundary	140	0.11	0.00
	Skilak Lake	140	0.20	0.01

2. REFERENCES

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Alaska LNG Liquefaction Plant Construction Permit Application

Project Information Form Attachment 11:

Liquefaction Plant Sources Impacting Class I Areas Additional Requirements

March 2018

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As part of Prevention of Significant Deterioration (PSD) rules promulgated under 40 Code of Federal Regulations (CFR) 52.21 and adopted by reference in 18 Alaska Administrative Code (AAC) 50.040 with the changes indicated in 18 AAC 50.306, additional impacts analyses on Class I areas must be submitted to reviewing authorities as part of a PSD permit application. The Alaska Gasline Development Corporation (AGDC) has provided the Alaska Department of Environmental Conservation (ADEC) with a protocol for the air quality and additional impact analyses on Class I areas required for the Alaska LNG Liquefaction Facility PSD permit application in the *Liquefaction Facility Air Quality Modeling Report Supporting Resource Report No. 9* (Resource Report No. 9 Appendix D), dated October 11, 2016 (Alaska LNG 2016). The information in this document is being provided to supplement the information in Resource Report No. 9 Appendix D and to satisfy the requirements in 40 CFR 52.21(p).

Class I areas warranting impact analyses were identified in consultation with Federal Land Managers (FLMs) and are documented in Resource Report No. 9 Appendix D. There are no Class I areas located in the near-field (within 50 kilometers [km]) of the Liquefaction Facility. However, there are two Class I areas located between 50 and 300 km of the Liquefaction Facility: (1) Tuxedni National Wildlife Refuge (Tuxedni NWR) at 86 km and (2) Denali National Park (Denali NP) at 183 km. The following sections present the results of the cumulative criteria pollutant air quality analyses as well as the acidic deposition and regional haze analyses conducted at these two Class I areas, which involves modeling of the proposed project sources as well as offsite sources.

1. DESCRIPTION OF THE MODELED OFFSITE SOURCE INVENTORY

Resource Report No. 9 Appendix D provides details regarding the development of the offsite source inventory that was included in the Class I cumulative impact analyses. In brief, a Q/d analysis was conducted following the FLAG 2010 guidance (FLAG 2010) for all permitted sources (facilities) identified within 300 km of Tuxedni NWR, Denali NP, and five other areas that were identified as "sensitive" Class II areas. The offsite source inventory was developed by selecting facilities with a Q/d value equal to or greater than 10 for any one of the Class I or sensitive Class II areas. In all cases the value of "d" was the distance of offsite sources from the nearest Class I or sensitive Class II area boundary and not the distance of the offsite source to the Liquefaction Facility. Therefore, this process was designed to remove sources from the inventory that FLAG 2010 indicates should not have a significant impact on the Class I area. For simplicity, the resulting inventory was used to evaluate cumulative impacts at all of the identified Class I and sensitive Class II areas even if a particular source only had a Q/d greater than 10 at one of the areas. Therefore, was no variation in the inventory used for each Class I and sensitive Class II area.

Because the selection of offsite sources was based on a Q/d analysis for Class I areas as well as sensitive Class II areas, the offsite source inventory included in the Resource Report No. 9 Appendix D modeling was larger than it needs to be for this analysis and it has been further evaluated prior to conducting the regional haze analysis in order to refine impacts based on recommendations in Resource Report No. 9 Appendix D.

Table 1 shows the 28 offsite sources that were included in the modeling supporting Resource Report No. 9 Appendix D. Table 1 also provides an updated Q/d for some sources based on updated emissions which are detailed in the subsections below. Emissions were only updated in the cases of substantial changes

such as a new source or a large operational change at an existing source. The updated Q/d indicates that only 5 sources have a Q/d equal to or greater than 10 at either Tuxedni NWR or Denali NP. It is important to restate that the revised offsite source inventory was only used to refine the regional haze assessment presented in Section 4.0.

