Public

Alaska LNG Liquefaction Plant Construction Permit Application

Project Information Form Attachment 3:

ADEC Modeling Protocol Approval Letter

and

Alaska LNG Response to Comments

March 2018

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THE STATE of ALASKA

GOVERNOR BILL WALKER

Department of Environmental Conservation

DIVISION OF AIR QUALITY
Air Permits Program

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January 17, 2018

Frank T. Richards, P.E.
Senior Vice President, Program Management
Alaska Gasline Development Corporation
3201 C Street, Suite 200
Anchorage, AK 99503

Subject: Approval of the October 2017 Modeling Protocol for the Alaska LNG Liquefaction Facility

Dear Mr. Richards,

The Alaska Department of Environmental Conservation (Department) is approving, with comment, the October 2017 modeling protocol submitted by the Alaska Gasline Development Corporation (AGDC) for the Alaska LNG Liquefaction Facility. The full set of comments are enclosed; the more substantive aspects of these comments are also summarized below.

AGDC's modeling protocol describes a generally acceptable approach for meeting the Prevention of Significant Deterioration (PSD) ambient demonstration requirements. However, the Department identified several aspects of the protocol that warrant additional information. AGDC may provide this information as part of their PSD permit application.

The more substantive comments are summarized as follows:

- The Department reviewed the Liquefaction Facility modeling protocol under the 2005 version of the U.S. Environmental Protection Agency's (EPA's) *Guideline on Air Quality Models* (Guideline), rather than the 2016 revision as referenced throughout the protocol. The Department used the 2005 version since that is the version currently adopted by reference in 18 AAC 50.040(f). The continued use of the 2005 version of the Guideline is also allowed by EPA for protocols approved by January 17, 2018.

- AGDC should address or provide the following in their application for a PSD permit:

    - A sensitivity analysis using the tall-tower meteorological data that AGDC collected at Nikiski to further support their proposed use of the 8-meter Kenai meteorological data; and

- A modeling analysis that includes construction emissions, or an adequate discussion as to why the normal operation scenario likely provides the worst-case ambient impacts.

The Department reviews modeling protocols on a case-specific basis for each project at a stationary source. The Department's approval only applies to the ambient demonstration that AGDC intends to submit in support of the PSD permit application for the Liquefaction Facility, as described in the October 2017 modeling protocol. The Department's findings regarding a previous modeling protocol that AGDC submitted regarding the Alaska LNG Gas Treatment Plant has been addressed in a December 13, 2017 response.

The Liquefaction Facility protocol did not explicitly state which pollutants would be subject to PSD review, but it implied that the following pollutants would likely be triggered: oxides of nitrogen (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter of 10 microns or less (PM-10), particulate matter with an aerodynamic diameter of 2.5 microns or less (PM-2.5), and ozone (O_3). The Department therefore reviewed the modeling protocol with the stated project and these pollutants in mind. Revised techniques may be warranted if there are substantive revisions to the Liquefaction Facility project description.

Questions regarding these comments should be directed to me by telephone at (907) 465-5324 or by e-mail at james.renovatio@alaska.gov

Sincerely,

James Julian Renovatio
Engineering Associate, ADEC

Enclosure: Department Comments Regarding AGDC's October 5, 2017 Modeling Protocol for the Alaska LNG Liquefaction Facility

cc: Jim Pfeiffer, AGDC (jpfeiffer@agdc.us)
Katie Blake, AGDC (KBlake@agdc.us)
Kalb Stevenson, AGDC (KStevenson@agdc.us)
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Jim Plosay, ADEC/APP Juneau
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Department of Environmental Conservation Comments Regarding AGDC's October 2017 Modeling Protocol for the Alaska LNG Liquefaction Facility

January 17, 2017

The Alaska Gasline Development Corporation's (AGDC's) October 2017 modeling protocol for the Alaska LNG Liquefaction Facility describes a generally acceptable approach for meeting the Prevention of Significant Deterioration (PSD) ambient demonstration requirements. However, the Alaska Department of Environmental Conservation (Department) found several aspects that warrant additional information. AGDC may provide this additional information as part of their PSD permit application for the Liquefaction Facility.

The Department understands that AGDC intends to predominately use the modeling analysis submitted to the Federal Energy Regulatory Commission (FERC) on April 17, 2017 for the modeling analysis that would be submitted with the PSD application.[1] The Department also understands that AGDC would revise/augment the analysis and supporting documentation, as needed, to meet the PSD requirements. The Department generally agrees that the two submittals should be consistent where possible. However, the Department also agrees that some variations are warranted due to the different requirements of these programs, along with the additional information and model updates that have occurred subsequent to the FERC submittal.

The following comments provide specific concurrence to major topics or request the additional information that AGDC should provide in their PSD permit application. The Department's comments follow the same outline as used in "Resource Report 9 Appendix D" of the protocol (i.e., the Liquefaction Facility modeling report provided to FERC). Any section not listed below indicates that the Department reviewed the section without comment, or the section contained background information that did not warrant comment. Topics that are discussed in multiple sections of the submittal are only addressed once.

1.0 Introduction

The Department reviewed the modeling protocol for the Liquefaction Facility using the 2005 version of the U.S. Environmental Protection Agency's (EPA's) *Guideline on Air Quality Models* (Guideline), as referenced by AGDC in this section, rather than the revised 2016 version, which is discussed in the comments provided in Attachment 2 of the modeling protocol. The Department used the 2005 version since that is the version currently adopted by reference under 18 AAC 50.040(f).[2] The continued use of the 2005 version of the Guideline is also allowed by EPA for protocols approved by January 17, 2018.[3]

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[1] AGDC submitted the modeling analysis to FERC in support of FERC licensing and National Environmental Policy Act (NEPA) requirements.

[2] 18 AAC 50.040(f) uses the phrase, "revised as of July 1, 2015." This date refers to the latest version of 40 CFR 51 available at the time the Department last updated this section of its regulations. However, the last update to the Guideline prior to this date occurred in November 2005.

[3] EPA's discussion regarding the allowed transition from the 2005 to the 2016 version of the Guideline may be found on page 5182 of the January 17, 2017 Federal Register (FR) notice, *Revisions to the Guideline on Air Quality Models:*

2.3 Air Quality Related Values

The modeling protocol indicates that AGDC's proposed approach to meet the PSD requirements for facilities with Class I impacts entails an evaluation of air quality related values (AQRV) in comport with the Federal Land Manager (FLM) FLAG 2010 guidance; this is an appropriate approach. The Department notes, however, that the FLM previously provided comment on the AGDC's AQRV analysis provided to FERC. Therefore, AGDC should address the FLM concerns in the analysis they submit to the Department in support of a PSD permit. See the following section for additional detail.

2.3.4 Class I and Sensitive Class II Areas for Air Quality Analysis

AGDC identified two Class I areas that may be impacted by the proposed Liquefaction Facility: the Tuxedni National Wildlife Refuge, approximately 80 kilometers distant, and Denali National Park and Preserve, approximately 180 kilometers distant. The Department must provide notice to the relevant FLM(s) regarding applicants' potential impacts to Class I areas in accordance with the PSD requirements under 40 C.F.R. 52.21(p). Consequently, the Department notified the U.S. Fish and Wildlife Service (FWS) and National Park Service (NPS), which are the relevant FLMs, of AGDC's potential impacts from the Liquefaction Facility. The NPS, in conjunction with the FWS, provided comment on AGDC's proposed approach to evaluate the potential Class I impacts on December 22, 2017.

The Department notes that AGDC indicates it provided further evaluation of impacts within areas designated as Class II 'sensitive' at the request of the FLM. Nevertheless, AGDC indicates, in the comments of Attachment 2 to their modeling protocol, that a Sensitive Class II analysis is not required of PSD applicants. The Department concurs with AGDC's position and, therefore, observes that there is no regulatory requirement to submit such an analysis as part of the PSD application.

3.0 Background Air Quality

The Department understands the referenced ambient air quality background data, presented in Table 3-1 of the modeling protocol, as that sourced from a 2015 to 2016 PSD monitoring effort in the proposed project area for:

- one-hour, three-hour, 24-hour, and annually-averaged sulfur dioxide (SO_2);
- one-hour and eight-hour carbon monoxide (CO);
- one-hour and annually-averaged nitrogen dioxide (NO_2);
- eight-hour ozone;
- 24-hour particulate matter with an aerodynamic diameter of less than 10 microns; and
- 24-hour and annually-averaged particulate matter with an aerodynamic diameter of less than 2.5 microns (PM-2.5).

Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches To Address Ozone and Fine Particulate Matter.

The Department finds these PSD-quality data are representative of the ambient background pollutant concentrations in the project area and as having been collected in accordance with the recommendations under Section 8.2 of the 2005 Guideline.

3.2 1-Hour NO_2 Background Development

AGDC's approach for developing the one-hour NO_2 background concentrations is both reasonable and consistent with EPA guidance.[4]

4.1 Project Emission Units

The Department anticipates that AGDC will provide additional modeled emission rate-related information for the project emissions units (EUs) with their PSD application. Such information may include, but is not limited to:

- EU-specific vendor or manufacturer emissions data, when available;
- analytical justification for the use of modeled emission rates predicated upon low load or controlled operational regimes;
- sensitivity analyses or other analytical justifications for novel modeling approaches, e.g. combined stacks;
- a factual basis for the selection and use of an atypical in-stack NO_2-to-NOx ratio; and/or
- the citation of policy or procedure germane to the use of arithmetic mean emission rates for equipment with functionally-limited operation, as warranted.

4.1.1 Modeled Scenarios

Assumptions that impact the modeled emission rates, e.g., those that limit the number of concurrently operated EUs or their annual hours of operation, will likely be incorporated as permit conditions to protect the modeled Alaska Ambient Air Quality Standard (AAAQS) and/or Maximum Allowable Increase, i.e. PSD increment. Therefore, the Department encourages AGDC to internally confirm that the modeling assumptions reflect viable operating scenarios and, if warranted, to revise their assumptions/modeled emission rates in the modeling analysis submitted with their application for a PSD permit. The details regarding any potential permit conditions will be developed during the Department's review of AGDC's application and are subject to public comment.

4.1.1.1 Normal Operations

The Department performed a cursory review of the EU parameters associated with AGDC's normal operations scenario. The emission rates and stack parameters, broached in Tables 4-3 through 4-4 and Appendix A of the modeling protocol, appear generally consistent with the type, size, and proposed use of units referenced. The Department, however, notes that it

[4] Memorandum from Tyler Fox, U.S. EPA Office of Air Quality Planning and Standards, to Regional Air Division Directors dated March 1, 2011: *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard.*

typically scrutinizes an applicant's as-modeled characterization of discrete EU emissions regimes and stack parameters for case-specific appropriateness during the application review. The Department may, therefore, have comments regarding the EU characterization after it reviews the permit application.

4.1.1.2 Normal Operations – Marine Vessels

AGDC may limit the consideration of marine vessels in their ambient demonstration to those emissions associated with hoteling and not those that arise from to-and-from activities. As a matter of general discussion, a source impact analysis, submitted in support of a PSD permit application, must observe secondary emissions in accordance with 40 C.F.R. 52.21(k)(1). The definition of 'secondary emissions' under 40 C.F.R. 52.21(b)(18) excludes those that "…*come directly from a mobile source*." As such, the itinerant emissions from marine vessels associated with to-and-from activities may not be considered secondary emissions, notwithstanding the January 17, 1984 findings from the U.S. Court of Appeals in *Natural Resources Defense Council v. U.S. EPA*. Therefore, the Department anticipates that only those emissions associated with stationary source-related marine activities, e.g. ship hoteling, will be considered in AGDC's ambient demonstration.

4.1.3 Construction Emissions

As broached in the section pertaining to marine vessel emissions, a source impact analysis, submitted in support of a PSD permit application, must observe secondary emissions in accordance with 40 C.F.R. 52.21(k)(1); these include non-mobile emissions associated with construction activities. AGDC will, therefore, need to include a separate modeled scenario for their construction emissions, or provide justification as to why the normal operations scenario represents the most conservative characterization of impacts to ambient air quality. If selecting the former approach, AGDC should model the construction emissions during the year of highest anticipated impacts to ambient air quality.

4.2 Offsite Sources

The Department finds AGDC's selection of near-field off-site sources appropriate for inclusion in their cumulative analysis; AGDC may wish to note that the Tesoro Corporation changed its name to Andeavor in 2017. The Department will review the assumed details of AGDC's modeled off-site inventory for representativeness of the underlying sources being included once it receives an application for a PSD permit that contains an ambient demonstration. Such a review will observe emissions characteristics such as the assumed emission rates and in-stack NO_2-to-NOx ratios, along with an evaluation of any changes to baseline or increment-consuming EUs.

5.1 Model Selection

AGDC's selection of the AERMOD model is appropriate for their near-field analysis of the proposed Liquefaction Facility. The Department notes, however, that AGDC intends to use of a version of this model, and select elements of its components, that have been superseded. Specifically, the use of AERMET version 15181, which has been superseded by version 16216, and AERMOD version 15181, which has been superseded by version 16216r at the time of this protocol approval.

The Department, upon a review of the pertinent model change bulletins, does not anticipate that using the current versions of the model will lead to increased impacts. Nevertheless, AGDC's proposal to perform a sensitivity analysis should offer an analytical basis to demonstrate that their analysis, using the proposed model, complies with the 'applicable air quality model' provision under 40 C.F.R. 52.21(l)(1), this obviating the need to perform an entirely new analysis. The Department offers the following caveats to the former position:

- The sensitivity analysis indicates that the maximum impacts may have been underestimated when using AERMET version 15181 and AERMOD version 15181;
- Substantive changes to the EU inventory, emissions, or stack parameters warrant an updated ambient demonstration; and/or
- Use of the 60 meter meteorological data, collected at Nikiski, leads to materially greater impacts than the ultimate-use eight meter meteorological data from Kenai, which was used in the FERC analysis.

The Department will require AGDC to use the current version of each AERMOD component in their ambient demonstration should any of the former conditions occur.

5.2 Model Options

The Department acknowledges AGDC's intent to employ common, albeit non-default AERMOD options, such as those used to characterize the emissions from capped or horizontal stacks. Based upon the information advanced in the subsequent discussion, AGDC may use the 'POINTHOR' and 'PONITCAP' beta options for characterizing horizontal and capped stacks as needed.

While the aforementioned options are EPA-approved techniques in the 2016 version of the Guideline, they are considered alternative modeling techniques under the 2005 version, as adopted by reference in 18 AAC 50.040(f). Therefore, for AGDC's ambient demonstration, their use requires case-specific approval in accordance with 18 AAC 50.215(c). Details of such an approval, both implicit and explicit, are as follows:

- 18 AAC 50.215(c)(1) requires a demonstration that the alternative approach is more appropriate than the preferred air quality model. EPA provided the required demonstration of the capped/horizontal stack options when they promulgated the 2016 version of the

Guideline. A summary of this demonstration may be found in the January 17, 2017 Federal Register; see 82 FR 5182.

- 18 AAC 50.215(c)(2) requires approval of an alternative modeling technique from both the EPA Region 10 Administrator and the Department's Commissioner. The Commissioner delegated the responsibility for approving alternative modeling methods to the Air Permits Program (APP) Manager on June 3, 2008. The APP Manager approved the use of the capped/horizontal stack algorithms for the Liquefaction Facility analysis on November 17, 2017; see Attachment A. EPA Region 10 approved their case-specific use on December 12, 2017; see Attachment B.

The Department notes that the use of an alternative modeling technique in a PSD analysis is subject to public comment in accordance with 40 CFR 52.21(l)(2), which is adopted by reference in 18 AAC 50.040(h)(10). Therefore, the Department will solicit comment regarding AGDC's use of the capped/horizontal stack options during the period of public comment for its preliminary permit decision on the proposed Liquefaction Facility.

5.3 Meteorological Data

AGDC will need to provide an AERMOD sensitivity analysis using the 60 meter meteorological data that they collected at Nikiski to support their use of the eight meter Kenai meteorological data for the ambient demonstration to be submitted with their application for a PSD permit. This analysis should compare the modeled design concentrations when using the Kenai data to the modeled design concentrations when using the Nikiski data. Areas of potential impact should be identified and accompanied by relevant discussion, such as the lack of 10 meter wind data from Nikiski. AGDC may limit the analysis to just the worst-case pollutants, rather than modeling all of the PSD-triggered pollutants, so long as they assesses an annual, a 24-hour, and a one-hour impact. The analysis should be conducted at the project impact level rather than the cumulative impact level.

AGDC's accompanying discussion should describe the Nikiski meteorological data, how it was processed, and how the AERMET surface parameters compare to the surface parameters used to process the Kenai meteorological data. The write-up should also include a table that compares the design concentrations, along with AGDC's conclusion as to whether the eight meter Kenai data adequately represents the plume transport conditions for the Liquefaction Facility EUs. The Department anticipates that AGDC will provide electronic copies of all AERMET and AERMOD modeling files used to conduct the sensitivity analysis as part of their ambient demonstration submission.

5.3.4 Use of Vertical Wind Speed Standard Deviation (sigma-w) Measurements

AGDC's proposal to treat the site-specific sigma-w values that are less than 0.1 meter per second (m/s) as missing is appropriate for the proposed Liquefaction Facility ambient demonstration. See the associated discussion in Section 2.6.4.1 of the *ADEC Modeling Review Procedures Manual* for relevant detail.

5.4 Receptors

The Department will require additional justification for AGDC's proposed use of a 152 meter (500 foot) maritime setback as an ambient air boundary. The specification of a maritime setback distance as an ambient air boundary is generally appropriate, though case-specific justification for a particular distance is warranted. For example, the use of a 100 meter setback is typical and appropriate for oil and gas platforms in Cook Inlet due to inherent tidal and safety reasons. Further guidance germane to the subject of establishing ambient air boundaries is available from EPA.

5.7 NO_2 Modeling Approach

AGDC may use the ambient ratio method (ARM2) for the proposed Liquefaction Facility ambient demonstration as subject to the following discussion. The ARM2 algorithm is a Tier 2 evaluation technique used to estimate the atmospheric conversion of NO to NO_2 from empirical data. It is a non-default option under the 2005 Guideline, unlike the 2016 revision, which is adopted by reference 18 AAC 50.040(f). As a non-default option, and alternative modeling technique, it requires approval from both EPA Region 10 and the Department Commissioner in accordance with 18 AAC 50.215(c)(2).

EPA Region 10 provided its case-specific approval in a December 12, 2017 letter; see Attachment B. The Department provided its case-specific approval by way of the Air Permits Program Manager, to whom the Commissioner delegated responsibility on June 3, 2008. The current Program Manager, Jim Plosay, also provided a case-specific approval for AGDC's use of ARM2 in a November 20, 2017 communication.

The Department notes, however, that the EPA's approval carried the caveat that the version of AERMOD proposed by AGDC was imbued with a lower 'default' NO to NO_2 ratio of 0.2 rather than the 0.5 employed by recent versions of AERMOD. Further, while EPA indicated that the ultimate approval of a particular ratio was placed with the Department, scrutiny of the lower value is warranted. Therefore, the Department anticipates that AGDC will provide them with a case-specific basis and justification for the use of the 0.2 ratio.

5.8 Shoreline Fumigation

As broached in the Introduction section, the Department understands that AGDC prepared an ambient demonstration for FERC in support of the Liquefaction Facility Construction Project stationary source; their use of the 1988 Shoreline Dispersion Model (SDM) was included as an element of this demonstration. The SDM is an analytical tool that can be used to estimate the ground-level fumigation impacts associated with emissions from tall on-shore sources, among other similar situations. AGDC's use of this tool would be typically be considered an alternative model under the 2005 Guideline, subject to both EPA approval and public comment. However, the Department, drawing upon the findings of a December 6. 2017 e-mail from EPA Region 10, is instead considering its application by AGDC a screening-level approach and not subject to consideration as an alternative modeling technique. Succinctly, the findings articulated in the aforementioned e-mail, provided in Attachment C, are predicated upon the 'highly conservative' nature of the SDM tool's case-specific application. Relevant detail are provided in this e-mail for further review and consideration of the reader.

6.0 Class I and Sensitive Class II Area Modeling Methodology

AGDC may use CALPUFF to estimate their Class I increment impacts, as proposed in Section 6.0 of Resource Report 9. CALPUFF is an acceptable model under the 2005 version of the Guideline for simulating long-range transport scenarios.

6.5 Visibility Modeling Approach

The Department intends to seek FLM comment regarding the adequacy of the Class I regional haze analysis. The Department understands that AGDC may revise their proposed approach based on the FLM comments received to date on the draft regional haze analysis they submitted to FERC.

