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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

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Alaska LNG
3201 C Street, Suite 200
Anchorage, Alaska 99503
T: 907-330-6300
www.alaska-lng.com

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:

<u>Tuxedni NWR Regional Haze Analysis</u>

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

<u>Denali NP Regional Haze Analysis</u>

- 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 (µg/m³)	Ambient Background Concentration (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	AAAQS (µg/m³)
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 (µg/m³)	Ambient Background Concentration (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	AAAQS (µg/m³)
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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