1.1. Beluga River Power Plant

The owner of the Beluga River Power Plant, Chugach Electric Association (Chugach), has joined Matanuska Electric Association (MEA) and Anchorage's Municipal Light & Power (ML&P) in a power pooling agreement to focus on increasing reliability and decreasing costs. The agreement involves pooling and dispatching the power generated from Chugach's Southcentral Power Project (SPP), MEA's Eklutna Power Plant, and ML&P's George Sullivan Plant #2 before using the much less efficient Beluga River Power Plant (Zak 2017). The plan to decrease power generation at the Beluga River Power Plant is evident in the decreasing emissions shown in the ADEC Point Source Inventory (ADEC 2017b). For example, NO_x emissions in 2016 were less than 10% of NO_x emissions in 2011. The low 2016 emissions are likely attributed to the fact that ML&P's Plant #2 came online that year. To account for the continued reduced operation of Beluga River Power Plant in the future (due to the power pooling agreement), 2016 actual emissions were used in the revised Q/d analysis presented in Table 1. Table 1 shows that the Q/d for Beluga River Power Plant is less than 10 for both Tuxedni NWR and Denali NP; therefore, it was excluded from the regional haze assessment presented in Section 4.0.

1.2. SPP and Eklutna Power Plant

Because the SPP and Eklutna Plant will be providing power to the Anchorage region in lieu of the Beluga River Power Plant as part of a power pooling agreement, a Q/d analysis was performed for these facilities as they were not previously included in the Q/d analysis supporting Resource Report No. 9 Appendix D. These sources were not previously considered because they were not included in the 2011 National Emissions Inventory (NEI 2011). Note that George Sullivan Plant #2, also included in the pooling agreement, was already included in the Q/d analysis supporting Resource Report #9 Appendix D. The updated analysis yielded Q/d values less than 10 for both SPP and Eklutna at both Tuxedni NWR and Denali NP, therefore they were not included in the regional haze assessment presented in Section 4.0.

1.3. Kenai LNG Plant

In late 2017, ADEC acknowledged plans by ConocoPhillips Alaska, Inc. (CPAI) to shift the Kenai LNG Plant to standby operations (ADEC 2017a) while CPAI looked for a buyer. The plant had not exported LNG since 2015 when CPAI announced it was looking for a buyer. Prior to that the plant had been operating at much lower capacity or in standby mode when sales contracts and regular shipments were terminated because of concerns about declining Cook Inlet gas reserves in 2011. Therefore, the actual emissions used in the regional haze modeling were updated to reflect more recent modes of operation. Emissions from the highest of the of the past 3 years (2014) were used to develop the analysis shown in Table 1 and in the regional haze modeling analysis described in Section 4.0. This will still overstate emissions since the plant is transitioning to standby mode, where emissions will be less than in 2014 when shipments were still

occurring. In more recent developments, on January 31, 2018 Andeavor acquired the Kenai LNG Plant from CPAI and has not announced plans for its future. However, since the plant export license expires in the first quarter 2018, it is not likely that the plant will transition out of standby mode soon.

Note that while the revised Q/d analysis in Table 1 shows a value less than 10 for both Class I areas, the Kenai LNG Plant was included in the regional haze analyses since it was previously subject to the Best Available Retrofit Technology (BART) regional haze analyses required by USEPA. However, it is also relevant to note that more recently it has been determined that it is not considered a fuel conversion plant and should not have been subject to BART under USEPA's 1999 Regional Haze Rule.

1.4. **Nikiski Combined Cycle Plant**

The Q/d analysis supporting Resource Report #9 Appendix D based Q on twice the actual emissions from the 2011 NEI (NEI 2011) and yielded a 10 for the Homer Electric Association Nikiski Combined Cycle Plant at Tuxedni NWR. Since this is right at the threshold for modeling, and emissions were likely overstated, Q/d was reevaluated for this source using potential emissions. Considering the potential emissions from the plant's 2015 operating permit (ADEC 2015) yielded a Q/d of 8 and the facility was excluded from the regional haze analysis described in this document.

1.5. **List of Offsite Sources Included in Regional Haze Analyses**

Table 1 shows all 28 sources with a Q/d equal to or greater than 10 for any one of the Class I or sensitive Class II areas identified in Resource Report #9 Appendix D. These offsite sources were included in the air quality and acidic deposition analyses described in Sections 2.0 and 3.0 below. However, the inventory modeled for regional haze analysis presented in Section 4.0 required the refinements as described above resulting in the following modeled offsite inventory:

Tuxedni NWR Regional Haze Analysis

- Healy Power Plant
- Kenai LNG Plant
- Swanson River Field
- Ted Stevens Airport

Denali NP Regional Haze Analysis

- Clear Air Force Station
- George Sullivan Plant Two
- Healy Power Plant
- Kenai LNG Plant
- Swanson River Field
- Ted Stevens Airport