7.1.1 Criteria Pollutant Project Only Impacts

The Department encourages AGDC to compare the maximum project impacts to the significant impact levels (SILs) listed in Table 5 of 18 AAC 50.215(d) as the first step in evaluating their impacts. AGDC would then only need to provide the assessments presented in Tables 7-1, 7-2, 7-3, and 7-4 of Appendix F for those pollutants and averaging periods that have maximum impacts that exceed the SIL. This approach would eliminate the need to obtain and justify off-site emissions/back-ground data for those pollutants and averaging periods where the maximum impacts are less than the SIL. While AGDC likely obtained correct information for the FERC analysis described in the modeling protocol, eliminating unnecessary assessments reduces the risk of inadvertent errors that could delay the permit process. See the following discussion for additional detail.

A project impact analysis provides a reasonable approach for demonstrating that the proposed project will not cause or contribute to a violation of a given AAAQS or Class II increment for those situations where the existing margin of compliance with the AAAQS/increment exceeds the SIL. AGDC's pre-construction data shows that the existing margin of compliance with the AAAQS is greater than the SILs. Therefore, demonstrating that a project impact is less than the SIL provides an adequate approach for demonstrating that the emissions will not cause or contribute to a violation of the associated AAAQS. Using this approach would likely eliminate the need for conducing cumulative impact analyses of at least the one-hour and 8-hour CO and annual SO_2 impacts.

Determining whether the existing margins of compliance with the Class II increments exceed the SILs requires a little more effort, but it would only need to be considered for a relatively small number of pollutants. There are no Class II increments for some pollutants and averaging periods. For the remaining pollutants and averaging periods, the question would only need to be addressed for those pollutants/averaging periods where the maximum impact is less than the SIL. As an illustrative example, British Petroleum Exploration Alaska previously demonstrated that there is a wide margin of compliance with the SO_2 increments in the ambient demonstration that they submitted in support of Construction Permits AQ0166CPT04 and AQ0270CPT04. AGDC could therefore drop the cumulative annual SO_2 increment analysis, if the maximum project impact remains below the SIL.

8.0 Assessment of Ozone and Secondary Particulate Impacts

The Department intends to review the ozone and secondary particulate impact analysis under the 2005 version of the Guideline, which is adopted by reference 18 AAC 50.040(f). It, therefore, encourages AGDC to reference and reiterate that the existing ambient ozone and PM-2.5 concentrations show that the AAAQS are not threatened. AGDC may also consider noting that the existing impact from secondary PM-2.5 formation is incorporated into the AAAQS demonstration through the use of local background data.

Other Comments

AGDC correctly noted in their protocol comments that they will need to address the following PSD ambient demonstration requirements that we not required by FERC:

- The Pre-application Air Quality Analysis, i.e., pre-construction monitoring data; and
- The Additional Impact Analysis.

<u>Pre-construction Monitoring</u>

The Department understands that AGDC has not yet completed its efforts to collect PSD-quality pre-construction monitoring data as an element of their application and associated ambient demonstration. These data are a required element under 40 C.F.R 52.21(m), which, if outstanding at the time of application, will preclude permit issuance until their collection, review, and approval. Contemporaneously, however, the Department has an obligation under AS 46.14.160 to review all applications for completeness and provide a written response should any deficiencies be identified. Therefore, the Department will provide AGDC with a letter of incompleteness within 60-days of receiving their application for a PSD permit that is predicated upon the former outstanding element. The reader may wish to note that this will not invalidate AGDC's application a priori, but only hold all Department efforts once general permit review and draft document preparation reach an impasse.

<u>Additional Impact Analysis</u>

The Department finds that AGDC proposed a reasonable approach to address the soil, vegetation, and associated growth requirements prescribed by 40 CFR 52.21(o). The

Department likewise accepts AGDC's proposed approach for conducting a VISCREEN analysis. AGDC's proposal to use 258 kilometers as the background visual range and 40 parts-per-billion as a background ozone concentration is consistent with the values used in past applications for the Cook Inlet area. The Department will, therefore, continue to accept these values for the proposed Liquefaction Facility VISCREEN analysis.

Attachment A – ADEC Request to Use Alternative Modeling Techniques for Liquefaction Facility

MEMORANDUM

State of Alaska

Department of Environmental Conservation
Division of Air Quality

TO: Jim Plosay, Manager
Air Permits Program

THRU: Aaron Simpson ASS
Permits Section Supervisor, Juneau

FROM: Alan E. Schuler, P.E. AES
Engineer, DEC

DATE: November 17, 2017

FILE NO: Alaska LNG Liquefaction Facility

PHONE: (623) 271-9028

SUBJECT: Request to use alternative modeling techniques for Liquefaction Facility

Please allow the Alaska Gasline Development Corporation (AGDC) to use the following alternative modeling techniques in the ambient demonstration that they will be submitting in support of a Prevention of Significant Deterioration (PSD) permit application for the Alaska LNG Liquefaction Facility:

- The Ambient Ratio Method 2 (ARM2) for estimating the ambient nitrogen dioxide (NO_2) impacts, and
- The capped/horizontal stack algorithms for characterizing capped and horizontal stacks.

The ambient demonstrations provided by applicants must generally comply with the U.S. Environmental Protection Agency's (EPA's) *Guideline on Air Quality Models* (Guideline), per 18 AAC 50.215(b). Non-Guideline techniques may still be approved on a case-specific basis, but only if they meet the requirements listed in AAC 50.215(c). The use of a non-guideline (alternative) modeling technique as part of a PSD application must also be subject to public comment per 40 CFR 52.21(l)(2), which the Department has adopted by reference in 18 AAC 50.040(h)(10).

The ARM2 and capped/horizontal stack algorithms are approved modeling techniques under the current 2016 version of the Guideline, but they are considered as alternative modeling techniques under the 2005 version of the Guideline adopted by reference in 18 AAC 50.040(f).[1] The algorithms therefore require case-specific approval under 18 AAC 50.215(c).

18 AAC 50.215(c)(1) requires a demonstration that the alternative approach is more appropriate than the preferred air quality model. EPA provided the required demonstration for the ARM2 and capped/horizontal stack algorithms when they promulgated the 2016 version of the Guideline. A summary of this demonstration may be found in the January 17, 2017 Federal Register (FR) notice of the Guideline revision (see 82 FR 5182).[2]

18 AAC 50.215(c)(2) requires approval from the EPA Region 10 (R10) Administrator and the Commissioner of alternative modeling techniques. The Commissioner delegated the responsibility

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[1] EPA finalized the current version of the Guideline in December 2016. The version adopted by reference in 18 AAC 50.040(f) is the prior version, which EPA finalized in October 2005.

[2] EPA has posted a courtesy copy of the January 2017 FR notice at: https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf

for approving alternative modeling methods to the Air Permits Program Manager on June 3, 2008. This memorandum provides a mechanism for obtaining your approval. I intend to seek R10 concurrence after obtaining your approval. I have discussed the pending request with the R10 regional modeler and do not anticipate any concerns since EPA has already adopted these techniques.

For the reasons described above, I ask that you allow AGDC to use the ARM2 and capped/horizontal stack algorithms in the AERMOD modeling analysis that they intend to submit with the PSD permit application for the Liquefaction Facility.

Approved:

James R. Plosay 11/20/17

Jim Plosay Date

Attachment B – EPA Region 10 Alternative Modeling Request for the Alaska LNG Project Liquefaction Facility Air Quality Impacts Analysis

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
AIR AND WASTE

DEC 12 2017

Mr. Alan Schuler, P.E.
Alaska Department of Environmental Conservation
Division of Air Quality
Air Permits Program
410 Willoughby Ave., Suite 303
Juneau, Alaska 99811-1800

Re: Alternative Modeling Request for the Alaska LNG Project Liquefaction Facility Air Quality Impacts Analysis

Dear Mr. Schuler:

The Alaska Department of Environmental Conservation (ADEC) has asked the U.S. Environmental Protection Agency (EPA) Region 10 to allow the use of two alternative dispersion modeling techniques for the Major New Source Review (NSR) permitting of a project in Alaska. The proposed Liquefaction Facility (LQF) of the Alaska LNG project (proposed by the Alaska Gasline Development Corporation, "AGDC") is proposed for construction on the eastern shore of Cook Inlet, in the Nikiski area of the Kenai Peninsula. ADEC is requesting alternative model approval for regulatory modeling techniques already approved under the January 2017 updates to the Guideline on Air Quality Models (40 CFR Part 51, Appendix W, hereafter referred to as "Appendix W"). The EPA understands Alaska adopts the provisions of Appendix W by reference in 18 AAC 50.0540(f), which specifically references the July 1, 2004 revision of Appendix W. I understand Alaska is in the process of updating these regulations, and a change that references the 2017 revision of Appendix W will likely be finalized sometime in 2018. Therefore, to comply with the provisions of the 2004 revision of Appendix W, ADEC is seeking alternative model approval for these two methods considered alternative models under the 2004 revision of Appendix W.

The EPA understand AGDC is proposing to use two modeling techniques in an AERMOD dispersion modeling analysis in support of the PSD application for the LQF:

1) The Ambient Ratio Method 2 (ARM2) Tier 2 NO_2 module, and
2) The capped/horizontal stack algorithms.

Both of these methods are accepted regulatory approaches under the current Appendix W and use of these models in the context and within the configurations specified in the current Appendix W is approved. Therefore, EPA Region 10 approval of the use of these models does not require a Section 3.2.2 alternative model acceptability determination, as defined in Appendix W. Therefore, it is not necessary to seek EPA's Model Clearinghouse concurrence with these approvals because these decisions are made outside the context of a Section 3.2.2 determination.

ARM2 TIER2 NO_2 MODEL

EPA Region 10 has reviewed the use of the ARM2 model for the LQF project, as proposed in the modeling protocol. Based on our review, it is evident the proposed methodology is in compliance with the current approved methodology specified for this model in the current Appendix W. However, ADEC must review and approve the use of an alternative lower ambient NO_2/NO_x ratio that is appropriate for the circumstances of this project, in accordance with the Section 4.2.3.4 requirements of the 2017 revision of Appendix W. Therefore, use of the model as proposed is approved with the understanding ADEC will review and approve the alternative ambient ratio in accordance with current guidance. Appendix W does not require consultation with the EPA Regional Office for use of Tier 2 NO_2 methods. If modeling is to be revised, we highly recommend the current regulatory version of AERMOD (16216r, at the time of this letter) be used.

The LQF modeling protocol[1] was developed based on the structure of AERMOD version 15181. The ARM2 model in AERMOD 16216r is a regulatory option for Tier 2 evaluation of NO_2, as specified in Section 4.2.3.4(d) of Appendix W. A non-regulatory beta version of the ARM2 model was built into AERMOD version 15181. No significant changes were made to the methodology or algorithms used in the ARM2 method in the AERMOD 16216r update, based on my review of the model code and model change documentation. However, the default lower ambient NO_2/NO_x ratio limit was originally set to 0.2 in the 15181 version of AERMOD. The approved regulatory version of ARM2 in AERMOD 16216r is configured with a minimum ambient NO_2/NO_x ratio of 0.5.

The lower ambient ratio of 0.2 was adopted by AGDC, as specified in the LQF modeling protocol. As specified in Appendix W Section 4.2.3.4(d), the reviewing agency may allow the use of alternative lower NO_2/NO_x ratio values if they are appropriate for a specific source. Alternative values should be based on representative source-specific data which satisfies quality assurance procedures. In the protocol, AGDC offers an argument justifying the use of the 0.2 ratio for the proposed LQF facility. Ultimately, ADEC must determine if this alternative lower ratio is appropriate for use for this project. A follow-up briefing with the EPA is not required as part of the alternative lower ratio approval.

CAPPED/HORIZONTAL STACK MODEL

EPA Region 10 has reviewed the use of the capped/horizontal stack algorithms proposed in the LQF project modeling protocol. Based on our review, it is evident the proposed methodology is in compliance with the current approved methodology specified in the current Appendix W. Therefore, use of the POINTCAP and POINTHOR options in either AERMOD version 15181 or 16216r (or future AERMOD updates, if applicable) for the LQF project is approved.

AERMOD versions 15181 and 16216r both contain options for capped and horizontal stack releases (by applying the POINTCAP and POINTHOR source types, respectively). In both model versions AERMOD adjusts plume characteristics to account for the suppressed vertical momentum of the plume and changes to stack-tip downwash. In cases where the plume interacts with a building wake, adjustments are made to initial plume radius for handling by the PRIME downwash model. No significant changes were made to the methodology or algorithms used for POINTCAP and POINTHOR sources in the AERMOD 16216r update, based on my review of the model code and model change

[1] Alaska Gasline Development Corporation (2016): Alaska LNG Liquefaction Facility Air Quality Modeling Report Supporting Resource Report No. 9, Revision 1, 11 Oct 2016.

documentation. These sources are no longer considered BETA options in AERMOD since they are now regulatory options, as specified in the preamble to the January 17, 2017 Appendix W revision (Fed. Register Vol. 82, No. 10, Page 5188).

If you have any questions regarding these approvals or the details discussed in this letter, please do not hesitate to contact us.

Sincerely,

Jay McAlpine, PhD
Regional Air Permit Modeler
EPA Region 10 Office of Air and Waste

cc: Dave Bray, EPA Region 10 Office of Air and Waste
James Renovatio, Alaska Department of Environmental Conservation
Aaron Simpson, Alaska Department of Environmental Conservation

Attachment C –EPA Region 10 Response to ADEC Request for Consideration of Shoreline Dispersion Model

Schuler, Alan E (DEC)

From: McAlpine, Jay <McAlpine.Jay@epa.gov>
Sent: Wednesday, December 06, 2017 8:54 AM
To: Schuler, Alan E (DEC); Bridgers, George
Cc: Bray, Dave
Subject: RE: Quick update on our status for Alaska LNG
Attachments: 2017-10-05_Modeling Protocol for the Alaska LNG Liquefaction Facility.PDF

Alan and George,

In our previous conversations we discussed the AGDC's proposal to evaluate shoreline fumigation effects on air quality from emissions from the proposed Alaska LNG Liquefaction facility on the Kenai peninsula. The modeling protocol (attached) for the PSD permitting of this facility contains a proposal to use the output of the Shoreline Dispersion Model (SDM) in addition to AERMOD to produce a conservative estimate of pollutant impacts. The main questions that arose from the conversation was: is an alternative model approval required for use of the SDM in the PSD AQIA for this project?

Alternative model approval is not required in some cases where a model is used in a conservative screening approach to provide the reviewing authority guidance on the need for a more sophisticated evaluation of air quality impacts. AERMOD is the required model for full evaluation of near-field project air quality impacts, but does not contain algorithms to predict the impacts of shoreline fumigation. Ideally, when shoreline fumigation is a concern, the fumigation approach in AERSCREEN could be used by the reviewing authority to guide decisions regarding the need for a full evaluation of fumigation impacts on air quality. Full evaluation using a model like SDM requires Section 3.2.2 alternative model approval because SDM is not an approved Appendix A regulatory model.

In this case, the applicant has proposed to use the SDM model to predict shoreline fumigation impacts from the project tall stacks in a screening approach. Cumulative modeling, using all proposed emission units, will be conducted first using AERMOD. The modeling protocol proposes to add SDM modeled maximum concentrations to the AERMOD modeled concentrations to estimate the impacts of the proposed source. This approach "double counts" impacts because the emissions from the tall stacks are included in both of the SDM and AERMOD modeling, and is therefore highly conservative. Also, if onshore atmospheric stability is characterized by "A" or "B" unstable conditions, AERMOD already accounts for the increased vertical dispersion seen in fumigation conditions and is therefore accounting for higher impacts nearer to the fenceline. It is EPA Region 10's preliminary conclusion this approach can be considered a highly conservative screening method to assess the need for a full cumulative evaluation of air impacts due to shoreline fumigation. We are recommending ADEC primarily evaluate the air quality impacts of the project using the results of the AERMOD modeling, and ADEC should consider the SDM results as a screening tool to evaluate the need for further evaluation of fumigation impacts. If SDM, or another fumigation model, is used to assess air impacts of the project directly then alternative model approval is required.

George, in our previous conversation I quickly summarized Region 10's recommendations and understanding of this issue. Could we confirm with Model Clearinghouse our interpretation and recommendations are appropriate in this case?

Thank you,
Jay

Jay McAlpine, PhD
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This document has been developed to address comments from the Alaska Department of Environmental Conservation (ADEC) regarding AGDC's October 2017 Modeling Protocol for the Alaska LNG Liquefaction Facility received on January 17, 2017. Comments are identified using the section numbers associated with them in the ADEC comment document. Prior to addressing the comments, AGDC would also like to use this document to address lead emissions from the Liquefaction Plant.

Liquefaction Plant Lead Emissions

The uncertainty associated with approaches to quantify lead emissions from project sources would be much larger than project lead emissions; therefore, lead emissions have not been quantified. The primary source of lead emissions from combustion sources results from lead additives contained in some fuels and subsequently emitted during combustion. Since lead is not an additive to any project fuels, lead will only be present at trace element levels as a result of engine lubricant constituents or as a result of engine wear and would not be noticeable relative to existing background concentrations. Currently, the only liquid fuel type containing a lead additive is leaded aviation gasoline used in piston-engine aircraft which are not part of the project inventory. Therefore, lead emissions from all Liquefaction Plant emission units are considered negligible, and project emissions will not cause or contribute to an exceedance of the lead National and Alaska Ambient Air Quality Standards.

In response to ADEC's March 6, 2018 "incompleteness letter" for the Project's Gas Treatment Plant (GTP), Table 9.2.6-3 of Resource Report 9 was revised to more accurately state lead emissions for both GTP and the Liquefaction Plant. That revised table is also provided below:

TABLE 9.2.6-3 Revised

PSD Applicability for the Liquefaction Facility and GTP – Operation

Pollutant	Liquefaction Facility Potential to Emit (tons per year)	LF PSD	GTP Potential to Emit (tons per year)	GTP PSD
Nitrogen Oxides (NO_X)	1,170	Yes	2,231	Yes
Carbon Monoxide (CO)	1,728	Yes	2,073	Yes
Volatile Organic Compounds (VOCs)	195	Yes	304	Yes
Particulate Matter (PM_{10})	259	Yes	263	Yes
Particulate Matter ($PM_{2.5}$)	259	Yes	263	Yes
Sulfur Dioxide (SO_2)	90	Yes	99[b]	Yes
Lead (Pb)	<0.6 ~~TBD~~	No ~~TBD~~	<0.6 ~~TBD~~	No ~~TBD~~
Total GHG Emissions (CO_2e)[a]	3,846,143	Yes	4,196,914	Yes

[a] GHG are reported in metric tons (tonnes) per year.

[b] Value based on 15 ppmv sulfur in the fuel gas which is representative of permitted long-term, normal operations. For a short-period of time during facility commissioning, the sulfur content of the fuel gas will be 90 ppmv sulfur in the fuel gas which is not expected to become an enforceable permit limit applicable to long-term, normal operations.

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Comment 2.3: Address FLM Concerns

Comment: The modeling protocol indicates that AGDC's proposed approach to meet the PSD requirements for facilities with Class I impacts entails an evaluation of air quality related values (AQRV) in comport with the Federal Land Manager (FLM) FLAG 2010 guidance; this is an appropriate approach. The Department notes, however, that the FLM previously provided comment on the AGDC's AQRV analysis provided to FERC. Therefore, AGDC should address the FLM concerns in the analysis they submit to the Department in support of a PSD permit. See the following section for additional detail.

Response: AGDC has reviewed concerns expressed by the U.S. National Park Service (NPS) on air quality analyses provided to the Federal Energy Regulatory Commission (FERC). Many of these concerns fall outside the scope of an analysis required for a PSD permit under 40 CFR 52.21(p). AGDC believes that the following are the only concerns relevant to the Liquefaction Plant Construction Permit Application that require additional information:

(1) Development of short-term emission rates for model analyses with AERMOD, VISCREEN, and CALPUFF, including emissions calculation spreadsheets and use of the U.S. Environmental Protection Agency's (USEPA's) intermittent source guidance from memorandum entitled *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Air Quality Standard* (March 11, 2011).

(2) Use of the National Emissions Inventory (NEI) 2011 versus NEI 2014 supporting the far-field cumulative analyses.

(3) Clarification on why the wet and dry flares would not be operated simultaneously and why the emergency and operational flares would not be operated simultaneously.

(4) Clarification on the difference between the sulfur content of pipeline natural gas used for emissions calculations for the Liquefaction Plant and pipeline specifications in Resource Report No. 13 for the Gas Treatment Plant (GTP).