Table 1: Q/d Determination for Off-site Sources (Facilities in Bold Font have Q/d > 10)

#	Offsite Facility	Included in Prior Q/d Analysis	NO$_x$[1] (tpy)	SO$_2$[1] (tpy)	PM$_{10}$[1] (tpy)	2 x Facility Total[1] (tpy)	Minimum Distance to Denali (km)	Minimum Distance to Tuxedni (km)	Q/d Denali	Q/d Tuxedni
	Offsite Sources Included in Modeling Supporting Resource Report #9 Appendix D									
1	Beaver Creek Production Facility	Y	99.9	343.1	1.4	888.9	187.1	101.0	5	9
2	Beluga River Power Plant[2]	Y	255.0	0.9	8.6	528.9	130.1	177.7	5	3
3	Bernice Lake Power Plant	Y	87.9	0.0	2.0	179.9	180.9	180.8	1	1
4	Bruce Platform	Y	107.4	0.2	1.7	218.4	166.3	99.5	2	3
5	**Clear Air Force Station**	**Y**	**224.6**	**204.5**	**3.1**	**864.2**	**35.8**	**186.9**	**25**	**5**
6	Drift River Terminal / Christy Lee Platform Aggregated Source	Y	77.3	4.0	1.1	164.7	193.1	49.7	1	4
7	**George Sullivan Plant Two**	**Y**	**1817.4**	**0.3**	**37.5**	**3710.5**	**158.9**	**455.3**	**24**	**9**
8	**Healy Power Plant**	**Y**	**315.8**	**460.2**	**27.7**	**1607.4**	**6.1**	**115.5**	**264**	**14**
9	Kenai Gas Field 14-6 Pad	Y	92.5	1.1	1.8	190.9	207.6	79.2	1	3
10	Kenai Gas Field 34-31 Pad	Y	43.4	0.6	1.1	90.0	205.9	79.4	1	2
11	Kenai Liquefied Natural Gas (LNG) Plant[3]	Y	324.2	0.25	11.1	670.5	182.6	85.9	4	8
12	Kenai Pipeline (KPL) Facility	Y	0.3	0.0	0.0	0.6	182.8	122.9	1	1
13	Kenai Refinery (Tesoro)	Y	342.4	14.9	25.3	765.2	182.0	101.8	5	8
14	King Salmon Platform	Y	129.2	91.7	4.9	451.6	160.8	93.1	3	5
15	LNG Plant #1	Y	214.9	0.0	0.3	430.4	130.3	195.1	4	3
16	Nikiski Generation Plant[4]	Y	751.7	29.2	28.5	809.4	182.3	103.1	5	8
17	Platform A	Y	318.3	34.9	5.0	716.3	169.2	90.6	5	8
18	Platform C, Middle Ground Shoal, Cook Inlet	Y	343.5	8.6	4.2	712.5	172.5	87.9	5	9
19	Steelhead Platform	Y	182.1	0.5	8.1	381.2	164.7	90.1	3	5

Table 1 (CONTINUED): Q/d Determination for Off-site Sources (Facilities in Bold Font have Q/d > 10)

#	Offsite Facility	Included in Prior Q/d Analysis	NO_x[1] (tpy)	SO_2[1] (tpy)	PM_{10}[1] (tpy)	2 x Facility Total[1] (tpy)	Minimum Distance to Denali (km)	Minimum Distance to Tuxedni (km)	Q/d Denali	Q/d Tuxedni
20	**Swanson River Field**	**Y**	**1071.3**	**0.1**	**16.8**	**2176.4**	**182.4**	**112.8**	**12**	**20**
21	**Ted Stevens Anchorage Airport**	**Y**	**2274.9**	**217.6**	**61.5**	**5108.0**	**155.4**	**370.4**	**33**	**14**
22	Tyonek Platform	Y	152.0	0.2	3.1	310.7	144.5	133.6	3	3
23	Valdez Diesel Power Plant	Y	140.2	22.3	3.5	331.9	269.5	354.8	2	1
24	AE&EC - Soldonta Turbine[4]	Y	245.4	12.1	36.9	294.4	205.7	94.4	2	4
25	Agrium - Kenai Nitrogen Operations Plant[4]	Y	214.4	8.9	174.8	398.1	183.1	86.0	3	5
26	Alaska Pipeline Co. - Gudenrath Compression Station[4]	Y	75.6	1.1	2.1	78.8	206.0	115.4	1	1
27	Dolly Varden Platform WITH KUUKPIK 5 RIG	Y	195.5	136.2	6.9	682.06	167.1	87.3	5	8
28	Grayling Platform WITH KUUKPIK 5 RIG	Y	339.3	37.6	9.3	777.54	163.6	90.5	5	9
Offsite Sources Considered for the current Analysis										
29	Southcentral Power Project[4]	N	1261.0	41.0	58.0	1360.0	160.4	183.2	9	8
30	Eklunta Power Plant[4]	N	188.0	21.0	221.0	430.0	142.3	227.3	4	2

Notes:

[1] Emissions based on 2011 NEI (NEI 2011), except where noted.

[2] Emissions based on 2016 ADEC point source inventory (ADEC 2017b).

[3] Emissions based on 2014 ADEC point source inventory (ADEC 2017b).

[4] Potential emissions from operating permit. Facility total is not doubled for the Q/d calculation.

2. NAAQS\AAAQS AND PSD INCREMENT COMPLIANCE ANALYSES

Proposed project sources were modeled along with the 28 offsite sources identified in Resource Report #9 Appendix D to estimate cumulative air quality impacts at Tuxedni NWR and Denali NP as described in Section 7.2 of Resource Report No. 9 Appendix D. The results of that analysis are compared to the National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS) and applicable PSD Class I Increment thresholds in Tables 7-19, 7-20, 7-26 and 7-28 of Resource Report No. 9 Appendix D which are reproduced in Tables 2, 3, and 4 below. The tables indicate that the total modeled impact does not exceed the NAAQS/AAAQS or PSD Class I Increment standard for any pollutant/averaging period for either Class I area.

When evaluating these impacts, consider that the results presented in Tables 2, 3 and 4 include emissions from a large offsite inventory and mobile marine vessels even though the emissions from mobile marine vessels are not required to be included in modeling supporting a PSD application.

Table 1: Cumulative NAAQS/AAAQS Compliance Analysis at Tuxedni NWR

Air Pollutant	Averaging Period	Model-Predicted Concentration ($\mu g/m^3$)	Ambient Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	AAAQS ($\mu g/m^3$)
Sulfur Dioxide	1-Hour [1]	0.70	5.0	5.70	196	196
	3-Hour [2]	0.68	5.0	5.68	1,300	1,300
	24-Hour [2]	0.32	2.3	2.62	NA	365
	Annual [4]	0.03	0	0.03	NA	80
Carbon Monoxide	1-Hour [2]	14.66	1,145	1,160	40,000	40,000
	8-Hour [2]	7.80	1,145	1,153	10,000	10,000
Nitrogen Dioxide	1-Hour [3]	4.79	32.3	37.09	188	188
	Annual [4]	0.22	2.6	2.82	100	100
Particulate Matter less than 10 Microns	24-Hour [6]	2.25	40.0	42.25	150	150
Particulate Matter less than 2.5 Microns	24-Hour [5]	0.93	12.0	12.93	35	35
	Annual [4]	0.12	3.7	3.82	12	15

Abbreviations:
   NA = not applicable
Notes:
[1]   Value reported is the 99th percentile of the annual distribution of daily maximum values averaged over the 3-year period.
[2]   Value reported is the highest, second highest concentration of the values determined for each of the 3 modeled years.
[3]   Value reported is the 98th percentile of the annual distribution of daily maximum values averaged over the 3-year period.
[4]   Value reported is the maximum annual average concentration for the 3-year period.
[5]   Value reported is the 98th percentile averaged over the 3-year period.
[6]   Value reported is the highest, 6th highest concentration over the 3-year period.

Table 2: Cumulative NAAQS/AAAQS Compliance Analysis at Denali NP

Air Pollutant	Averaging Period	Model-Predicted Concentration ($\mu g/m^3$)	Ambient Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	AAAQS ($\mu g/m^3$)
Sulfur Dioxide	1-Hour [1]	22.21	5.0	27.21	196	196
	3-Hour [2]	15.45	5.0	20.45	1,300	1,300
	24-Hour [2]	4.05	2.3	6.35	NA	365
	Annual [4]	0.258	0	0.26	NA	80
Carbon Monoxide	1-Hour [2]	46.63	1,145	1,192	40,000	40,000
	8-Hour [2]	17.34	1,145	1,162	10,000	10,000
Nitrogen Dioxide	1-Hour [3]	9.65	32.3	41.95	188	188
	Annual [4]	0.15	2.6	2.75	100	100
Particulate Matter less than 10 Microns	24-Hour [6]	2.22	40.0	42.22	150	150
Particulate Matter less than 2.5 Microns	24-Hour [5]	0.83	12.0	12.83	35	35
	Annual [4]	0.10	3.7	3.80	12	15

Abbreviations:

   NA = not applicable

Notes:

[1] Value reported is the 99th percentile of the annual distribution of daily maximum values averaged over the 3-year period.