(5) Subtraction methodology for the far-field analysis with CALPUFF.

(6) Selection of ammonia background concentrations for visibility analyses with CALPUFF.

(7) Exclusion of compressor stations from cumulative impact analyses.

(8) Speciation of particulate matter (PM) emission rates into elemental carbon (EC) and secondary organic aerosol (SOA) using AP-42.

Response (1): Additional information on short-term and long-term modeled emission rates for modeling supporting the Liquefaction Plant Construction Permit Application can be found in the spreadsheets entitled:

- "Emission Calculations for LNG rev7.xlsx"
- "AlaskaLNG Marine Emissions Inventory.xls"

- "LNG_Offsite Emissions and Stack Parameters.xlsx"

These spreadsheets are included electronically in the Liquefaction Plant Construction Permit Application within Attachment 7 modeling files, and are also available through FERC Docket Accession No. 20171101-5285. These spreadsheets include emissions data and other assumptions serving as the basis for modeled emissions and stack parameters used to support model analyses.

Regarding the use of USEPA's intermittent source guidance, while Appendix W does not provide guidance for a specific treatment of intermittent sources and indicates this should be done with caution, USEPA endorses special consideration of the treatment of such sources on a case-by-case basis using professional judgment by the applicant and reviewing authority. In preparing modeling analyses for the Liquefaction Plant, AGDC refined modeled emission rates for certain sources that fit the profile of the intermittent sources discussed in USEPA's intermittent source guidance memo and consistent with previous analyses conducted for Alaska projects. AGDC determined that the following modeled sources of emissions were consistent with the types of intermittent sources USEPA discusses in their guidance:

- Diesel-fired 224 kW auxiliary air compressor engine: provides backup air supply to the instrument air system in the event of a power failure or primary instrument air compressor failure. Equipment would operate less than 500 hours per year.
- Diesel-fired 429 kW firewater pump engine: located within the process facilities and distributes fire water around the facility in the event of an emergency. Equipment would operate less than 500 hours per year.
- Three sets of dry and wet flares (6 flares in total): located at the plant in the event of upset conditions when other daily operating equipment are shut down. These flares have a 3 x 50% design capacity. This means that during emergency flaring (maximum relief event), only two of the three flares would be operating at maximum capacity. The third set of flares is a spare. Emergency flaring is expected to be short in duration and much less than 500 hours per year, while pilot and purge gas would be combusted continuously.
- Elevated low-pressure (LP) flare: takes most gas streams from LNG storage, storage systems, and Boiloff gas compression system and supports marine operations. The LP flare would also take additional gas streams in the event of an upset by the thermal oxidizer. Similar to the dry and wet flares, maximum relief events to the LP flare are expected to be infrequent and much less than 500 hours per year, while a certain amount of pilot, purge, and other gas streams are combusted continuously.
- Maneuvering operations by LNG carriers and tugs: marine vessels supporting the LNG operations that are transient and only actively supporting loading of LNG at the plant intermittently. Tugs are utilized to assist in maneuvering the LNG carriers to dock and undock at the facility. While maneuvering operations were considered intermittent, other modes of marine vessel operation, including cool down, hoteling, loading, and purging lines, were considered with their maximum potential operations for applicable averaging periods according to the planned order of operations and expected number of calls per year. The modeled

emission rates for marine vessel operations are based on the worst-case emission rate for these modes of operation.

For these sources which do not operate continuously, AGDC completed analyses for the National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS), Prevention of Significant Deterioration (PSD) increments, and air-quality related values (AQRVs) with the short-term modeled emission rates described in Table 1.

Table 1: Basis for Short-Term Modeled Emission Rates for Sources that do not Operate Continuously

Model Analysis	Model	Description of Basis for Short-term Modeled Emission Rates
NAAQS/AAAQS	AERMOD (near-field) CALPUFF (far-field)	• 1-hour NO_2 and 1-hour SO_2 emission rates for the auxiliary air compressor, firewater pump, and dry and wet flares maximum relief events were based on 500 hours per year of operation, annualized. • 1-hour NO_2 and 1-hour SO_2 emission rates for the LP flare maximum relief events were based on 144 hours per year of operation, annualized. • 24-hour PM_{10}, 24-hour $PM_{2.5}$, 1-hour CO, 8-hour CO, 3-hour SO_2, and 24-hour SO_2 emission rates for the dry and wet flares maximum relief events were based on 0.5 hours per day. • 1-hour NO_2 and 1-hour SO_2 emission rates for maneuvering operations by LNG carriers and tugs were based on 204 calls per year lasting 1 hour each (204 hours per year of operation), annualized. (All modeled short-term emission rates for marine vessel operations based on worst-case of the maneuvering, cool down, hoteling, loading, and/or purging lines modes of operation according to the planned order of LNG loading operations.)
PSD Increments	AERMOD (near-field) CALPUFF (far-field)	• 24-hour PM_{10}, 24-hour $PM_{2.5}$, 3-hour SO_2, and 24-hour SO_2 emission rates for the dry and wet flares maximum relief events were based on 0.5 hours per day. • All modeled short-term emission rates for marine vessel operations based on worst-case of the maneuvering, cool down, hoteling, loading, and/or purging lines modes of operation according to the planned order of LNG loading operations.
AQRVs – Visibility/Plume Blight	VISCREEN (near-field)	• All short-term emission rates for the dry and wet flares and LP flare maximum relief events were based on 0.5 hours per day (or per applicable averaging period). • All short-term emission rates for marine vessel operations based on worst-case maneuvering, cool down, hoteling, loading, and/or purging lines modes of operation according to the planned order of LNG loading operations.
AQRVs – Deposition	CALPUFF (far-field)	• Not Applicable: Deposition modeling only involves annual averaging periods.
AQRVs – Regional Haze	CALPUFF (far-field)	• All short-term emission rates for the dry flares and LP flare maximum relief events were based on 0.5 hours per day. • All short-term emission rates for marine vessel operations based on worst-case maneuvering, cool down, hoteling, loading, and/or purging lines modes of operation according to the planned order of LNG loading operations.

All other modeled sources of emissions operate continuously and were modeled at a maximum hourly emission rate continuously. The spreadsheets referenced in Response (1) detail the calculation of these modeled emission rates.

Response (2): For far-field analyses, AGDC prepared an offsite emissions inventory supporting analyses for the Liquefaction Plant using the current National Emissions Inventory (NEI) at the time of the analysis (NEI 2011). Subsequent to that initial analysis, the NEI 2014 was released. To take into account updates to offsite sources, AGDC revisited its offsite source inventory in November 2017 with information available from ADEC's Point Source Inventory (available at http://dec.alaska.gov/Applications/Air/airtoolsweb/PointSourceEmissionInventory) and information publicly available from recently issued ADEC permits for minor or major stationary sources. Note that information derived for ADEC's Point Source Inventory only included data through 2016 at the time of the revised analysis. The offsite source emissions inventory was updated from the NEI 2011 in cases where there were substantial changes, such as new sources or operational changes at existing sources that were not characterized in the NEI 2011. Updates to the offsite inventory are summarized with the analyses for the Federal Class I Areas – Additional Requirements provided as Attachment 11 in the Liquefaction Plant Construction Permit Application.

Response (3): As discussed in Resource Report No. 13, vent and relief streams that could potentially contain a significant concentration of water (e.g., relief valves from the dehydration beds and relief/blowdown/vent streams from the regeneration section of the Dehydration Unit) or significant concentration of heavy hydrocarbons (e.g. relief/vent streams from the Debutanizer Column) that would freeze at cryogenic temperatures would be routed to the wet flare. Blowdown streams from the dehydration beds and other gas streams from the Inlet Facilities, liquefaction processing trains, Fractionation Unit, and Refrigerant Storage area would be routed to the dry flare.

These wet and dry flare systems are independent and serve different parts of the plant. Therefore, if equipment or other failure results in emergency upset conditions, process streams would be routed to either the wet or dry flare system, depending on the location of the failure. The occurrence of separate and unrelated failures resulting in simultaneous relief events by both the wet and dry flare systems associated with each processing train is remote. In addition, a failure resulting in flaring by either the wet or dry flaring systems would likely result in shutdown or very limited operation by the other part of the plant, which also makes simultaneous wet and dry flare maximum relief events improbable.

At the direction of project engineers, for air quality analyses supporting the Liquefaction Plant Construction Permit Application, emergency flaring (maximum relief) events were characterized in modeling analyses as occurring for 0.5 hours per day because these types of events are expected to be short in duration and infrequent. Simultaneous maximum relief events for both the wet and dry flares were conservatively included in all near-field air quality modeling demonstrations with AERMOD and visibility analyses with VISCREEN. Maximum relief events for the dry flares only were simulated for far-field deposition and regional haze analyses with CALPUFF because simultaneous events are so unlikely to occur. Dry flare maximum relief events were selected over wet flare maximum relief events because the dry flare had greater estimated modeled emission rates.

To clarify what appears to be a misconception, the Liquefaction Plant does not have separate operational and emergency flaring systems. All flares (wet and dry flares and LP flare) are designed for the destruction of process streams from venting, blowdown, or other designed maintenance activities if applicable, as well as emergency upset conditions. Furthermore, AGDC characterized emissions from these flaring systems with continuous pilot, purge, and assist gas combustion in addition to maximum relief events in all model analyses.

Response (4): Resource Report No. 13, which includes engineering and design material, indicates that feed gas to the Liquefaction Plant is pretreated at the GTP to contain less than 3 parts per million by volume (ppmv) hydrogen sulfide (H_2S). This is a nominal design specification for the output from GTP based on engineering calculations but may not represent maximum possible H_2S (or total sulfur) concentrations or fluctuations over time. Furthermore, it is not AGDC's desire to acquire restrictive permit limits and monitoring requirements based on a nominal fuel gas H_2S concentration. Therefore, for Liquefaction Plant air quality modeling analyses, modeled emission rates are based on more conservative potential-to-emit (PTE) considerations assuming natural gas with a H_2S content of 16 ppmv. This is based on the definition of pipeline quality natural gas with additional margin for other reduced sulfur compounds (e.g., carbonyl sulfide, mercaptans, etc.) that may be in the gas.

Response (5): Given the concerns expressed by FLMs on the subtraction methodology for determining project-only far-field haze impacts with CALPUFF, AGDC revised this approach to be consistent with FLM expectations when conducting analyses to support the Federal Class I Areas – Additional Requirements provided as Attachment 11 in the Liquefaction Plant Construction Permit Application.

Response (6): This response is lengthy and has been included as Attachment A to this document.

Response (7): AGDC does not plan to include compressor and heater stations associated with the pipeline as part of cumulative impact analyses for the Liquefaction Plant Construction Permit Application because emissions from these sources are not large enough to significantly contribute to maximum impacts in the Liquefaction Plant impact area nor are impacts from these sources likely to be collocated in space and time with those from the Liquefaction Plant are near and far-field locations. That aside, given lack of specific information required for accurately assessing impacts and issues related to increment consumption it is longstanding practice and guidance articulated in USEPA's *New Source Review Workshop Manual* ("The Puzzle Book," Draft October 1990), that it is "necessary to include in the NAAQS inventory those sources which have received PSD permits but have not yet begun to operate, as well as any complete PSD applications for which a permit has not yet been issued." Therefore, reasonably foreseeable developments that have not started the construction permitting process, such as the compressor and heater stations associated with the pipeline, are not included in cumulative impact analyses.

AGDC did consider if these facilities need to be addressed as part of additional impacts analyses for the Liquefaction Plant Construction Permit Application and concluded they do not. This is because of their distance from the Liquefaction Plant impact area and because these facilities must also apply for and obtain minor source permits, which would require separate review and approval by ADEC.

Response (8): To develop EC and SOA emission rates for AQRV analyses, AGDC used the ratios of AP-42 emission factors for filterable PM (EC) and condensable PM (SOA) to total PM for each type of equipment to speciate PM emission rates. These calculations and references for each type of equipment are provided in the "Emission Calculations for LNG rev7.xlsx" described in response 1 above.

Comment 4.1: Provide Justification for Emission Rates and Stack Parameters Modeled

Comment: *The Department anticipates that AGDC will provide additional modeled emission rate-related information for the project emissions units (EUs) with their PSD application. Such information may include, but is not limited to:*

- *EU-specific vendor or manufacturer emissions data, when available;*
- *analytical justification for the use of modeled emission rates predicated upon low load or controlled operational regimes;*
- *sensitivity analyses or other analytical justifications for novel modeling approaches, e.g. combined stacks;*
- *a factual basis for the selection and use of an atypical in-stack NO2-to-NOx ratio; and/or*
- *the citation of policy or procedure germane to the use of arithmetic mean emission rates for equipment with functionally-limited operation, as warranted.*

Response: Additional modeled emission rate-related information for the Liquefaction Plant emission units (EUs) can be found in the spreadsheets entitled:

- "Emission Calculations for LNG rev7.xlsx"
- "AlaskaLNG Marine Emissions Inventory.xls"
- "LNG_Offsite Emissions and Stack Parameters.xlsx"

These spreadsheets are available as described in comment 2.3, Response 1 above. A similar set of spreadsheets is also available for the GTP emissions calculations. These spreadsheets include emissions data and other assumptions serving as the basis for modeled emissions and stack parameters used in the modeling supporting the Liquefaction Plant Construction Permit Application.

Regarding the selection of in-stack NO_2-to-NOx ratios (ISRs), note that ISRs of 0.5 are listed for all Liquefaction Plant emission units in the "Emission Calculations for LNG rev7.xlsx" spreadsheet. However, for air quality modeling conducted with AERMOD, analyses were conducted with the Ambient Ratio Method 2 (ARM2) with upper and lower ambient ratios of 0.9 and 0.2, respectively, that were default values in AERMOD version 15181 which was used for the project air quality impact analyses. Subsequent updates to AERMOD incorporated in version 16216r now include a higher default lower ambient ratio of 0.5. As part of the Liquefaction Plant Construction Permit Application, AGDC is providing an AERMOD model version sensitivity analysis (Attachment 8) that describes and justifies a lower ambient ratio of 0.3 through a review of representative ISRs for Liquefaction Plant emission units. Refer to that document for emission unit-specific ISR justifications.

Comment 4.1.3: Construction Phase Air Emissions Demonstration

Comment: *As broached in the section pertaining to marine vessel emissions, a source impact analysis, submitted in support of a PSD permit application, must observe secondary emissions in accordance with 40 C.F.R. 52.21(k)(1); these include non-mobile emissions associated with construction activities. AGDC will, therefore, need to include a separate modeled scenario for their construction emissions, or provide justification as to why the normal operations scenario represents the most conservative characterization of impacts to ambient air quality. If selecting the former approach, AGDC should model the construction emissions during the year of highest anticipated impacts to ambient air quality.*

Response: This response is lengthy and has been included as Attachment B to this document.

Comment 5.1: Sensitivity to AERMOD Versions

Comment: *The Department, upon a review of the pertinent model change bulletins, does not anticipate that using the current versions of the model will lead to increased impacts. Nevertheless, AGDC's proposal to perform a sensitivity analysis should offer an analytical basis to demonstrate that their analysis, using the proposed model, complies with the 'applicable air quality model' provision under 40 C.F.R. 52.21(l)(1), this obviating the need to perform an entirely new analysis. The Department offers the following caveats to the former position:*

- *The sensitivity analysis indicates that the maximum impacts may have been underestimated when using AERMET version 15181 and AERMOD version 15181;*
- *Substantive changes to the EU inventory, emissions, or stack parameters warrant an updated ambient demonstration; and/or*
- *Use of the 60 meter meteorological data, collected at Nikiski, leads to materially greater impacts than the ultimate-use eight meter meteorological data from Kenai, which was used in the FERC analysis.*

The Department will require AGDC to use the current version of each AERMOD component in their ambient demonstration should any of the former conditions occur.

Response: AGDC is including an AERMOD version sensitivity analysis with the most recent version of AERMOD (version 16216r) and AERMET (version 16216) in Attachment 8 of the Liquefaction Plant Construction Permit Application.

Comment 5.3: 60-meter Tower Sensitivity Analysis

Comment: *AGDC will need to provide an AERMOD sensitivity analysis using the 60 meter meteorological data that they collected at Nikiski to support their use of the eight meter Kenai meteorological data for the ambient demonstration to be submitted with their application for a PSD permit. This analysis should compare the modeled design concentrations when using the Kenai data to the modeled design concentrations when using the Nikiski data. Areas of potential impact should be identified and accompanied by relevant discussion, such as the lack of 10 meter wind data from Nikiski. AGDC may limit the analysis to just the worst-case pollutants, rather than modeling all of the PSD-triggered pollutants, so long as they assess an annual, a 24-hour, and a one-hour impact. The analysis should be conducted at the project impact level rather than the cumulative impact level.*

AGDC's accompanying discussion should describe the Nikiski meteorological data, how it was processed, and how the AERMET surface parameters compare to the surface parameters used to process the Kenai meteorological data. The write-up should also include a table that compares the design concentrations, along with AGDC's conclusion as to whether the eight meter Kenai data adequately represents the plume transport conditions for the Liquefaction Facility EUs. The Department anticipates that AGDC will provide electronic copies of all AERMET and AERMOD modeling files used to conduct the sensitivity analysis as part of their ambient demonstration submission.

Response: This response is lengthy and has been included as Attachment C to this document.

Comment 5.4: Ship Ambient Boundary Justification

Comment: *The Department will require additional justification for AGDC's proposed use of a 152 meter (500 foot) maritime setback as an ambient air boundary. The specification of a maritime setback distance as an ambient air boundary is generally appropriate, though case specific justification for a particular distance is warranted. For example, the use of a 100 meter setback is typical and appropriate for oil and gas platforms in Cook Inlet due to inherent tidal and safety reasons. Further guidance germane to the subject of establishing ambient air boundaries is available from EPA.*

Response: This response is lengthy and has been included as Attachment D to this document.

Comment 5.7: Justification for ARM2 Default Lower Ambient Ratio

Comment: *The Department notes, however, that the EPA's approval carried the caveat that the version of AERMOD proposed by AGDC was imbued with a lower 'default' NO to NO2 ratio of 0.2 rather than the 0.5 employed by recent versions of AERMOD. Further, while EPA indicated that the ultimate approval of a particular ratio was placed with the Department, scrutiny of the lower value is warranted. Therefore, the Department anticipates that AGDC will provide them with a case-specific basis and justification for the use of the 0.2 ratio.*

Response: An AERMOD version sensitivity analysis is included in the Liquefaction Plant Construction Permit Application as Attachment 8. This analysis includes a review of typical equipment-specific in-stack NO_2-to-NO_x ratios in addition to an AERMOD sensitivity analysis that assesses the influence of changing the ARM2 default lower ambient ratio on project impacts.

Comment 7.1.1: SIL Analysis

Comment: *The Department encourages AGDC to compare the maximum project impacts to the significant impact levels (SILs) listed in Table 5 of 18 AAC 50.215(d) as the first step in evaluating their impacts. AGDC would then only need to provide the assessments presented in Tables 7-1, 7-2, 7-3, and 7-4 of Appendix F for those pollutants and averaging periods that have maximum impacts that exceed the SIL. This approach would eliminate the need to obtain and justify off-site emissions/back-ground data for those pollutants and averaging periods where the maximum impacts are less than the SIL. While AGDC likely obtained correct information for the FERC analysis described in the modeling protocol, eliminating unnecessary assessments reduces the risk of inadvertent errors that could delay the permit process. See the following discussion for additional detail.*

Response: AGDC has provided ADEC project-only and cumulative air quality impact analyses in Tables 7-1, 7-2, 7-3, and 7-4 of Appendix D for the Liquefaction Plant. AGDC recognizes that a cumulative analysis is only required for those pollutants and averaging periods that have maximum impacts that exceed Class II Significant Impact Levels (SILs), as listed in 40 CFR 51.165(b)(2) and 18 AAC 50.215(d). Table 2 below demonstrates that the Liquefaction Plant impacts are below the SILs for annual SO_2 and annual PM_{10}. Therefore, compliance with the NAAQS/AAAQS and PSD Class II Increments is demonstrated for these pollutants and averaging periods, and a cumulative air quality analysis is not required as part of the Construction Permit Application. As such, AGDC requests that ADEC exclude these pollutants and averaging periods from their review of the cumulative air quality assessments for the Construction Permit Application.

Table 2: Project Only Impacts from FERC Analysis Compared to Class II Significant Impact Levels (SILs)

Air Pollutant	Averaging Period	AERMOD-Predicted Concentration (µg/m³) [a]	Class II Significant Impact Level (µg/m³)
Sulfur Dioxide (SO_2)	1-Hour	**62.8**	7.9
	3-Hour	**45.3**	25
	24-Hour	**19.0**	5
	Annual	0.11	1
Carbon Monoxide (CO)	1-Hour	**2,953**	2,000
	8-Hour	**1,132**	500
Nitrogen Dioxide (NO_2)	1-Hour	**142.2**	7.5
	Annual	**8.4**	1
Particulate Matter less than 10 Microns (PM_{10})	24-Hour	**6.0**	5
	Annual	0.43	1
Particulate Matter less than 2.5 Microns ($PM_{2.5}$)	24-Hour	**5.3**	1.2
	Annual	**0.43**	0.2

µg/m³ = micrograms per cubic meter

Notes:

[a] Value reported is the maximum concentration for the 5-year period.

Comment 8: O_3 and $PM_{2.5}$ Assessment

Comment: *The Department intends to review the ozone and secondary particulate impact analysis under the 2005 version of the Guideline, which is adopted by reference 18 AAC 50.040(f). It, therefore, encourages AGDC to reference and reiterate that the existing ambient ozone and PM-2.5 concentrations show that the AAAQS are not threatened. AGDC may also consider noting that the existing impact from secondary PM-2.5 formation is incorporated into the AAAQS demonstration through the use of local background data.*

Response: To aid in evaluation of project ozone (O_3) and secondary fine particulate matter ($PM_{2.5}$) impacts, a review of existing ambient O_3 and $PM_{2.5}$ measurements is presented in Table 3. Table 3 summarizes publicly available data collected regionally and summarized by the State of Alaska. These summaries indicate that there are no exceedances of the NAAQS/AAAQS for either O_3 or $PM_{2.5}$. Ozone values shown are all below the standards and consistent with global background values for similar latitudes even with the presence of large regional sources of precursor emissions indicating that any existing or potential impact to O_3 are likely to be minimal and not lead to any exceedances of the NAAQS/AAAQS. $PM_{2.5}$ design value measurements are generally half the NAAQS/AAAQS. Regionally elevated $PM_{2.5}$ measurements have been attributed organic and elemental carbon from fireplace, woodstove, and motor vehicle emissions with no mention of significant contributions from large regional point sources (Air Quality Program, Public Health Division, Department of Health and Human Services, Municipality of Anchorage *Air Quality in Anchorage A Summary of Air Monitoring Data and Trends 1980 – 2010* [October 2011]). Consistent with this, $PM_{2.5}$ concentrations are typically highest during the mid-winter months and median concentrations during this period are about twice those experienced during the summer. Spring and summer concentrations are normally very low except when locations are affected by wild fire smoke. Regardless of culpability, the existing impact from secondary $PM_{2.5}$ formation is incorporated into the cumulative impact analysis through the use of local background data. In conclusion, the existing ambient data indicates that the NAAQS/AAAQS are not threatened even with the current level of emissions in the Upper Cook Inlet.

Table 3: Summary of Recent Ambient Pollutant Concentrations Measured by Upper Cook Inlet Monitoring Programs

Company/ Agency	Location/ Name/ID	Monitoring Period	Pollutant/ Averaging Period/ Rank					
			O_3 (ppm)		$PM_{2.5}$ (μg/m^3)			
			8-hour		24-hour			Annual
			1st High	4th High	1st High	2nd High	98th %tile	Average
Alaska Ambient Air Quality Standard			**--**	***0.070***	**--**	**--**	***35***	***12***
Chevron [a]	Trading Bay	2008-2009	--		--			--
	Swanson River	2008-2009	--		--			--
Agrium [a]	Nikiski	2013-2014	0.061	0.051	71[b]		8.0	3.6
AK LNG [a]	Nikiski	2015	0.050	0.047	24	18	12	3.7
ADEC [c]	Anchorage Garden (02-20-0018)	2016	--	--	30.7	28.7	16.1	6.4
	Anchorage Parkgate (02-20-1004)	2016	--	--	21.9	15.8	13.8	4.8
	Butte (02-170-0008)	2016	--	--	44.1	40.9	29.2	5.7
	Palmer (02-170-00012)	2016	0.045	0.044	16.2	13.4	19.2	2.8

[a] Based on data reviewed by the State of Alaska (http://dec.alaska.gov/air/ap/docs/IndustrialDataSummary080717.xlsx).

[b] The highest $PM_{2.5}$ concentration measured is attributed to smoke emissions from the Funny River wildland fire.

[c] ADEC-operated monitors that report to USEPA-AQS (https://aqs.epa.gov/aqsweb/airdata/download_files.html#Annual).

Comment 8.1: Pre-Construction Monitoring

Comment: *The Department understands that AGDC has not yet completed its efforts to collect PSD quality pre-construction monitoring data as an element of their application and associated ambient demonstration. These data are a required element under 40 C.F.R 52.21(m), which, if outstanding at the time of application, will preclude permit issuance until their collection, review, and approval. Contemporaneously, however, the Department has an obligation under AS 46.14.160 to review all applications for completeness and provide a written response should any deficiencies be identified. Therefore, the Department will provide AGDC with a letter of incompleteness within 60-days of receiving their application for a PSD permit that is predicated upon the former outstanding element. The reader may wish to note that this will not invalidate AGDC's application a priori, but only hold all Department efforts once general permit review and draft document preparation reach an impasse.*

Response: A description of 52.21(m) pre-construction monitoring requirements applicable to the Liquefaction Plant is included as Attachment 9 of the Construction Permit Application. Available pre-construction monitoring data for NO_x and particulate matter are included in Attachment 7 electronic modeling files.

Comment 8.2: Additional Impacts Analysis

Comment: *The Department finds that AGDC proposed a reasonable approach to address the soil, vegetation, and associated growth requirements prescribed by 40 CFR 52.21(o). The Department likewise accepts AGDC's proposed approach for conducting a VISCREEN analysis. AGDC's proposal to use 258 kilometers as the background visual range and 40 parts-per-billion as a background ozone concentration is consistent with the values used in past applications for the Cook Inlet area. The Department will, therefore, continue to accept these values for the proposed Liquefaction Facility VISCREEN analysis.*

Response: AGDC is including the additional impacts analysis required under 40 CFR 52.21(o) in Attachment 10 of the Liquefaction Plant Construction Permit Application.

Attachment A

Liquefaction Plant

Addressing Background Ammonia and Ammonia Sources

The ammonia data input to CALPUFF has a direct effect on the amount of visibility degradation predicted by the model. Typically, a smaller ammonia background concentration results in less secondary particle formation from a modeled source's SO_2 and NO_x emissions and would produce less visibility degradation at modeled areas. The Western Regional Air Partnership (WRAP)[1] and USEPA (in its Best Achievable Retrofit Technology (BART) rule[2]) have acknowledged the limitations of CALPUFF chemistry for predicting wintertime nitrates. This is especially true for the very cold Alaskan winters, in which the temperatures are often well below the 50ºF (or higher) that the CALPUFF MESOPUFF-II chemistry is based upon. The independent evaluations[3] of just nitrate formation show an over-prediction factor ranging from 2 to 4 for just this issue unless very low ammonia background concentrations are input to CALPUFF. This nitrate over prediction is a particular issue for characterizing Alaska LNG Liquefaction Plant visibility impacts at Class I areas given Plant emissions are dominated by NO_x with comparatively inconsequential SO_2 emissions as will be discussed further in this document.

Typically, a smaller ammonia concentration results in less secondary particle formation from a modeled source's SO_2 and NO_x emissions and would produce less visibility degradation at Class I areas. To determine the appropriate ammonia concentration for input to CALPUFF, a review of available guidance and literature was conducted. The Federal Land Managers' Air Quality Related Values Work Group document[4] suggests using 10 ppbv for grassland, 0.5 ppbv for forests, and 1 ppbv for arid lands, unless better data is available for a specific modeling domain. The "CALMET/CALPUFF Modeling Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States"[5] recommends a much smaller background ammonia value of 0.1 ppbv for Alaska. This recommendation was used for the WRAP Regional Modeling Center (RMC) BART modeling for sources Alaska as well as for the BART determination modeling for Golden Valley Electric Association (GVEA) Healey Plant[6] located in Central Alaska.

Table A1 summarizes the findings of the literature review, noting measured and modeled ammonia concentrations in Alaska. Although the values listed represent many different assumptions (models, resolution, time frame and averaging period) they all indicate a generally low and seasonal ammonia background values in Alaska. In particular, recent ammonia measurements collected at Gates of the Arctic National Park from May-October in 2015 ranged from 0.20 to 1.41 ppbv with a seasonal average was 0.46 ppbv.

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[1] See slide # 9 at http://www.wrapair.org/forums/ssjf/meetings/050907/WRAP_Regional_Modeling_SSJF2.pdf.

[2] Federal Register, July 6, 2005, Volume 70, pages 39121 and 39123.

[3] See Figure 1 and Figure 2 http://mycommittees.api.org/rasa/amp/CALPUFF%20Projects%20and%20Studies/CALPUFF%20Evaluation%20with%20SWWYTAF,%202009,%20Kharamchandani%20et%20al.pdf

[4] United States Department of the Interior (USDOI). Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report – Revised. Natural Resource Report NPS/NRPC/NRR – 2010/232. October 2010.

[5] Western Regional Air Partnership Air Quality Forum Regional Modeling Center (WRAP). CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States. August 15, 2006.

[6] See pg. 30 https://dec.alaska.gov/air/ap/docs/GVEA%20BART%20Final%20Determination%20Report%202-5-10.pdf

Table A1: Summary of Ambient Ammonia Levels Literature Review

Source of Estimate	Ammonia NH_3 (ppb)	Description	Location	Year(s)
Adams et al. (1999) Plate 3[a]	0.003-0.01	Modeled annual average	North Slope, Alaska	1990s
Osada et al. (2011)[b]	<0.224	Suggested conclusion from marine modeling studies	"Remote" Marine Regions	2000s
Dentener and Crutzen (1994) Figure 2a and Fig. 3a[c]	0.06-0.1	Modeled annual average	North Slope, Alaska	1980/ 1990s
Schirokauer et al. (2014) Table 3 and Figure 12[d]	0-5 in May-August, 3-14 during May-October, average 5	Measured NH_3 at 7 sites during May-October focusing on Sitka since it was less influenced by local sources	Southeast Alaska	2008-2009
Shepard et al. (2011) Figure 2[e]	0.0-1.25	Modeled monthly average for most months	North Slope, Alaska	2000s
Xu and Penner (2012) Fig. 2 and Fig. 5[f]	0.001-0.01	Modeled annual average	North Slope, Alaska	1990/ 2000s
National Atmospheric Deposition Program, Ambient Ammonia Monitoring Network (NDAP. AMoN 2018)[g]	0.20-1.41 during May-October, average 0.46	Measured NH_3 at Gates of the Arctic National Park - Bettles during May-October	Interior, Alaska	2015

a Adams, P.J., J.H. Seinfeld, and D.M. Koch. 1999. Global concentrations of tropospheric sulfate, nitrate, and ammonium aerosol simulated in a general circulation model. Journal of Geophysical Research, 104, D11, 13,791-13,823.

b Osada, K., S. Ueda, T. Egashira, A. Takami, and N. Kaneyasu. 2011. Measurements of Gaseous NH3 and Particulate NH4+ in the Atmosphere by Fluorescent Detection after Continuous Air-water Droplet Sampling. Aerosol and Air Quality Research, 11, 170-179, doi:10.4209/aaqr.2010.11.0101.

c Dentener, F.J. and P.J. Crutzen. 1994. A Three-Dimension Model of the Global Ammonia Cycle. Journal of Atmospheric Chemistry, 19, 331-369.

d Schirokauer, D., L. Geiser, A. Bytnerowicz, M. Fenn, and K. Dillman. 2014. Monitoring air quality in Southeast Alaska's National Parks and Forests: Linking atmospheric pollutants with ecological effects. Natural Resource Technical Report NPS/SEAN/NRTR—2014/839. National Park Service, Fort Collins, Colorado

e Shephard, M.W., K.E. Cady-Pereira, M. Lou, D.K. Henze, R.W. Pinder, J.T. Walker, C.P. Rinsland, J.O. Bash, L. Zhu, V.H. Payne, and L. Clarisse. 2011. TES ammonia retrieval strategy and global observations of the spatial and seasonal variability of ammonia. Atmospheric Chemistry and Physics, 11, 10743-10763, doi:10.5194/acp-11-10743-2011.

f Xu, L. and J.E. Penner. 2012. Global simulations of nitrate and ammonium aerosols and their radiative effects. Atmospheric Chemistry and Physics, 12, 9479-9504, doi:10.5194/acp-12-9479-2012.

g NADP. AMoN. 2018. Gates of the Arctic National Park Ammonia Measurements. Available at: http://nadp.slh.wisc.edu/data/sites/siteDetails.aspx?net=AMON&id=AK06 Accessed on March 7, 2018.

Satellite data over Alaska also shows a clear indication of seasonality in measured ammonia levels. Ammonia levels are affected by changes in temperatures for a variety of reasons, depending on the source of ammonia emissions. In Southcentral Alaska, vegetation and soil microbial activities are likely the main ammonia emissions source. During periods with below freezing temperatures and snow coverage the biological processes that produce ammonia are dormant and no ammonia is emitted. Other sources of ammonia may include animals, human populations, and fertilizer application. While animals and humans do emit ammonia when the temperatures are below freezing, the overall emissions from these sources are quite low. Animal waste and fertilizer application also have seasonal emissions that are dependent on temperatures above freezing. Altogether, ammonia emissions in Southcentral Alaska are low, and those emissions sources that do exist are most active in the warmer months. As shown in Table A2, 30 years of normal temperature data collected from the stations in the Kenai area suggests that the growing season starts in May and lasts through October based on temperatures above freezing. The remaining months have freezing temperatures with dormant vegetation and snow cover resulting in negligible ammonia emissions from dominant emissions sources.

Table A2: 30-Year (1981-2010) Climatological Normal Temperatures in degrees Fahrenheit

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BIG RIVER LAKES	19.9	23.2	28.1	37.5	48.0	56.2	59.4	57.9	50.3	37.9	26.0	22.0
INTRICATE BAY	17.8	20.7	24.8	33.9	44.5	52.5	56.6	55.0	47.7	35.8	26.2	21.5
KASILOF 3 NW	17.2	19.6	24.1	33.6	42.4	49.5	53.7	52.4	45.9	34.6	23.1	19.1
KENAI 9N	16.3	19.4	24.9	34.6	44.8	52.4	55.9	54.5	47.3	35.0	23.3	18.8
KENAI AP	16.4	19.7	25.7	36.2	46.0	52.5	56.3	55.0	48.1	35.2	23.2	19.0
SOLDOTNA 5SSW	13.4	17.4	24.8	34.6	44.4	51.2	55.2	53.3	45.6	33.3	19.2	16.2
Temperature data obtained from the National Climatic Data Center												

These findings, in conjunction with an understanding of CALPUFF's inherent limitations and conservatisms regarding ammonia and in-transit chemistry, support the use of seasonal rather than annual uniform concentrations of ammonia in the model. As shown in Table A3, the colder months of November to April, were modeled with an ammonia value of 0.1 ppbv in CALPUFF, based on the WRAP BART modeling discussed above. While the WRAP BART modeling suggests using 0.1 year around, all evidence suggests a seasonal variation. Therefore, months of May to October were modeled with an ammonia value of 1.0 ppbv. This value reflects the value recommended by FLAG for arid lands and falls within the range of values documented in Table A1.

Table A3: Ambient Ammonia Background Concentrations for Use in CALPUFF

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Ammonia Concentration (ppbv)	0.1	0.1	0.1	0.1	1.0	1.0	1.0	1.0	1.0	1.0	0.1	0.1

Concerns have been raised that the Agrium Kenai Nitrogen Operations (KNO) could restart adding to regional ammonia emissions and negatively affecting regional haze. To address this concern, speciated $PM_{2.5}$ measurements collected by the IMPROVE network at Tuxedni National Wildlife Refuge from 2005 through 2013 were reviewed (IMPROVE 2018)[7]. Tuxedni is located 86 kilometers (53 miles) from the proposed Liquefaction Plant and the nearby Agrium KNO. Importantly, Tuxedni measurements spanned the period when Agrium KNO closed down (October 2007). Therefore, ammonium nitrate measurements prior to the shut-down and following the shutdown can be compared to understand if Agrium KNO emissions have any noticeable impact on ammonium nitrate driven visibility issues at Tuxedni. As previously discussed, this analysis focuses on ammonium nitrate particulate formation given that Liquefaction Plant emissions are dominated by NO_x and not SO_2 emissions. Without considering upset conditions, Plant potential to emit is 1,560 tons per year NO_x and only 92 tons per year SO_2 at a maximum of 16 ppmv sulfur in the fuel gas. SO2 emissions drop to only 35 tons per year combusting fuel gas containing less than the 3 ppmv nominal design specification. Given the low SO_2 emissions, the Liquefaction Plant is not considered an important source of ammonium sulfate driven visibility impairment.

Ammonium nitrate measurements before and after the Agrium KNO shut-down were compared using a statistical difference of means t-test. The results of the t-test demonstrate that the Agrium KNO did not influence the ammonium nitrate formation at Tuxedni when it was operating (t-test provides a 99.9% confidence, $p=0.00003$ for the null hypothesis). That is to say that the average ammonium nitrate measured at the IMPROVE monitor in Tuxedni from January 1, 2005 to October 14, 2007 (while the Agrium KNO was operating) was statistically the same as the average ammonium nitrate measured from October 15, 2007 to December 31, 2013 (after the Agrium KNO closed), regardless of the Agrium KNO operations. From this it can be concluded that ammonium nitrate driven visibility impairment at Tuxedni or any other areas further away is not sensitive to Agrium KNO ammonia emissions. This is not to say that Agrium KNO ammonia emissions do not contribute to visibility, the ammonia emissions when combined with regional NO_x emissions, such as those that would come from the Liquefaction Plant, are simply not large enough to be a statistically significant source of haze.

This lack of sensitivity can be explained following a review of particle contribution to light extinction on the haziest days at Tuxedni and the sulfate-nitrate-ammonium system. Ammonium sulfate and ammonium nitrate are interrelated as the acidic sulfates and nitrates compete for available gaseous ammonia, a neutralizing base. Sulfates preferentially react with ammonia and the remaining ammonia is available for reaction to form ammonium nitrate. Thus, the formation of ammonium nitrate is dependent on the availability of ammonia, which is dependent upon the concentration of sulfate. It is not until all the sulfur is consumed that particulate production will shift to ammonium nitrate formation provided particle production is not limited first by ammonia. This situation is evident from Figure A1 which shows ammonium sulfate particles dominate ammonium nitrate particles on the haziest days at Tuxedni nearly 10 to 1.