[2] Value reported is the highest, second highest concentration of the values determined for each of the 3 modeled years.

[3] Value reported is the 98th percentile of the annual distribution of daily maximum values averaged over the 3-year period.

[4] Value reported is the maximum annual average concentration for the 3-year period.

[5] Value reported is the 98th percentile averaged over the 3-year period.

[6] Value reported is the highest, 6th highest concentration over the 3-year period.

Table 3: Cumulative PSD Increment Compliance Analysis at Tuxedni NWR and Denali NP

Air Pollutant	Averaging Period	Model-Predicted Concentration at Tuxedni NWR (µg/m³)	Model-Predicted Concentration at Denali NP (µg/m³)	Class I Increments (µg/m³)
Sulfur Dioxide	1-Hour [1]	NA	NA	NA
	3-Hour [2]	0.64	15.45	25
	24-Hour [2]	0.30	4.05	5
	Annual [3]	0.03	0.26	2
Carbon Monoxide	1-Hour [1]	NA	NA	NA
	8-Hour [1]	NA	NA	NA
Nitrogen Dioxide	1-Hour [1]	NA	NA	NA
	Annual [3]	0.18	0.12	2.5
Particulate Matter less than 10 Microns	24-Hour [2]	1.74	1.67	8
	Annual [3]	0.10	0.08	4
Particulate Matter less than 2.5 Microns	24-Hour [2]	1.78	1.76	2
	Annual [3]	0.10	0.08	1

Abbreviations:
    NA = not applicable
Notes:
[1] Neither USEPA nor ADEC have established increment thresholds for 1-hour NO_2, 1-hour SO_2, 1-hour CO, or 8-hour CO.

[2] Value reported is the maximum of the highest-second-high values from each of the five modeled years.

[3] Value reported is the maximum annual average concentration for the 5-year period.

3. ACIDIC DEPOSITION

Proposed project sources were modeled with and without the 28 offsite sources identified in Resource Report #9 Appendix D to estimate source-only and cumulative acidic deposition impacts at Tuxedni NWR and Denali NP as described in Section 7.2.5 of Resource Report No. 9 Appendix D.

Deposition analyses were performed using the CALPUFF modeling system and FLAG 2010 guidance (FLAG 2010). Results were compared to source-only Deposition Analysis Thresholds (DATs). FLMs have established DATs to use with source-only impacts as screening levels for incremental increases in the deposition flux of sulfur (S) and nitrogen (N) compounds due to a proposed facility. When these screening thresholds are exceeded a cumulative impact analysis is conducted and impacts are compared to location or ecosystem-specific Critical Loading Values (CLVs).

Like DATs, CLVs are based on long-term (annual) exposure; therefore, compliance is not sensitive to short-term events such as emergency flaring. CLVs are based on ecosystem-specific data that provide appropriate protection of the resources that are most directly affected by acidic deposition. At the present time, specific CLVs are not available for ecosystems in all areas and in particular the predominant plant species in Tuxedni NWR and/or Denali NP. As a result, CLVs need to be established based on a review of existing literature. Table 5, which has been compiled from data summarized by the National Park Service (NPS 2017), provides several nitrogen CLVs for broad species classes in ecosystems that are potentially found in the Class I areas under review. Where ranges are given for the CLVs, the upper end of the range should be considered for deposition impact comparisons at Tuxedni NWR and Denali NP for several reasons:

- *Seasonal Considerations.* For both Tuxedni NWR and Denali NP, a significant portion of the deposition occurs when soils are frozen and snow covered and plants are dormant. During this period, the deposition accumulates in snow (on the surface). The dormant plants are thus less affected by deposition impacts. The accumulated deposition (both wet and dry deposition pathways) also are less capable of affecting plants during the spring (melt period), as the melt generally occurs over a short timeframe, providing a lower opportunity for soil infiltration and plant uptake. Biological processes are also less active during the melt period given the lower ambient temperatures (Hatfield and Prueger, 2015). Consideration of these factors would result in a higher site-specific CLV (an annual value) as loading over the winter would not be considered equivalent to loading from the summer.