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[7] IMPROVE. 2018. Data from Federal Land Manager Environmental Database Accessed on March 2, 2018 at: http://views.cira.colostate.edu/fed/SiteBrowser/Default.aspx?appkey=SBCF_PmHazeComp

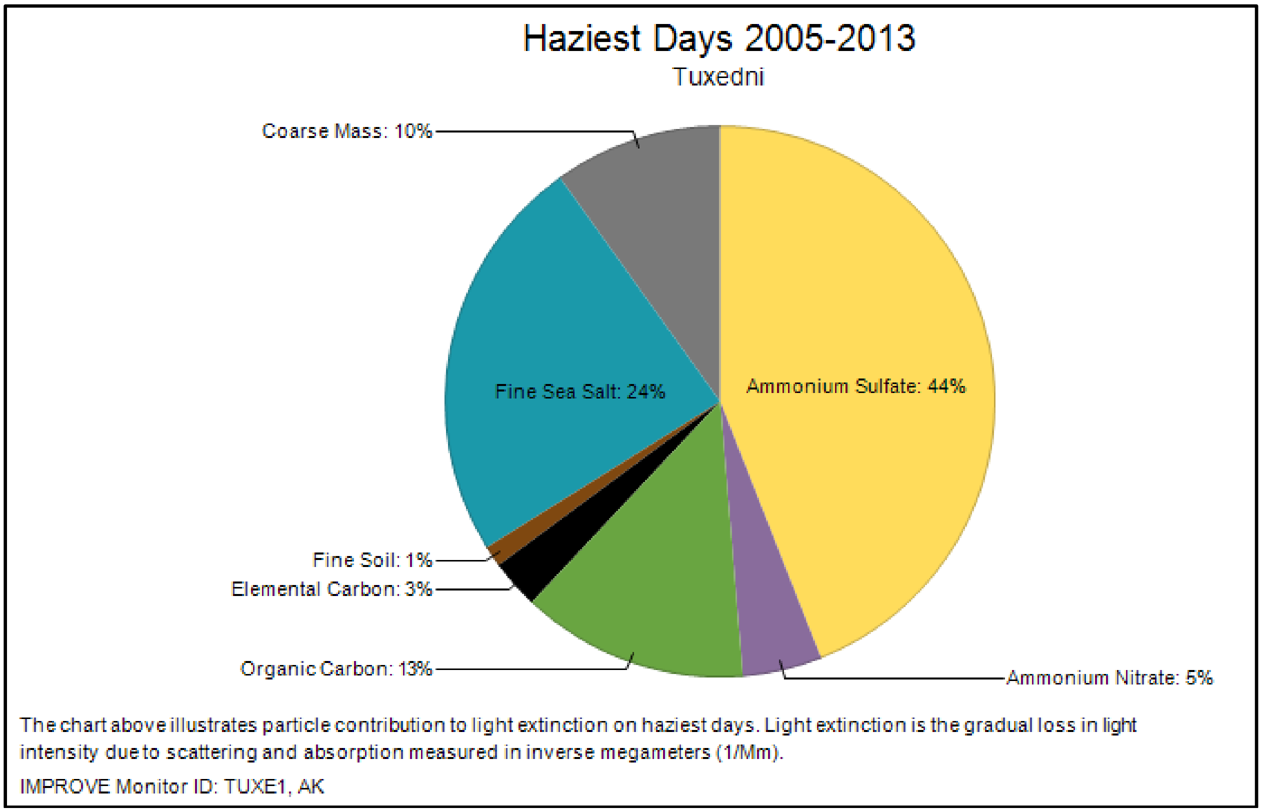

Figure A1: Light Extinction Contribution at Tuxedni between 2005 and 2013 on the Haziest Days

Another simple reason that visibility at Tuxedni will not be sensitive to Agrium KNO ammonia emissions is that particles resulting from gaseous pollutant interactions with ammonia are no more responsible for visibility impairment on the haziest days than fine sea salt and organic carbon. The source of the sea salt is obvious and the organic carbon fraction is most likely the result of forest fires as opposed to motor vehicle exhaust like many sites in Alaska.

Given the highest haze impacts at Tuxedni are predominantly from sulfur, ammonium nitrate accounts for 5% of the light extinction, and considering the sources types that contribute most to the haze, it is clear that haze impacts at Tuxedni are not sensitive to ammonia from the Agrium KNO and certainly not sensitive to a source like the Liquefaction Plant which is a large NO_x source with much smaller SO_2 emissions.

Attachment B

Liquefaction Plant

Construction Phase Air Emissions Demonstration

As part of the Prevention of Significant Deterioration (PSD) application, the Alaska Gasline Development Corporation (AGDC) has provided the Alaska Department of Environmental Conservation (ADEC) with a protocol for the air quality analyses required for the Alaska LNG Liquefaction Plant construction 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). A general discussion of construction emissions associated with the project was provided in that document. In summary, while the total emissions of planned construction activities have been quantified (as part of Resource Report No. 9 Appendix C, Alaska LNG 2017a) they were not modeled for the following reasons:

- ADEC does not typically consider general construction associated with land clearing and general earthwork part of construction of the stationary source.
- Construction emissions are not subject to the same federal and state permitting rules as emissions that come from the stationary source itself.
- It is not possible to predict with precision which construction activities will actually overlap in time, or to know the relative locations of the associated equipment for different activities when they do overlap.
- To model construction emissions, hypothetical worst-case assumptions would be required that produce the highest possible predicted impacts for each of the averaging times covered in the ambient air quality standards. By providing only absolute maximum impact estimates, such results are particularly unsuitable for comparison with several of the short-term National Ambient Air Quality Standards (NAAQS) that are based on multiple-year averages of certain percentile concentrations.

In many cases, the ambiguities cited lead to a situation in which the emissions could not be modeled in a manner that would produce specific or well defined impacts. Emissions with any of these attributes are generally not modeled because the resulting predicted impacts come with large uncertainty. While this is the case, ADEC requires reasonable assurance that the NAAQS will be protected during construction of the stationary source. For a source like the LNG Plant, this is generally done by showing that the compliance demonstration for the normal operation scenario which is included in Resource Report No. 9 Appendix D (Alaska LNG 2016) provides higher ambient impacts as those produced by non-mobile construction activities. The information in this document provides this demonstration by examining qualifying emissions from the various phases of construction in more detail.

1 BACKGROUND

The requirement to consider construction emissions in the PSD stationary source impact assessment (40 CFR 52.21(k)) shows up through the need to consider secondary emissions. While construction emissions could refer to emissions from a very wide range of sources, the definition of Secondary Emissions found in 40 CFR 52.21(b)(18)) puts some limits on what needs to be considered. To summarize, Secondary Emissions:

- do not come from the major stationary source itself,

- include emissions from any offsite support facility which would not be constructed or increase its emissions except as a result of the construction or operation of the major stationary source,
- do not include any emissions which come directly from a mobile source, such as emissions from the tailpipe of a motor vehicle, and
- do not count in determining the potential to emit of a stationary source (40 CFR 52.21(b)(4)).

This definition sets out four tests to be used in determining whether such emissions are to be included in air quality impact assessments for PSD purposes: the emissions must be specific, well defined, quantifiable and impact the same general area as the primary emissions from the stationary source undergoing review (USEPA 1981).

While narrowly focused on North Slope construction in oil fields, ADEC policy guidance (ADEC 2006) sheds light on how the agency views emissions from construction activities. ADEC indicates that:

- Construction activities lasting less than 24 months are considered Temporary Construction Activities according to 18 AAC 50.990(107) and Secondary Emissions from those activities are not required to demonstrate compliance with the air quality increment standards.
- ADEC can provide for air quality management of construction phase units/activities without having the units/activities listed in the permit.
- At the discretion of ADEC, it is acceptable to waive the modeling demonstration for construction phase emissions qualifying as Secondary Emissions if site-wide fuel sulfur restrictions are accepted or the units fall below specific size.

Similar to USEPA's reasoning for excluding some emissions from modeling, in the ADEC policy guidance, ADEC also recognizes that characterizing small close to the ground emission units/activities, such as those common to earth moving, small electrical generators and heat plants, can be difficult and the modeling results can be questionable and as a result provides the ability to regulate them through fuel standards rather than modeling.

The ADEC definition of Temporary Construction Activity is designed to protect the PSD Increments in situations where emissions from a construction activity will be stationary enough for long enough to impact increment compliance. Even for this large project, it is difficult to envision an aspect of construction that would impact increment compliance considering that qualifying emissions from construction activities occur over short durations in very different locations.

2 LIQUEFACTION PLANT CONSTRUCTION COMPONENTS AND SCHEDULE

Activities supporting the construction of the Liquefaction Plant would last approximately 7.5 years. The three liquefaction trains would be constructed and completed approximately six months apart. The majority of the facilities would be modularized with minimal stick-build occurring on site.

The planned schedule is outlined in Table B1. Resource Report No. 1 (Alaska LNG 2017c) provides a description of planned construction activities directly related to the Liquefaction Plant, which generally consist of the following main components:

1. Facility Construction – Infrastructure Development and Site Preparation Activities (2020-2024)
    - Earthwork
    - Material Transport
    - Access Road Construction
    - Install Piling, Construct Foundations
    - Liquefaction Plant and Operations Center Pad Construction
    - Additional Above Ground Facility Construction (e.g. LNG tanks)

    Note that activities associated with the Liquefaction Plant construction are comprised of several disconnected activities that will take place in several different areas over the four-year period. These activities would likely last two years or less at any given location.

2. LNG Plant Equipment Installation (2022-2027)
    - Installation of LNG Plant Utilities and Flares
    - Installation of Train 1 Module
    - Installation of Train 2 Module
    - Installation of Train 3 Module

    This equipment and its associated infrastructure would be prefabricated off site at specialty manufacturing and prefabrication locations and then incorporated into the modules that would be transported to the site. Each of the above is a separate installation activity with a separate commissioning period. Each of the train installation/start-ups will last less than two years.

3. Marine Terminal (2020-2024)
    - Material Offloading Facility (MOF) Construction
    - Dredging
    - Installation of Trestle/Berths
    - Installation of Product Loading Facility (PLF) modules and Mooring Dolphins

- MOF Reclamation/Demobilization

Marine Terminal offshore construction activities would take place during ice-free periods in Cook Inlet from approximately April 1 through October 31. While there is no seasonal limit to the onshore construction work, installation would start from offshore and work inward. Because of seasonal limitations, there will be separate and distinct periods of offshore activity that would span less than two years. Any continuous related onshore activities would also span less than two years.

4. Construction of Mainline Spread 4E – From LNG Plant Out to 13 miles (2022, 2024)

    - Access Road and Right-of-Way Construction
    - Pipeline Construction

    Only a portion of Spread 4E construction activities in the immediate vicinity of the Liquefaction Plant, where the mainline would be connected to the Liquefaction Plant, have the possibility of impacting the vicinity around the Liquefaction Plant. Construction of Spread 4E will take place over two separate one-year periods.

Secondary emissions associated with the above activities would come from portable, but not mobile, nonroad engines (NREs) such as concrete and asphalt batch plants, portable welding equipment, seasonal portable heaters, and portable pneumatic systems. Operation of worker camps (temporary and permanent) would include secondary emissions such as portable power generation and incineration. These secondary emissions would occur in many distinct phases in several different locations over the eight years that span project construction.

It should be noted that there is no plan for any temporary worker camp to remain in one location for more than 12 months such that the engines would no longer be considered nonroad engines and would need a construction permit application. Should a worker camp be anticipated to be static for more than 12 months the permit would be amended to include it, or its operation would be included in a separate permit in accordance with ADEC guidance regarding nonroad engines.

Project construction would also be comprised of some activities that are not considered secondary emissions. For example, construction of the Liquefaction Plant site would include use of mobile heavy equipment such as cranes and heavy transport vehicles. Mobile heavy equipment associated with scrapers, dozers, trenching, and stockpiling any soil would be used for site clearing and stabilization, and roadway and surface preparation and construction. While emissions from these sources as well as those mobile vehicles used for logistics can be approximately quantified, they are by no means specific or well defined from a modeling perspective and are in most cases mobile, therefore, are not considered secondary emissions. Similarly, fugitive dust emissions from these types of sources, as well as windblown fugitive dust, are not considered secondary emissions. Fugitive dust is discussed in more detail below.

Table B1: Liquefaction Plant Construction Schedule

	Emission Producing Activities	Year 1				Year 2				Year 3				Year 4			
		2019				2020				2021				2022			
		1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
GTP	Facility Construction - Infrastructure Development																
	Facility Construction - Site Preparation Activities, & Field Erected Equipment Delivery/Setting																
	Camp Construction / Operation																
	PBLT Construction (Prudhoe Bay Transmission Line)																
	West Dock Construction																
	Sealift #1-4 Offload / Set Modules (West Dock)																
	Install GTP Plant Utilities and Flares																
	Utility Interconnect / Startup																
	Install GTP Train 1 / Propane Modules																
	GTP Train 1 / Propane Refridgeration Commissioning / Startup																
	Install GTP Train 2																
	GTP Train 2 Commissioning / Startup																
	Install GTP Train 3																
	GTP Train 3 Commissioning / Startup																
Mainline	Spread 1A Civil (near GTP)																
	Spread 1A Pipeline (near GTP)																
	Spread 4E Civil (Near Liquefaction Plant)																
	Spread 4E Pipeline (Near Liquefaction Plant)																
Liquefaction Plant	Facility Construction - Infrastructure Development																
	Facility Construction - Site Preparation Activities, Commence Piling & Equipment Concrete Foundations																
	Facility Construction - LNG Tank Construction																
	Installation & Interconnection of Train 1, 2, 3 Modules & Equipment, Power & Utilities. Commisioning & Startup.																
	Camp Construction / Operation																
Marine Terminal	Site Preparation Activities, MOF (material offloading facility) Construction, Dredging																
	Installation of Trestle, Berths, Quadropod, PLF (product loading facility) Modules and Mooring Dolphins																
	MOF Reclamation/Demobilization (emissions only from logistics)																

Table B1: Liquefaction Plant Construction Schedule Cont.

	Emission Producing Activities	Year 5				Year 6				Year 7				Year 8				Year 9			
		2023				2024				2025				2026				2027			
		1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
GTP	Facility Construction - Infrastructure Development																				
	Facility Construction - Site Preparation Activities, & Field Erected Equipment Delivery/Setting																				
	Camp Construction / Operation																				
	PBLT Construction (Prudhoe Bay Transmission Line)																				
	West Dock Construction																				
	Sealift #1-4 Offload / Set Modules (West Dock)																				
	Install GTP Plant Utilities and Flares																				
	Utility Interconnect / Startup																				
	Install GTP Train 1 / Propane Modules																				
	GTP Train 1 / Propane Refridgeration Commissioning / Startup																				
	Install GTP Train 2																				
	GTP Train 2 Commissioning / Startup																				
	Install GTP Train 3																				
	GTP Train 3 Commissioning / Startup																				
Mainline	Spread 1A Civil (near GTP)																				
	Spread 1A Pipeline (near GTP)																				
	Spread 4E Civil (Near Liquefaction Plant)																				
	Spread 4E Pipeline (Near Liquefaction Plant)																				
Liquefaction Plant	Facility Construction - Infrastructure Development																				
	Facility Construction - Site Preparation Activities, Commence Piling & Equipment Concrete Foundations																				
	Facility Construction - LNG Tank Construction																				
	Installation & Interconnection of Train 1, 2, 3 Modules & Equipment, Power & Utilities. Commisioning & Startup.																				
	Camp Construction / Operation																				
Marine Terminal	Site Preparation Activities, MOF (material offloading facility) Construction, Dredging																				
	Installation of Trestle, Berths, Quadropod, PLF (product loading facility) Modules and Mooring Dolphins																				
	MOF Reclamation/Demobilization (emissions only from logistics)																				

3 LIQUEFACTION PLANT CONSTRUCTION EMISSIONS

The total construction emissions for each of the four main components mentioned above have been quantified in Appendix C of Resource Report No. 9. While most emissions were not broken down by activity, they were separated into the subcategories listed below and quantified temporally.

- Stationary Nonroad Generators (primarily power generation for camps) – *Secondary Emissions*. In most cases, emissions are specific, quantifiable, well-defined, and would impact the same area as the Liquefaction Plant.

- External Combustion (portable heaters that would operate at various locations as needed) – *Secondary Emissions*. While these emissions are specific, quantifiable, well-defined, and could impact the same area as the Liquefaction Plant, depending on size they can be difficult to characterize leading to large uncertainty in model predicted impacts. In this case impacts from these sources are better managed through fuel sulfur standards than modeling.

- Nonroad Portable Equipment (stationary but portable engines associated with various industrial and construction equipment) – *Secondary Emissions.* These emissions are specific, quantifiable, well-defined, and would impact the same area as the Liquefaction Plant. However, depending on size and purpose they can be difficult to characterize and the modeling results can be questionable. For these cases, impacts are better managed through fuel sulfur standards than modeling.

- Nonroad Mobile Equipment (mobile engines associated with various industrial, construction, and mining equipment). – Because these emissions are mobile, and regulated through fuel and emissions standards, they are *Not Secondary Emissions.*

- On-road Vehicles (tailpipes of mobile sources such as passenger cars, light-duty/heavy-duty trucks) – Because these emissions are mobile and regulated through fuel and emissions standards, they are *Not Secondary Emissions*.

- Fugitive Dust (paved/unpaved roads, material handling, wind erosion) – *Not Secondary Emissions*. While estimates of emissions have been developed for these source-types, characterizing their temporal and spatial variability in a dispersion model is difficult without large uncertainty. While established haul roads and material removal locations for a source such as a mine is rather well defined, there is uncertainty in the specific location of the emissions for these source-types that are associated with construction activities. With varying locations, ADEC has recognized that much of this type of construction activity is difficult to accurately characterize in a modeling analysis and attempts to do so typically require assumptions (such as an over-sized and over-active source) that likely lead to overstated air quality impacts. ADEC has also acknowledged the difficultly in characterizing small close to the ground activities (such as earth moving) that can produce questionable modeling results (ADEC 2006). For these reasons, modeled impacts for these fugitive dust sources would not be well-defined and quantifiable. Therefore these fugitive dust sources should not considered secondary emissions and impacts from these sources should be managed through Best Management Practices as opposed to modeling.

Full details related to the types of equipment, activities and emissions associated with construction phase air emissions are detailed in Resource Report No. 9 Appendix C. Emissions from Resource Report No. 9 Appendix C were re-organized and tabulated by pollutant and year as shown in Table B2 through Table B6. The portion of the total emissions that are considered secondary emissions is also indicated. Note that emissions due to logistics were included in the sum of total emissions, even though these emissions would be greatly spread out and would not impact the immediate vicinity of the Liquefaction Plant.

Table B2: Liquefaction Plant Construction NO_X Emissions

Construction Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Liquefaction Plant Construction - (Total) Infrastructure Development, Site Prep., Installation & Interconnection of Train 1, 2, 3 Modules & Equipment, Power & Utilities & LNG Storage Tanks	--	--	7	421	534	221	160	103	61
Liquefaction Plant Construction (Secondary Emissions Only)	--	--	--	15	29	40	47	40	26
Camp Construction / Operation (Total)	--	--	--	7	16	15	13	10	9
Camp Construction / Operation (Secondary Emissions Only)	--	--	--	2	5	6	5	3	2
Marine Terminal Construction (Total) (does not incl. marine vessels)	--	65	44	4	--	--	--	--	--
Marine Terminal Construction (Secondary Emissions Only)	--	24	21	3	--	--	--	--	--
Mainline Spread 4E - Civil + Pipeline(1) (LNG out to 13 miles)	3	4	6	13	17	12	--	--	--
Mainline Spread 4E - Civil + Pipeline(1) (LNG out to 13 mi) (Secondary Emissions Only)	--	0.5	0.8	2	6	4	--	--	--
LNG Logistics - (NO SECONDARY EMISSIONS) Transporting of personnel, equipment, const. materials, camps and supplies to const. sites	--	301	586	828	286	57	51	44	40
Total Construction Emissions (tons)	**3**	**68**	**57**	**444**	**567**	**248**	**173**	**113**	**70**
Secondary Emissions (tons)	**0**	**24**	**22**	**22**	**40**	**51**	**51**	**43**	**29**
Approximate Percentage that are Secondary Emissions	**<1%**	**35%**	**39%**	**5%**	**7%**	**21%**	**29%**	**38%**	**41%**
Total Modeled Emissions - LNG Normal Operations, Incl. Max. Flare and Marine Terminal	**4,456 (tons per year)**								

Notes:

(1) Emissions for Spread 4E assumed to be 15% of the total Spread 4 emissions, which is conservative based on:

- Number of operation hours for Spread 4E = 14% of total Spread 4 operation hours for civil mainline construction.
- Number of operation hours for Spread 4E = 6% of total Spread 4 operation hours for pipeline mainline construction.
- Length of Spread 4E (13 mi) = 8% of total length of Spread 4 (172 mi).

Table B3: Liquefaction Plant Construction CO Emissions

Construction Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Liquefaction Plant Construction - (Total) Infrastructure Development, Site Prep., Installation & Interconnection of Train 1, 2, 3 Modules & Equipment, Power & Utilities & LNG Storage Tanks	--	--	3	624	1,017	995	765	427	387
Liquefaction Plant Construction (Secondary Emissions Only)	--	--	--	47	61	66	58	28	21
Camp Construction / Operation (Total)	--	--	--	2	4	4	4	3	3
Camp Construction / Operation (Secondary Emissions Only)	--	--	--	0.2	0.5	0.6	0.5	0.3	0.2
Marine Terminal Construction (Total) (does not incl. marine vessels)	--	27	18	2	--	--	--	--	--
Marine Terminal Construction (Secondary Emissions Only)	--	9	7	1	--	--	--	--	--
Mainline Spread 4E - Civil + Pipeline(1) (LNG out to 13 miles)	5	5	7	12	9	11	--	--	--
Mainline Spread 4E- Civil + Pipeline(1) (LNG out to 13 mi) (Secondary Emissions Only)	--	0.2	0.2	1	2	1	--	--	--
LNG Logistics - (NO SECONDARY EMISSIONS) Transporting of personnel, equipment, const. materials, camps and supplies to const. sites	--	34	60	78	26	6	5	5	6
Total Construction Emissions (tons)	**5**	**31**	**28**	**640**	**1,030**	**1,009**	**768**	**430**	**390**
Secondary Emissions (tons)	**0**	**9**	**8**	**49**	**63**	**68**	**58**	**28**	**21**
Approximate Percentage that are Secondary Emissions	**<1%**	**29%**	**29%**	**8%**	**6%**	**7%**	**8%**	**7%**	**5%**
Total Modeled Emissions - LNG Normal Operations, Incl. Max. Flare and Marine Terminal	**14,467 (tons per year)**								

Notes:

(1) Emissions for Spread 4E assumed to be 15% of the total Spread 4 emissions, which is conservative based on:

- Number of operation hours for Spread 4E = 14% of total Spread 4 operation hours for civil mainline construction.
- Number of operation hours for Spread 4E = 6% of total Spread 4 operation hours for pipeline mainline construction.
- Length of Spread 4E (13 mi) = 8% of total length of Spread 4 (172 mi).

Table B4: Liquefaction Plant Construction PM_{10} Emissions

Construction Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Liquefaction Plant Construction - (Total) Infrastructure Development, Site Prep., Installation & Interconnection of Train 1, 2, 3 Modules & Equipment, Power & Utilities & LNG Storage Tanks	--	--	35	2,136	3,707	3,518	3,236	2,533	1,130
Liquefaction Plant Construction (Secondary Emissions Only)	--	--	--	2	3	4	4	3	2
Camp Construction / Operation (Total)	--	2	--	369	989	990	990	986	986
Camp Construction / Operation (Secondary Emissions Only)	--	--	--	2	6	7	5	3	2
Marine Terminal Construction (Total) (does not incl. marine vessels)	--	640	434	36	--	--	--	--	--
Marine Terminal Construction (Secondary Emissions Only)	--	1.4	1.2	0.2	--	--	--	--	--
Mainline Spread 4E - Civil + Pipeline(1) (LNG out to 13 miles)	42	42	71	142	145	85	--	--	--
Mainline Spread 4E- Civil + Pipeline(1) (LNG out to 13 mi) (Secondary Emissions Only)	--	0.03	0.04	0.1	0.3	0.2	--	--	--
LNG Logistics - (NO SECONDARY EMISSIONS) Transporting of personnel, equipment, const. materials, camps and supplies to const. sites	--	7	13	13	4	0.9	0.8	2	5
Total Construction Emissions (tons)	**42**	**684**	**540**	**2,684**	**4,841**	**4,593**	**4,226**	**3,519**	**2,115**
Secondary Emissions (tons)	**0**	**1**	**1**	**5**	**9**	**11**	**9**	**6**	**4**
Approximate Percentage that are Secondary Emissions	**<1%**	**<1%**	**<1%**	**<1%**	**<1%**	**<1%**	**<1%**	**<1%**	**<1%**
Total Modeled Emissions - LNG Normal Operations, Incl. Max. Flare and Marine Terminal	**1,332 (tons per year)**								

Notes:

(1) Emissions for Spread 4E assumed to be 15% of the total Spread 4 emissions, which is conservative based on:

- Number of operation hours for Spread 4E = 14% of total Spread 4 operation hours for civil mainline construction.
- Number of operation hours for Spread 4E = 6% of total Spread 4 operation hours for pipeline mainline construction.
- Length of Spread 4E (13 mi) = 8% of total length of Spread 4 (172 mi).

Table B5: Liquefaction Plant Construction $PM_{2.5}$ Emissions

Construction Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Liquefaction Plant Construction - (Total) Infrastructure Development, Site Prep., Installation & Interconnection of Train 1, 2, 3 Modules & Equipment, Power & Utilities & LNG Storage Tanks	--	--	4	229	395	372	341	265	119
Liquefaction Plant Construction (Secondary Emissions Only)	--	--	--	2	3	4	4	3	2
Camp Construction / Operation (Total)	--	0.4	--	39	104	105	104	102	101
Camp Construction / Operation (Secondary Emissions Only)	--	--	--	2	6	7	5	3	2
Marine Terminal Construction (Total) (does not incl. marine vessels)	--	71	48	4	--	--	--	--	--
Marine Terminal Construction (Secondary Emissions Only)	--	1.4	1.2	0.2	--	--	--	--	--
Mainline Spread 4E - Civil + Pipeline(1) (LNG out to 13 miles)	5	5	8	17	17	13	--	--	--
Mainline Spread 4E- Civil + Pipeline(1) (LNG out to 13 mi) (Secondary Emissions Only)	--	0.0	0.0	0.1	0.2	0.2	--	--	--
LNG Logistics - (NO SECONDARY EMISSIONS) Transporting of personnel, equipment, const. materials, camps and supplies to const. sites	--	5	10	12	4	0.8	0.7	1.0	2
Total Construction Emissions (tons)	**5**	**76**	**61**	**289**	**517**	**491**	**445**	**367**	**220**
Secondary Emissions (tons)	**0**	**1**	**1**	**5**	**9**	**10**	**9**	**6**	**4**
Approximate Percentage that are Secondary Emissions	**<1%**	**1%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**
Total Modeled Emissions - LNG Normal Operations, Incl. Max. Flare and Marine Terminal	**1,330 (tons per year)**								

Notes:

(1) Emissions for Spread 4E assumed to be 15% of the total Spread 4 emissions, which is conservative based on:

- Number of operation hours for Spread 4E = 14% of total Spread 4 operation hours for civil mainline construction.
- Number of operation hours for Spread 4E = 6% of total Spread 4 operation hours for pipeline mainline construction.
- Length of Spread 4E (13 mi) = 8% of total length of Spread 4 (172 mi).

Table B6: Liquefaction Plant Construction SO_2 Emissions

Construction Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Liquefaction Plant Construction - (Total) Infrastructure Development, Site Prep., Installation & Interconnection of Train 1, 2, 3 Modules & Equipment, Power & Utilities & LNG Storage Tanks	--	--	0.01	0.8	1.1	0.6	0.4	0.3	0.2
Liquefaction Plant Construction (Secondary Emissions Only)	--	--	--	0.02	0.04	0.1	0.1	0.1	0.0
Camp Construction / Operation (Total)	--	--	--	2	5	6	5	3	2
Camp Construction / Operation (Secondary Emissions Only)	--	--	--	2	5	6	5	3	2
Marine Terminal Construction (Total) (does not incl. marine vessels)	--	0.1	0.1	0.01	--	--	--	--	--
Marine Terminal Construction (Secondary Emissions Only)	--	0.03	0.03	0.00	--	--	--	--	--
Mainline Spread 4E - Civil + Pipeline[(1)] (LNG out to 13 miles)	0.01	0.01	0.02	0.1	0.1	0.2	--	--	--
Mainline Spread 4E- Civil + Pipeline[(1)] (LNG out to 13 mi) (Secondary Emissions Only)	--	0.00	0.00	0.01	0.01	0.01	--	--	--
LNG Logistics - (NO SECONDARY EMISSIONS) Transporting of personnel, equipment, const. materials, camps and supplies to const. sites	--	6	17	24	8	1.4	1.3	1.0	0.9
Total Construction Emissions (tons)	**0**	**0**	**0**	**3**	**7**	**7**	**5**	**3**	**3**
Secondary Emissions (tons)	**0**	**0**	**0**	**2**	**5**	**6**	**5**	**3**	**2**
Approximate Percentage that are Secondary Emissions	**0%**	**0%**	**0%**	**66%**	**71%**	**86%**	**100%**	**100%**	**67%**
Total Modeled Emissions - LNG Normal Operations, Incl. Max. Flare and Marine Terminal	**185 (tons per year)**								

Notes:

(1) Emissions for Spread 4E assumed to be 15% of the total Spread 4 emissions, which is conservative based on:

- Number of operation hours for Spread 4E = 14% of total Spread 4 operation hours for civil mainline construction.
- Number of operation hours for Spread 4E = 6% of total Spread 4 operation hours for pipeline mainline construction.
- Length of Spread 4E (13 mi) = 8% of total length of Spread 4 (172 mi).

4 AIR QUALITY IMPACTS DUE TO LIQUEFACTION PLANT CONSTRUCTION

4.1. Comparison to Liquefaction Plant Normal Operations

With the exception of PM_{10}, Table B2 through Table B6 shows that total emissions due to construction are less than emissions related to normal Liquefaction Plant operations as modeled in Resource Report No. 9 Appendix D. Total $PM_{2.5}$ emissions are not more than half the emissions from normal operations, and total NO_X, CO, and SO_2 construction emissions are each lower by approximately an order of magnitude. As mentioned above, emissions due to logistics were included in the sum of total emissions, even though they would be greatly spread out and would not impact the immediate vicinity of the Liquefaction Plant.

It is noted that emissions from Liquefaction Plant normal operations are generally released at a relatively high height when compared to the low level sources that comprise the secondary emissions from construction. This height difference makes the comparison of the related air quality impacts less straightforward. However, given the difference in emission rates is generally an order of magnitude or more and that the emissions due to construction will be spread over several areas, it is expected that modeled air quality impacts due to emissions from construction would be less than that modeled for normal Liquefaction Plant operations shown in Resource Report No. 9 Appendix D for all pollutants except PM_{10}, even without consideration of which emissions qualify as secondary.

The majority of particulate construction emissions are due to fugitive dust from unpaved areas. Excluding these emissions as secondary emissions based on the discussion in the previous section, the remaining secondary construction particulate emissions that would be modeled are just a small fraction of those modeled for normal operations (<1% for the worst-case year for PM_{10}). However, to alleviate potential concerns regarding fugitive dust, data from ongoing particulate matter monitoring stations in the Anchorage area can be reviewed to show no recorded PM_{10} or $PM_{2.5}$ values over the NAAQS. Specifically, the maximum 98th percentile $PM_{2.5}$ value over the most recent 3 years of data available (2013-2016) for either of the two monitors in Anchorage is 19 $\mu g/m^3$, well within the NAAQS limit of 35 $\mu g/m^3$. It should be noted that particulate concentrations in the Anchorage area would be greater than on the Kenai Peninsula due to Anchorage being a much more populated area with more emission sources and ongoing construction in the area. Furthermore, fugitive dust is not expected to be an air quality issue in the vicinity of the Liquefaction Plant due to the wet maritime environment and daily dust suppression through the use of an estimated 10,000 gallons of water per day from water trucks (Alaska LNG 2017c). Resource Report No. 9 Appendix J describes the Fugitive Dust Control Plan (Alaska LNG 2017b).

Emissions related to the construction and operation of temporary or permanent worker camps located near the Liquefaction Plant are the most continuous and stationary of all construction-related activities, but still far less than those due to normal operations. As such, impacts due to these emissions would be less than impacts due to normal operations.

4.2. Final Construction Phases and Early Plant Operations

As documented in Resource Report No. 9 Appendix D, the plant start-up and early plant operations scenarios were not modeled because when compared to the normal operations scenario these scenarios would yield lower modeled impacts due to lower emissions, less equipment operating, and/or fewer operating hours. The report did not address, however, the potential air quality impacts due to early plant operations that occur simultaneously with final construction phases. The worst-case combination of these activities would occur over the course of one year when Train 1 is fully operational, Train 2 would be commissioned, and construction/installation of Train 3 would be in the final stages.

Early plant operations combined with final construction phases would not yield higher impacts than the normal operations scenario. As shown in Tables B2 through B6, the total emissions for any given year for “Facility Construction” are a small fraction of emissions from the normal operations scenario and would not significantly add to emissions from early plant operations. Given that air quality impacts due to early plant operations would not be greater than impacts from normal operations, the same could be said about early plant operations combined with final construction at the Liquefaction Plant site.

5 CONCLUSIONS

Considering the total and secondary emissions due to construction presented in Table B2 through Table B6 as well as conclusions detailed in Resource Report No. 9 Appendix D, the following can be said about potential air quality impacts due to Liquefaction Plant construction activities:

- Construction-related emissions would occur in distinct phases at several locations which would greatly spread out any related air quality impacts, as opposed to permanent stationary sources associated with normal operations that have the ability to concentrate impacts in specific areas over long periods of time.
- The total construction-related emissions are much lower than modeled emissions for normal operations for all pollutants except PM_{10}. It is clear that, except for PM_{10}, modeled air quality impacts due to emissions from construction would be less than that modeled for normal Liquefaction Plant operations shown in Resource Report No. 9 Appendix D, even without concern for which emissions have been considered secondary.
- If modeling were limited to those construction emissions that are considered secondary emissions, impacts would be far less than those determined for normal operations, for all pollutants, as secondary emissions are only a small fraction of emissions due to normal operations.
- While fugitive dust emissions should not be considered secondary emissions because their impacts are not well defined or quantifiable, they should be considered even though quantifying impacts through modeling is not appropriate. Any concerns regarding fugitive dust emissions, should be alleviated by the fact that ongoing particulate matter monitoring stations in located in Anchorage, where numerous construction activities are ongoing, have not recorded any NAAQS exceedances. Furthermore, daily fugitive dust suppression using water would hinder most air quality impacts due to particulates. As a result, it is not expected that Liquefaction Plant construction-related particulate emissions would cause any NAAQS exceedances.
- Emissions related to the construction and operation the worker camps potentially located within the Liquefaction Plant impact area are the most continuous and stationary of all construction-related emissions, but still far less than those due to normal operations.

6 REFERENCES

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Attachment C

Liquefaction Plant

60-meter Tower Sensitivity Analysis

1 PURPOSE AND SCOPE

The purpose of this document is to determine if the objectives of the Nikiski meteorological monitoring program have been met based on the first year of data collected. The Nikiski meteorological monitoring program consists of a tower instrumented at four levels from 2 to 60 meters above ground level and is located near the proposed Alaska LNG Liquefaction Plant and marine terminal (Facility). Alaska LNG Plans to use meteorological data collected at the National Weather Service (NWS) station located in Kenai, Alaska, to license and permit the Liquefaction Plant. The primary objective for the Nikiski meteorological monitoring program is to show that it is acceptable to use the 8-meter Kenai NWS data to predict impacts from Liquefaction Plant stacks that are considerably taller than the tower height. Modeling with the Kenai NWS data is preferred because (1) it is a long-term record, (2) it is has been previously approved by the Alaska Department of Environmental Conservation (ADEC) in permitting other projects and modeling a wide range of stack heights in the Nikiski area, and (3) it is the ADEC-preferred data set for modeling projects of all sizes on the Kenai Peninsula. The location of the two meteorological monitoring stations is shown in Figure C1.

The data collected by the Nikiski meteorological monitoring program meets all recommended and required specifications for dispersion modeling conducted to evaluate Liquefaction Plant air quality impacts. As required by US Environmental Protection Agency's (USEPA) Guideline on Air Quality Models in 40 Code of Federal Regulations 51 Appendix W (Appendix W), the dataset represents at least one year of meteorological data that is at or near the source being modeled with several levels of measurements that are at or near expected plume heights. Though it meets the minimum requirement of at least one year, ADEC would prefer modeling conducted with 3 or more years. However, this does not diminish the utility of the data to meet program objectives given that impacts predicted with the data collected at Nikiski can be compared with the predicted impacts obtained when modeling with data collected concurrently by the Kenai NWS. Specifically, it was important to establish how impacts predicted with the single-level, 8-meter Kenai NWS data compares to impacts predicted with data from the Nikiski meteorological monitoring program, since the tall tower data is recommended by Appendix W for tall stacks. The effect of tall tower data on the modeling of short stacks is of less concern, since modeling of shorter stacks (e.g., up to 20 meters) using low-level (usually 8-10 meter) NWS data, such as the Kenai dataset, has been routinely accepted by ADEC and the USEPA for many years.

Section 8.4 Appendix W suggests in several subsections that use of data from an onsite or near-site tall meteorological tower with instrumentation up to or near the level of emitted plumes is preferable for modeling tall stacks. This does not imply that data collected from a shorter tower is unacceptable for modeling tall stacks. If it can be shown that the impacts predicted with data from a shorter tower are comparable, or more conservative than those predicted with data collected from a tall tower, then the shorter tower data is said to be representative of the transport and dispersion of emitted pollutants from the sources under consideration and is acceptable for regulatory applications. Thus, to demonstrate that the 1-year of Nikiski tower data meets program objectives, a direct comparison of pollutant concentrations predicted with the multiple-level Nikiski data needs to be compared to those predicted with the 8-meter Kenai NWS data to assess whether it is appropriate to model the impacts from tall Liquefaction Plant stacks with the 8-meter Kenai data. The primary focus of this paper is on providing such a comparison.

The remainder of this document is organized as follows. General descriptions of the Nikiski and Kenai meteorological monitoring towers are provided in Section 2. Section 3 describes a brief evaluation of general similarities and differences between the wind datasets. Section 4 presents a comparison of dispersion modeling results obtained with both sets of meteorological data for the Liquefaction Plant, as well as specific subsets of Plant sources. A summary of conclusions derived from these analyses is provided in Section 5.

2 THE METEOROLOGICAL TOWERS

The proposed Plant would be constructed on the eastern shore of Cook Inlet, Alaska in the Nikiski area of the Kenai Peninsula. The Plant is located approximately 4.8 kilometers (3 miles) southeast of Nikiski and 13.7 kilometers (8.5 miles) northwest of Kenai (Figure C1).

The westernmost boundary of the Plant lies on the coast. The terrain around the Plant is relatively flat with some higher terrain features (approximately 10 to 30 meters above the Plant base elevation) about 8 kilometers to the north. There are also several hills about 8 kilometers east of the Plant that peak at approximately 40 meters above the Plant's base elevation.

In accordance with USEPA's Appendix W, hourly meteorological data used for air quality dispersion modeling should be spatially and climatologically representative of the area of interest. In order for the data to be spatially representative, the meteorological tower site must have similar surface characteristics, land use, and terrain influences as those around the sources being modeled. Considering that the Kenai Peninsula within several kilometers of the proposed Plant is generally featureless and has homogenous land-use and land cover, meteorological data collected regionally should be considered spatially representative.

For meteorological data to be climatologically representative, enough meteorological data should be collected to ensure that the worst-case meteorology conditions are adequately represented in modeled results. USEPA recommends that a minimum of one year of site-specific data or five consecutive years of representative NWS data be used in modeling to predict air quality impacts for comparing to ambient standards. This is because one year of anomalous data may result in over or under-prediction of modeling impacts, whereas the use of multiple years of data increases the probability that the widest range of potential meteorological conditions will be represented in the modeling analysis producing a more consistent characterization of project impacts which is preferable.

For this study, the impacts predicted with two meteorological datasets were compared. One meteorological monitoring station is operated by the NWS approximately 11 kilometers south of the proposed Plant at the Kenai Municipal Airport and about 5 kilometers east of the Cook Inlet shoreline (call sign KENA). The Kenai meteorological instruments are mounted 8 meters above ground level. Although multiple years of data are available for this site, for the purposes of this study, just one year of Kenai meteorological data (calendar year 2015) was used to provide a direct comparison with the Nikiski dataset collected over the same single-year period. This dataset is considered both spatially and climatologically representative since it is located near the project site and consists of multiple years of data. Integrated Surface Hourly data (ISH) (NOAA 2016a) in conjunction with 1-minute Automated Surface Observing System (ASOS, NOAA 2016b) for 2015 was obtained and processed with USEPA regulatory dispersion modeling pre-processors AERMET and AERMINUTE. See Section 3.0 for additional information.

The other meteorological dataset consists of measurements collected from a tall tower at Nikiski (Nikiski Tall Tower) with instrumentation at 2 meters, 10 meters, 30 meters, and 60 meters. The 2- and 10-meter instrument levels measure temperature and relative humidity. The 10-meter level also records wind speed and wind direction; however, the 10-meter wind data have been invalidated because it was collected at too low of a height relative to the local roughness length. The 30- and 60-meter levels are equipped with instruments that measure temperature and relative humidity, as well as wind speed and direction. The Nikiski Tall Tower is located off of the Kenai Spur Highway S-490 about 3 kilometers north of the proposed Facility site and about 1 kilometer west of the Cook Inlet shoreline. The Nikiski meteorological dataset consists of only one year of hourly observations collected during calendar year 2015. While this dataset is clearly spatially representative of the project site, it is not necessarily climatologically representative given it consists of only a single year of data.

Figure C1: Meteorology Tower Locations in Relation to the Proposed Liquefaction Plant

3 COMPARISON OF MET DATASETS THROUGH OBSERVED WINDS

A comparative analysis was conducted on the two meteorology datasets to document the difference in annual average wind patterns. The primary focus of this analysis was to compare wind speed and wind direction data from both towers, in the form of wind roses. Understanding the unique features of each wind rose highlights any larger-scale climatological differences between these two sites. This analysis focuses on the wind variables because other variables such as temperature and relative humidity are not expected to differ significantly between the two sites.