- *Lower/reduced wet S and N concentrations in the wet deposition fraction*. One source estimates that dry fallout (deposition) can contain as much as 10 times as many nutrients as rain (Wetzel 2001). This reinforces the seasonal factors noted above, as the accumulated sulfur and nitrogen during the winter season (in/on the snow) would quickly runoff into the environment during the spring melt. This rapid influx would limit uptake capabilities by local vegetation, especially due to their lower biological activity as noted above.

Based on these considerations and the data presented in Table 5, a nitrogen CLV of 5 kg/ha/yr should be protective of Tuxedni NWR which has an ecosystem described by low elevation coastal forests similar to those found in maritime ecosystems on the west coast of the continental United States. Unlike Tuxedni NWR, Denali NP is large, landlocked, and has considerable altitude variation. Based on a description provided by the National Park Service, Denali NP is dominated by Taiga and Northwestern Forested Mountains (NPS 2017). While it is possible to establish different CLVs applicable to different parts of the park and assess impacts from acidic deposition based on where maximum impacts are occurring, this refinement is not necessary given the low cumulative impacts. Therefore, a single nitrogen CLV of 3.0 kg/ha/yr is low enough to be protective of all ecosystems potentially occurring in Denali NP and was used to assess project impacts.

While the FLMs provide considerable guidance on their websites regarding CLVs for nitrogen deposition, sulfur deposition is not given the same treatment likely due to lack of data, the limited number of Class I areas outside the eastern part of the United States that experience elevated sulfur deposition or are currently impacted by incremental increases in sulfur deposition. There is also the general idea that in the west nitrogen impacts are observed well before sulfur impacts. That said, a considerable body of literature exists for studies conducted by northern European researchers who have been dealing with this issue on a large scale for some time. The consensus among literature reviewed puts the CLV for sulfur deposition in kg/ha-yr for northern latitude forested soils between 2 and 4 kgS/ha/yr (Nilsson 1988a, Thord 1993 and Nilsson 1988b). While this range provides a metric for comparison, there is some potential uncertainty when applying these values to the Tuxedni NWR and Denali NP ecosystems. Therefore, more consideration should be given when cumulative impacts approach the lower end of this threshold range.

Modeled source-only sulfur and nitrogen deposition impacts from the Liquefaction Facility are shown in Table 6. Except for sulfur deposition at Denali NP, DATs are exceeded indicating the need to conduct a cumulative impact analysis. To add some perspective to the impacts shown in Table 6, the sulfur deposition flux from the Liquefaction Facility is slightly above the DAT at Tuxedni NWR. The onshore sources located at the Liquefaction Facility are most culpable for these impacts and are based on combusting gas containing the maximum amount of sulfur allowed while still qualifying as pipeline quality natural gas (16 ppmv). In reality, this is well above the design specification for the gas and the actual fuel sulfur content will be much lower (by as much as half), which will eliminate the exceedance. The nitrogen deposition flux from the Liquefaction Facility also exceeds the DAT at Tuxedni NWR and Denali NP.

Cumulative deposition model results are shown in Table 7. These results include emissions from the Liquefaction Facility, mobile vessel emissions and emissions from the 28 offsite sources identified in in Resource Report No. 9 Appendix D. Results indicate that the modeled nitrogen and sulfur deposition fluxes are significantly less than the CLVs at both Class I areas.

Table 5: Nitrogen Critical Load Values by Species and Ecosystem (kg/ha/yr)

Indicator/Species	Tundra	Taiga	Marine West Coast Forests	Northwestern Forested Mountains
Forest	---	---	5	4 – 17
Herbaceous Plants and Shrubs	1.0 – 3.0	6.0	---	4 – 10
Lichen and Bryophytes	1.0 – 3.0	1.0 – 3.0	2.7 – 9.2	1.2 – 3.7
Mycorrhizal Fungi	---	---	5.0	5.0 – 10.0
Nitrate Leaching	---	--	---	4.0 – 17.0

Source: NPS (2017) https://www.nature.nps.gov/air/studies/criticalLoads/Ecoregions/AK_Taiga_Tundra.cfm accessed 10/2017.