Since the 10-meter Nikiski wind data is not suitable for modeling, the comparison between the Nikiski and Kenai data required evaluating the winds at the 30-meter level for Nikiski against the 8-meter observed winds at Kenai. Based on atmospheric boundary layer theory, it is understood that this difference in height has the potential to create a slight high wind speed bias in the Nikiski measurements when compared to Kenai measurements and the potential for a slight rotation between the two levels. Wind roses created for calendar year 2015 from both towers are shown in Figure C2 and Figure C3.

In general, the wind roses are similar with a few notable differences, such as an apparent shift in the prevailing winds from southerly winds at Nikiski toward southwesterly winds at Kenai. The dominant wind direction for both Kenai and Nikiski is from the north-northeast, and frequencies for this sector compare well at 23% and 18%, respectively. Nikiski has a secondary prevalence of winds out of the south with a frequency of 13% compared to Kenai's 4% frequency. On the other hand, Kenai's windrose shows more occurrences of winds from the northeast (15%) and east-northeast (10%) compared with Nikiski (13% and 6%, respectively). The higher wind speeds (i.e., greater than 6 m/s) are slightly more prevalent in the Nikiski dataset than in the Kenai dataset, presumably due to the fact that the Nikiski data were collected at a higher level above ground than the Kenai data. Overall, it can be concluded that the differences in wind direction frequencies for the northerly sectors are minor.

Greater differences between the wind direction frequencies in Figure C2 and Figure C3 are seen for the southerly sectors than for the northerly sectors. The strong southerly wind component at Nikiski is largely shifted toward the south-southwest at Kenai. Generally, the stronger wind speeds occurred for Nikiski in the southerly direction and for Kenai in the south-southwesterly direction.

The differences between these two datasets are most likely attributable to orientation of the Cook Inlet in the vicinity of the monitoring site, the influence of the Kenai River drainage in Kenai and the difference in height of the instrumentation between the two sites. It is also important to note that the Nikiski tower is closer to the coast than the Kenai tower. This suggests the Nikiski tower could be more exposed to coastal influences than the Kenai tower which is located 4 kilometers inland. The Nikiski wind rose (Figure C2) shows a higher southerly wind frequency than Kenai (Figure C3) as well as stronger westerly winds. These differences can be attributed to the differences in station exposure to the Cook Inlet, where Nikiski is more exposed to the Cook Inlet to the west and south.

An analysis of data collected solely by the Nikiski tower was conducted to evaluate how much the prevailing wind direction rotates as height above ground level increases. This effect which is caused by friction is more pronounced near the ground and decreases higher in the boundary layer. As would be expected, there is very little variability in wind direction frequencies between the 30 meter and 60 meter Nikiski wind levels, and the wind speeds are only marginally stronger at 60 meters.

As previously discussed, the comparison of wind roses is based on the annual distribution of wind speed and wind direction. The annual frequency plots are presented in order to highlight general patterns of winds at the two monitoring locations. It is important to note that such plots are not generally useful for comparing winds over short-term averaging periods or for providing information on where maximum short-term pollutant concentrations will be predicted by dispersion modeling using the corresponding meteorological input data. For this reason, additional analyses based on a comparison of dispersion model results obtained with the Nikiski and Kenai meteorological datasets is used in Section 4 to address the effects of tall versus short tower inputs on predicted pollutant impacts for shorter averaging periods.

Figure C2: Nikiski Tall Tower 30-Meter Level Annual Wind Rose for 2015

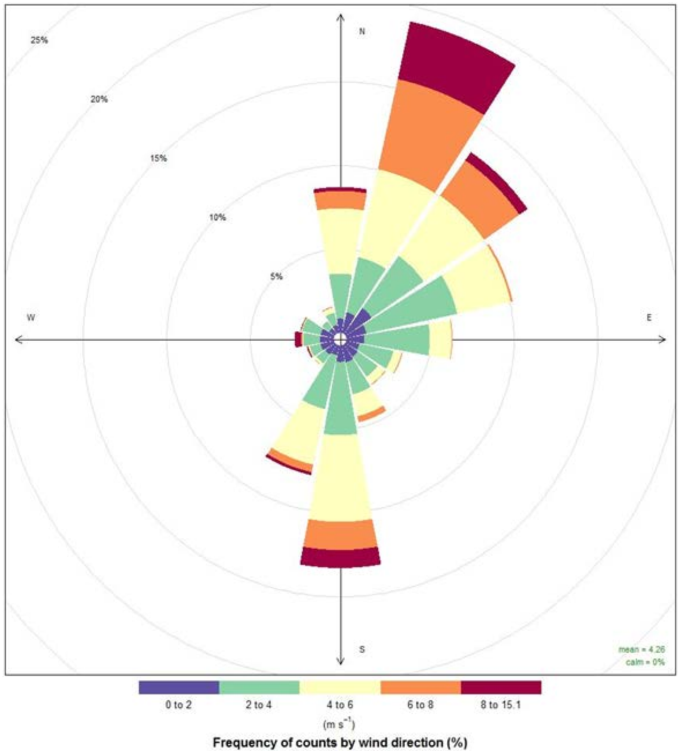
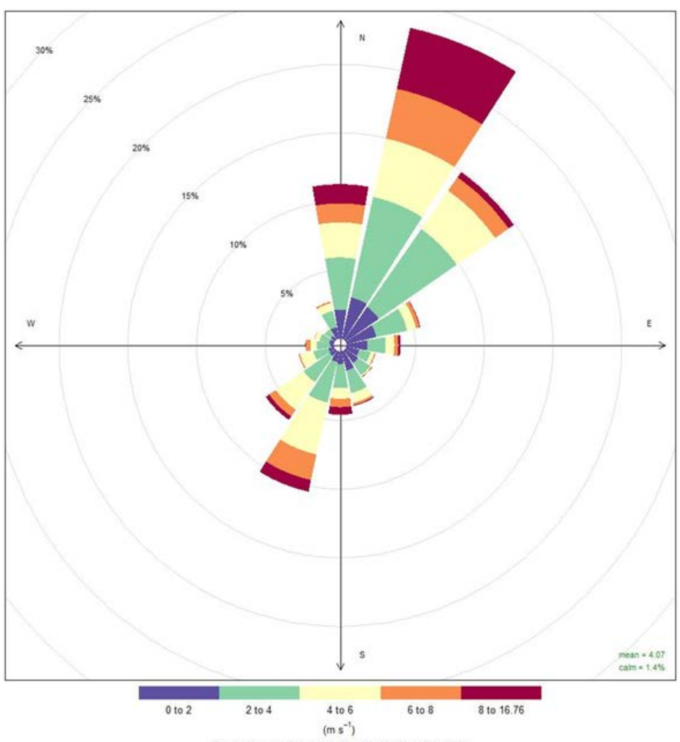


Figure C3: Kenai 8- Meter Annual Wind Rose for 2015



4 COMPARISON OF METEOROLOGICAL DATASETS THROUGH MODELING

Dispersion modeling was conducted to compare results obtained when the different meteorological datasets were used for input. This is a better method for assessing how the datasets affect the predicted short-term impacts than the previously-presented wind rose analysis. Modeling was conducted by utilizing AERMOD as it would be applied in a regulatory setting and the two meteorology datasets previously discussed.

The following points were considered when conducting the modeling and interpreting the results:

- Modeling conducted only included the Alaska LNG Liquefaction Plant and marine terminal sources, i.e., Plant-only. Nearby offsite sources were not included in this analysis because (1) they are not the focus of the permitting, (2) they are generally comprised of sources with shorter stacks, and (3) ADEC has approved modeling these sources with meteorological data collected at 10 meters or less.
- While the focus of this analysis is really on the tallest Plant sources, Plant-only modeling included all Plant stacks (i.e., both short and tall). A culpability analysis conducted for the maximum impacted receptor indicated this is an acceptable approach. That analysis showed that the sources with stacks 20 meters and taller contributed the most to the maximum impacted receptor concentrations; therefore, analyses conducted with and without the shorter stacks showed very little difference and the analyses presented in this section were carried out with all Plant sources included for simplicity.

Before the meteorological datasets could be used for modeling, the datasets were processed through AERMET (version 15181), the USEPA meteorological data preprocessor which generates a model-ready meteorological file for AERMOD. AERMET requires concurrent upper air data and surface characteristics in addition to the meteorological surface data. Table C1 provides a brief description of the inputs used in the AERMET processing. AERMET version 15181 was used for this analysis even though this is not the latest version of AERMET because this analysis was conducted prior to the release of the latest version of AERMET (version 16216). Conducting this analysis with the latest version of AERMET should not change the conclusions presented in this analysis because 1) changes between version 15181 and 16216 were limited to minor bug fixes, and 2) this study is based on a comparison between processed data sets which is valid provided both data sets are processed with the same model version.

Table C1: AERMET Processing Descriptions

Dataset	Surface/Upper Air Data source(s)	Surface Characteristic Determination
Kenai 8-meter Tower	• Integrated Surface Hourly data (ISH) (NOAA 2016a) and 1-minute Automated Surface Observing System (ASOS, NOAA 2016b)[1] • Concurrent upper air sounding data for Anchorage (NOAA 2016c)	• Surface characteristics input into AERMET were identical to those used to generate the AERMOD ready Kenai Airport 2008-2012 dataset found on ADEC's website.
Nikiski Tall Tower	• 2 meters, 10 meters, 30 meters, and 60 meters[2] meteorological measurements from (Alaska LNG 2016)[3] • Concurrent upper air sounding data for Anchorage (NOAA 2016c)	Surface characteristics were determined with AERSURFACE[4] using following seasonal assignments: • Midsummer with lush vegetation (June-August); • Autumn with un-harvested cropland (September-October); • Late autumn after frost and harvest, or winter with no snow[5,6] (January, March); • Winter with continuous snow on ground[5,6] (February, November-December); and • Transitional spring with partial green coverage or short annuals (April-May).

1 AERMINUTE version 14337 was utilized to translate 1-minute observations into hourly average winds for input to AERMET.
2 The Nikiski 30-meter meteorological dataset used in modeling utilized meteorological measurements only up to 30 meters.
3 Additional data processing was performed for the Nikiski wind speed standard deviation sigma-w measurements that are extremely low (near or at zero and below instrument threshold values). Following recommendations provided by USEPA's AERMOD modeling contractor, any reported values of sigma-w below 0.1 m/s were set to missing so as to avoid an anomalous problem in the model that can be caused by inappropriate input data.
4 The current version of AERSURFACE uses the 1992 version of National Land Cover Database (NLCD). Because these data do not cover Alaska, AERSURFACE was modified (based on version 13016) for use in Alaska by mapping NLCD 1992 land use categories to appropriate NLCD 2001 categories.
5 Consistent with the method used to process the Kenai NWS data which ADEC provides, surface characteristics assigned to Kenai did not differentiate between whether or not there was continuous snow on the ground during winter. However this differentiation was made in Nikiski processing as required by AERSURFACE.
6 If there was an observed snow depth at the Kenai NWS station for at least half the month, it was assigned as "winter with continuous snow on the ground"; otherwise it was assigned as "winter with no snow".

After meteorological data were processed, a total of three modeling assessments with the following inputs were performed with AERMOD version 15181:

1.) Sources from the Liquefaction Plant only with the 2015 Kenai 8-meter tower meteorological dataset.

2.) Sources from the Liquefaction Plant with the 2015 Nikiski meteorological dataset (using data from both the 30-meter and 60-meter upper levels).

3.) Sources from the Liquefaction Plant with the 2015 Nikiski meteorological dataset (using data only up to the 30-meter level).

Similar to AERMET, AERMOD version 15181 was used for this analysis even though this is not the latest version because this analysis was conducted prior to the release of the latest version of AERMOD (version 16216r). Conducting this analysis with the latest version of AERMOD should not change the conclusions presented in this analysis because 1) changes between version 15181 and 16216r were limited to minor bug fixes, adding new default options and adding new non-default options; and 2) this study is based on a comparison between processed data sets which is valid provided both data sets are processed with the same model version.

Each modeling assessment considered 1-hour NO_2, 24-hour $PM_{2.5}$, Annual $NO_{2,}$ and Annual $PM_{2.5}$ pollutants and averaging periods. Modeled results for each of these assessments are found in Table C2. Given the similarity between the results, additional analyses were then performed to provide a deeper understanding of the differences for short-term averaging periods. These analyses are described below.

First, a receptor-by-receptor difference analysis was conducted between AERMOD modeled 1-hour nitrogen dioxide ($NO_{2)}$ impacts which utilized the Nikiski 30- and 60-meter combined data and the same 1-year period from data collected by the Kenai 8-meter station. Figure C4 shows the results in the form of differences (Kenai minus Nikiski) in predicted eighth-high values (National Ambient Air Quality Standards [NAAQS] design concentration) at all receptors. The plotted differences in Figure C4 indicate which meteorological dataset resulted in the higher predicted impacts as a function of location. Color coding is provided to show the magnitude of the differences. Positive differences correspond to higher predicted concentrations using the Kenai data and negative differences are seen where the Nikiski data yielded higher concentrations. The differences between the two model runs represented in this figure are quite small over most of the modeling domain. However, there are some limited areas east and west of the proposed Liquefaction Plant for which significantly higher 1-hour concentrations are predicted with the Nikiski meteorological input data (negative differences). The largest differences appear to be the result of slight differences in wind direction between the two datasets under specific dispersion conditions. This causes two adjacent receptors to have roughly the same predicted impact with one being predicted by the Nikiski dataset and the other the Kenai dataset. This leads to what appears to be large differences in predicted magnitudes when it is really a difference in location of the impact. This could become important in a complex source environment or an area with complex terrain neither of which are the case. These areas aside, the plotted differences are predominately positive, indicating that the Kenai meteorological data yielded the more conservative concentrations over most of the modeling domain.

A similar difference plot for eighth-high, 24-hour $PM_{2.5}$ concentrations (NAAQS design concentration) is seen in Figure C5. The majority of the differences shown in this plot throughout the modeling domain are minimal (either small positive or small negative values) with the exception of receptors near the proposed Plant’s eastern and southern boundaries (positive differences) and north of the marine terminal (negative difference). However all differences for this pollutant are less than 3 micrograms per cubic meter ($\mu g/m^3$), showing that the selection of meteorological inputs has little effect on the modeling results for this pollutant and averaging time.

The receptor difference plots described above enable the analysis of changes in spatial patterns of predicted concentrations that result from changing meteorological input datasets, and show the parts of the modeling domain where one dataset or another results in higher predicted impacts. These differences, however, do not allow comparing the effects of changing meteorological inputs on the magnitudes of the highest impacts over the entire receptor grid. This comparison is more important in evaluating compliance with ambient standards for the Liquefaction Plant which is not located in a complex source environment or in complex terrain. To address this need, quantile-quantile (Q-Q) plots were generated as follows: (1) both the Kenai and Nikiski model-predicted design value concentrations per receptor are separately ranked from highest to lowest; (2) then the two sets of ranked points are plotted and compared to a one-to-one correlation line representing perfect agreement between the Nikiski and Kenai concentrations. When a concentration pair lies above or below the one-to-one line, this means that one of the meteorological datasets resulted in a higher predicted concentration for that rank. In the following Q-Q plots (Figure C6 through Figure C9), values above the one-to-one line indicate that higher impacts were predicted using the Nikiski dataset; plotted data falling below the one-to-one line means that modeling conducted with the Kenai meteorological data produced higher concentration values. An analysis of Q-Q plots generally focus on the highest concentrations since these are used to demonstrate compliance.

Figure C6 is a Q-Q plot comparing model-predicted 1-hour NO_2 design concentrations that utilized Kenai and Nikiski (30 and 60 meter) meteorological datasets. This figure shows that the Kenai data resulted in more conservative (higher) results for all concentration ranks, including some values that are significantly higher.

The plots for eighth high 24-hour $PM_{2.5}$ results show a pattern that is different from that for 1-hour NO_2. As shown in Figure C7, the Kenai impacts are generally more conservative for the lower concentrations, but the use of the Nikiski (30 and 60 meter) data resulted in higher $PM_{2.5}$ impacts for the higher concentrations. However, the two sets of results differ by, at most, only about 0.5 $\mu g/m^3$, a very small amount given the large gap between modeled maximum concentrations (4 $\mu g/m^3$) and the magnitude of the applicable ambient air quality standard (35 $\mu g/m^3$). While it would seem that modeling with multi-level data is preferred for predicted 24-hour $PM_{2.5}$ concentrations, the differences are really small enough to consider the two datasets interchangeable.

Based on the analyses conducted, it is difficult to tell if the differences observed are the result of the difference in monitoring station location or the difference in measurement height. To attempt to answer this question, Q-Q analyses were completed assuming the two levels of Nikiski measurements were collected from two different towers. One is making measurements at only 30 meters and one making measurements at 30 and 60 meters. If the resulting analysis predicts small differences, this is an indication that predictions are less sensitive to measurement height than location.

Figure C8 compares the model-predicted 1-hour NO_2 concentrations output from separate runs utilizing 30 meter Nikiski data alone and combined 30 and 60 meter Nikiski data. The resulting plot shows that the addition of the 60 meter meteorology level had virtually no effect on the magnitudes of 1-hour NO_2 modeling results, as the overall trend closely follows the one-to-one line.

The Q-Q plot in Figure C9 compares the results obtained with the Nikiski 30-meter data alone versus the Nikiski 30 and 60 meter combined meteorology on the predicted 24-hour $PM_{2.5}$ concentrations. This plot shows that including an added level of meteorological measurements had almost no effect on model output, with nearly one-to-one correspondence over the full range of predicted values and in particular, very small differences in the maximum ranking values.

As an added check to confirm that the impacts from shorter stacks are not dominating the analysis hiding the differences between impacts predicted with the two datasets, the Q-Q plots shown in Figure C10 through Figure C13 were produced to repeat the prior analyses with the exception that the impacts presented exclude sources with stacks 20 meters or shorter. An examination of these plots shows that conclusions do not change when only tall stacks (over 20 meters tall) are considered confirming conclusions based on previously completed culpability analyses which indicated impacts were dominated by emissions from tall stacks at the Liquefaction Plant.

Finally, model runs for annual averaging periods were performed to verify that modeled impacts using the three meteorological datasets were similar for longer term averaging periods. Annual modeling results are shown in Table C2. Short-term results are also shown for completeness. As can be seen, the modeling using Kenai 8-meter data generated equivalent but slightly higher annual modeling results as compared to the results from the modeling using the Nikiski Tower.