Table 6: Project-Only Acidic Deposition Results

Class I Area	Averaging Period	Predicted Impact (kg/ha/yr)	NPS Class I Deposition Analysis Thresholds (DAT) (kg/ha/yr)	Percent of DAT	Exceeds DAT ?
Sulfur Deposition					
Tuxedni NWR	Maximum Annual over 3-Years	0.0052	0.005	104	YES
Denali NP		0.0037	0.005	74	NO
Nitrogen Deposition					
Tuxedni NWR	Maximum Annual over 3-Years	0.014	0.005	272	YES
Denali NP		0.014	0.005	287	YES

Table 7: Cumulative Acidic Deposition Results

Class I Area	Averaging Period	Predicted Impact (kg/ha/yr)	NPS Class I Critical Loading Value (CLV) (kg/ha/yr)	Percent of CLV
Sulfur Deposition				
Tuxedni NWR	Maximum Annual over 3-Years	0.054	2 - 4	<3
Denali NP		0.080	2 - 4	<4
Nitrogen Deposition				
Tuxedni NWR	Maximum Annual over 3-Years	0.12	5	2
Denali NP		0.093	3	3

4. REGIONAL HAZE

A regional haze analysis was conducted to assess potential visibility impairment at Tuxedni NWR and Denali NP. The analyses were performed using the CALPUFF modeling system and FLAG 2010 guidance (FLAG 2010). It is important to note that the subtraction technique used to determine source—only impacts documented in Resource Report #9 Appendix D was not followed for this analysis. Based on recommendations from the National Park Service, source-only impacts were determined by source only modeling. Modeled impacts were determined in terms of the 98th percentile change in light extinction and compared to the following thresholds of concern (FLAG 2010):

- 5% Change – Source is considered to contribute to regional haze visibility impairment, and

- 10% Change – Source is considered to cause regional haze visibility impairment.

Project-only impacts due to the Liquefaction Facility and Marine Terminal alone were first determined. With the exception of mobile marine vessel emissions, the modeling inputs and settings used were identical to that documented in Resource Report No. 9 Appendix D. Emissions from mobile marine vessels were excluded from the current analysis since they are not considered part of the stationary source under PSD permitting regulations. Table 8 presents the project-only impacts. FLAG 2010 guidelines (FLAG 2010) indicate that if a project-related change in extinction is less than 5%, then it is presumed there would be no adverse visibility impact. Table 8 indicates that regional haze impacts were less than the threshold of concern for all modeled years at Denali NP and for 2002 at Tuxedni NWR. Modeled impacts for 2003 and 2004 at Tuxedni NWR were slightly above the 5% threshold. This is an indication the source could contribute to regional haze visibility impairment and a cumulative regional haze analysis was conducted for comparison to the 10% threshold to determine if a regional haze visibility impairment will actually be predicted.

The cumulative regional haze analysis included the proposed project sources as well as offsite sources with a Q/d greater than 10 at Tuxedni NWR and Denali NP, as discussed in Section 1 and listed in Table 1. This is a refinement to the cumulative regional haze analysis presented in Resource Report No. 9 Appendix D, which included a much larger offsite inventory than was really necessary.

Table 9 presents the regional haze modeling results for Tuxedni NWR and Denali NP. The modeled 98th percentile change in light extinction is less than the 10% threshold for both Class I areas indicating the project is not predicted to cause a regional haze visibility impairment.

Table 8: Project-Only Haze Impacts

Class I Area	Model Year	Number of Days with Extinction Above		Max Change in Extinction (%)	8th Highest Change in Extinction (%)	AQRV Threshold (%)
		5%	10%			
Tuxedni NWR	2002	3	2	13.6	4.3	5.0
	2003	10	2	14.3	**5.2**	5.0
	2004	8	1	10.2	**5.5**	5.0
Denali NP	2002	0	0	3.2	2.4	5.0
	2003	0	0	2.5	1.8	5.0
	2004	0	0	4.3	2.5	5.0

Table 9: Cumulative Regional Haze Modeling Results

Class I Area	Year	Number of Days with Extinction Above		Maximum Change in Extinction (%)	8th Highest Change in Extinction (%)	AQRV Threshold (%)
		5%	10%			
Tuxedni NWR	2002	30	5	20.1	8.7	10
	2003	29	6	22.5	9.0	10
	2004	33	7	14.9	9.9	10
Denali NP	2002	13	3	12.0	7.0	10
	2003	6	0	7.6	4.3	10
	2004	18	2	10.5	7.2	10

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