Table C2: Modeled Design Value Impacts

Pollutant	Averaging Period	Rank	Modeled Impacts		
			Kenai (8-meter Tower)	Nikiski (30- and 60-meter Measurements)	Nikiski (30-meter Measurements)
NO_2	1-hour	H8H[1]	141.2	135.4	133.3
	Annual	Annual Mean	8.56	7.63	7.41
$PM_{2.5}$	24-hour	H8H[1]	3.72	4.14	4.06
	Annual	Annual Mean	0.42	0.37	0.36

[1] Highest-8th-high design concentration

Figure C4: Difference in 1-Hour NO_2 Highest-Eighth-High Plant-Only Impacts obtained with 2015 Kenai (8 meters) and Nikiski (30 and 60 meter) Meteorology

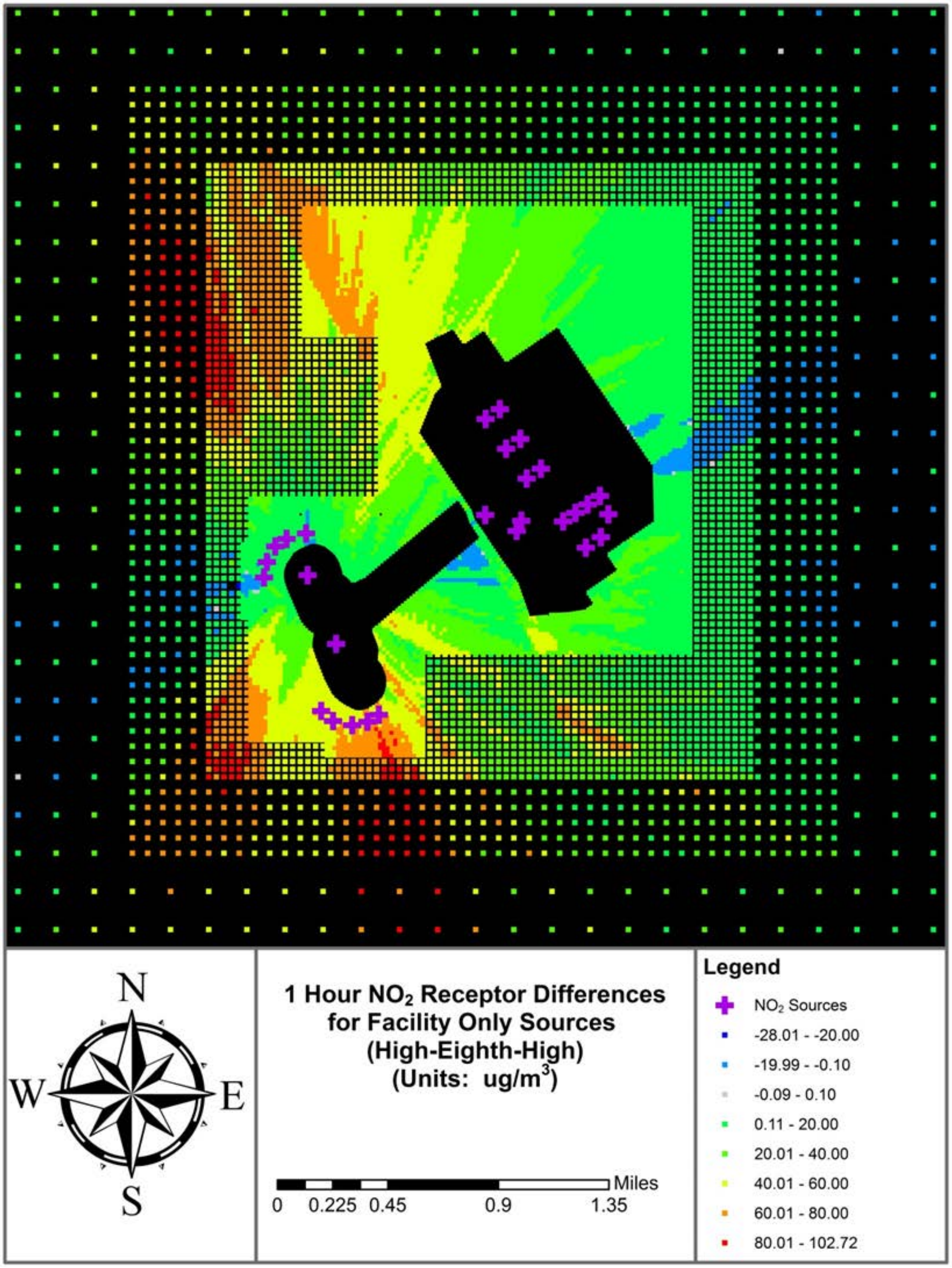


Figure C5: Difference in 24-Hour $PM_{2.5}$ Highest-Eighth-High-Plant-Only Impacts Predicted with 2015 Kenai (8 meter) and Nikiski (30 and 60 meter) Meteorology

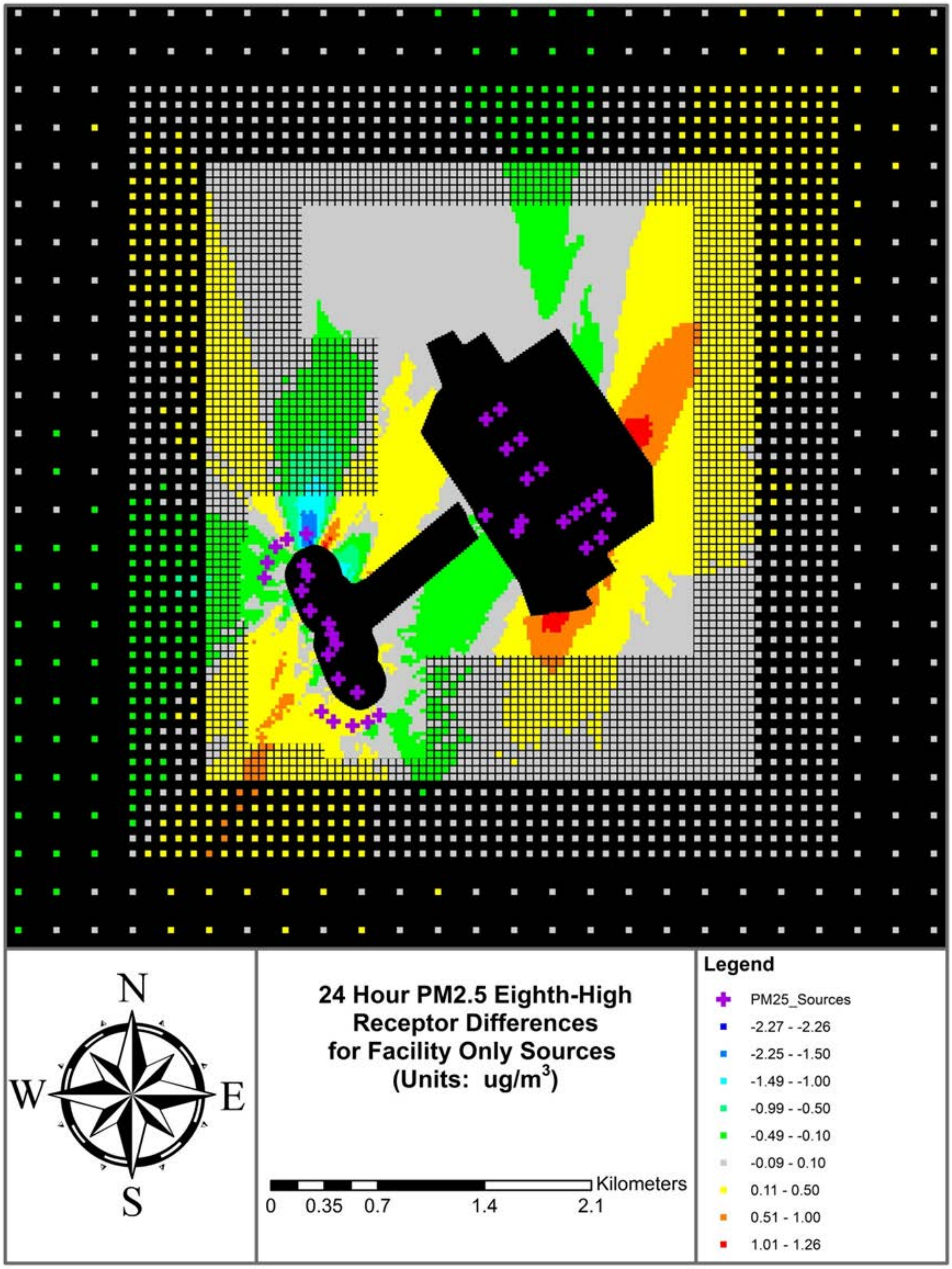


Figure C6: Q-Q Plot Comparing Nikiski (30 and 60 meter levels) and Kenai 1-Hour NO_2 AERMOD-Predicted Impacts for Plant-Only Sources (units µg/m^3)

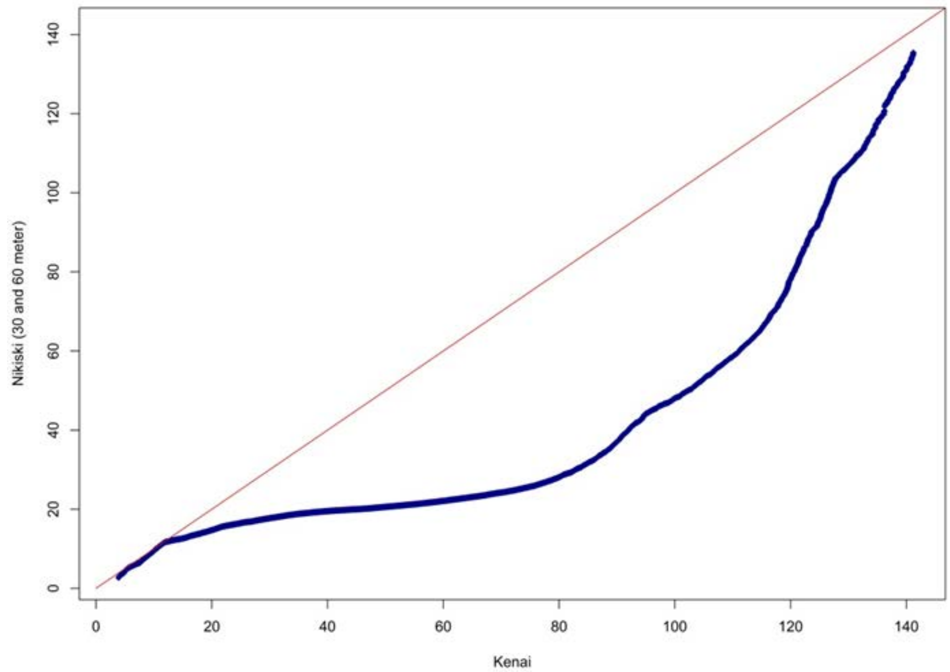


Figure C7: Q-Q Plot Comparing Nikiski (30 and 60 meter levels) and Kenai 24-Hour $PM_{2.5}$ AERMOD-Predicted Impacts for Plant-Only Sources (units µg/m^3)

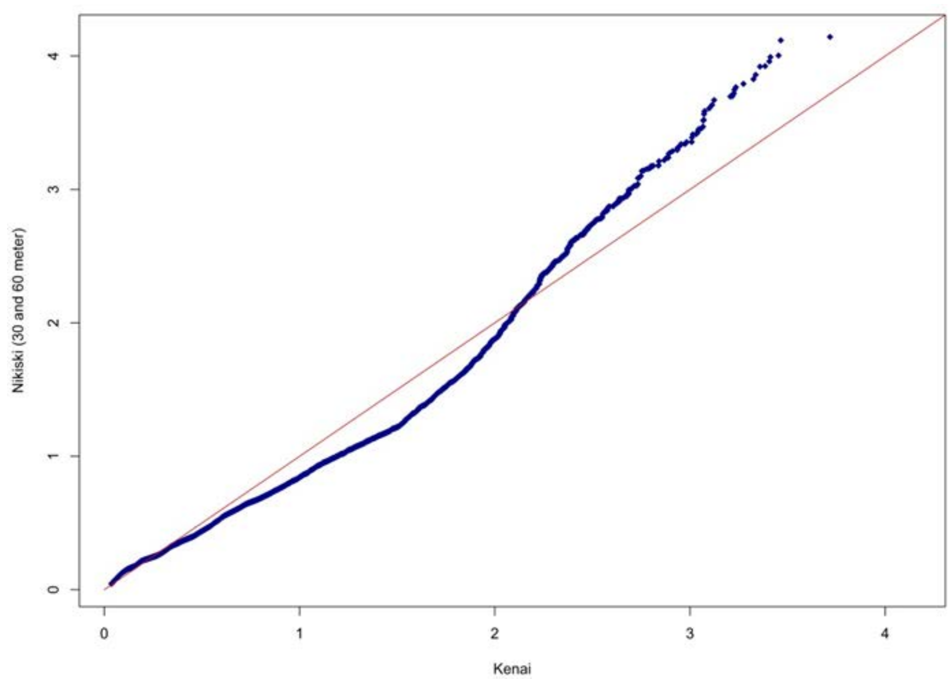


Figure C8: Q-Q Plot Comparing Nikiski 30 Meter Winds and Nikiski 30 and 60 Meter Combined Winds NO_2 AERMOD-Predicted Impacts for Plant-Only Sources (units µg/m^3)

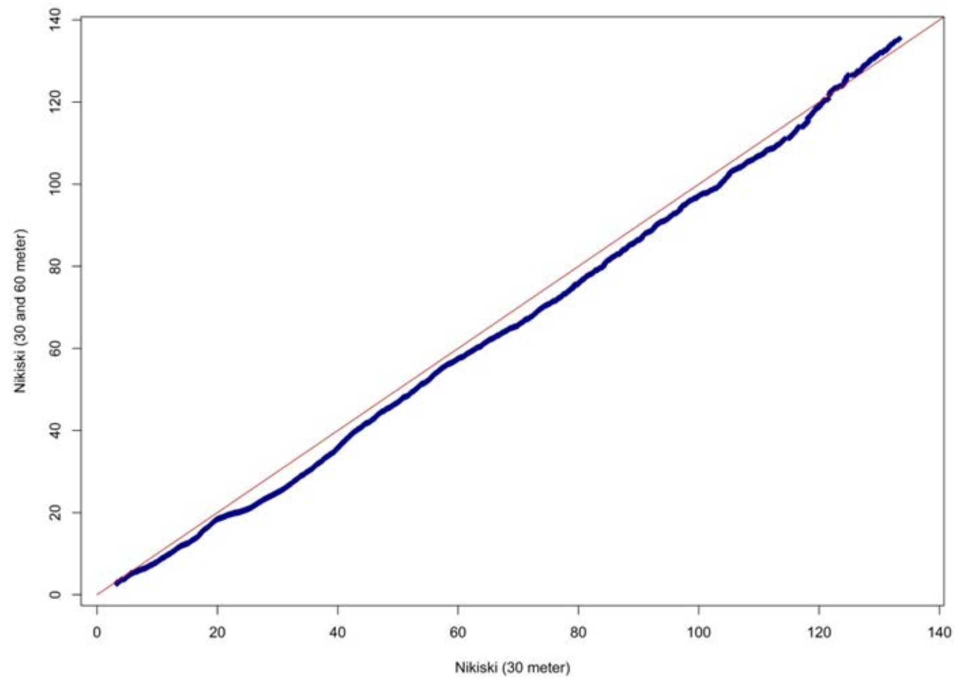


Figure C9: Q-Q Plot Comparing Nikiski 30 Meter Winds and Nikiski 30 and 60 Meter Combined Winds $PM_{2.5}$ AERMOD-Predicted Impacts for Plant-Only Sources (units µg/m^3)

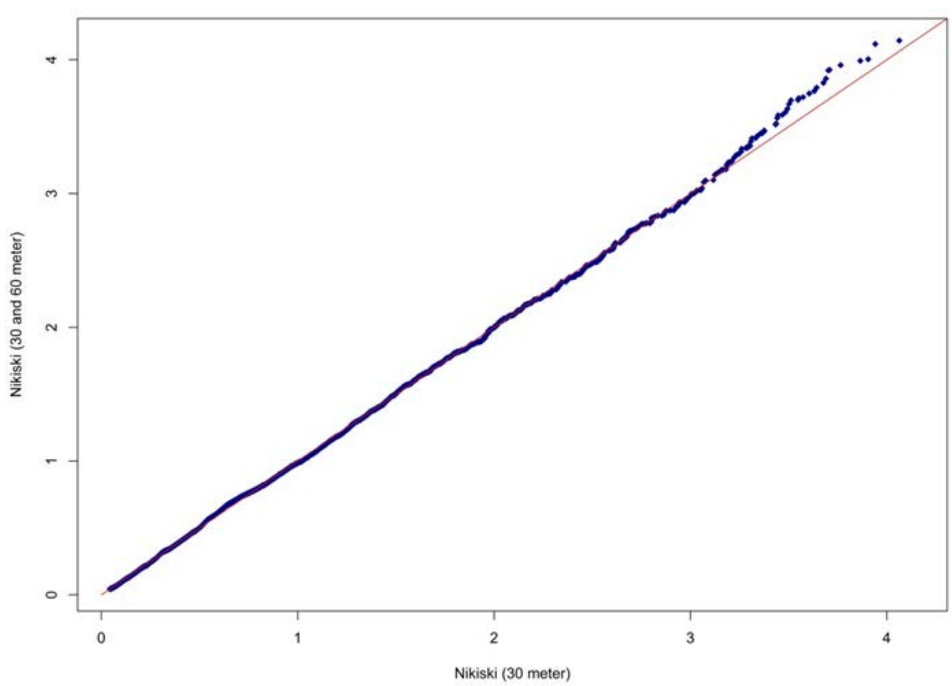


Figure C10: Q-Q Plot Comparing Nikiski (30 and 60 meter levels) and Kenai 1-Hour NO_2 AERMOD-Predicted Impacts for Plant-Only Sources Taller than 20-Meters (units µg/m³)

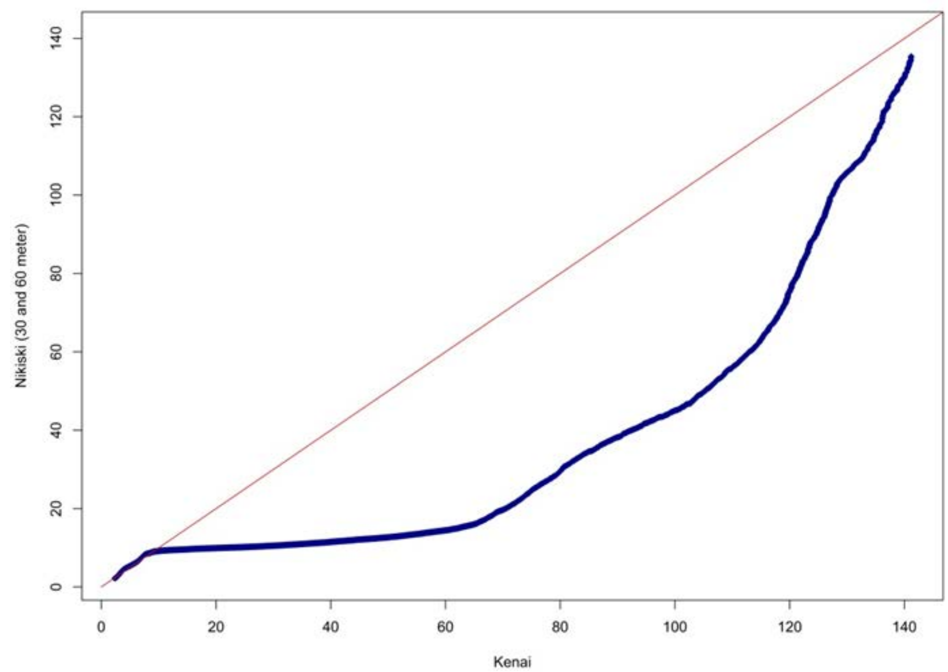


Figure C11: Q-Q Plot Comparing Nikiski (30 and 60 meter levels) and Kenai 24-Hour $PM_{2.5}$ AERMOD-Predicted Impacts for Plant-Only Sources Taller than 20-Meters (units µg/m³)

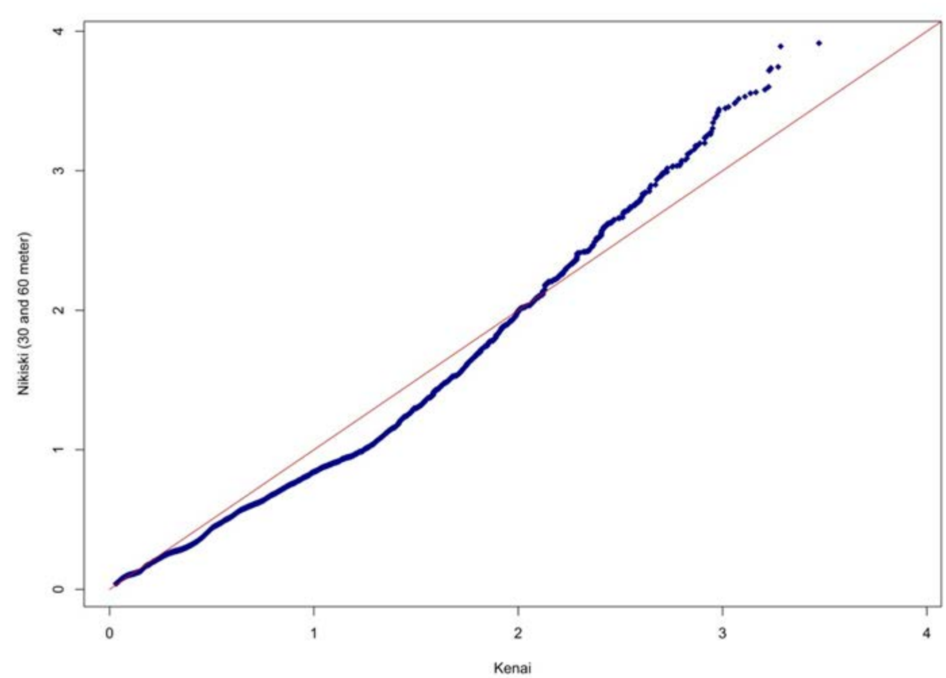


Figure C12: Q-Q Plot Comparing Nikiski 30 Meter Winds and Nikiski 30 and 60 Meter Combined Winds NO_2 AERMOD-Predicted Impacts for Plant-Only Sources Taller than 20-Meters (units µg/m^3)

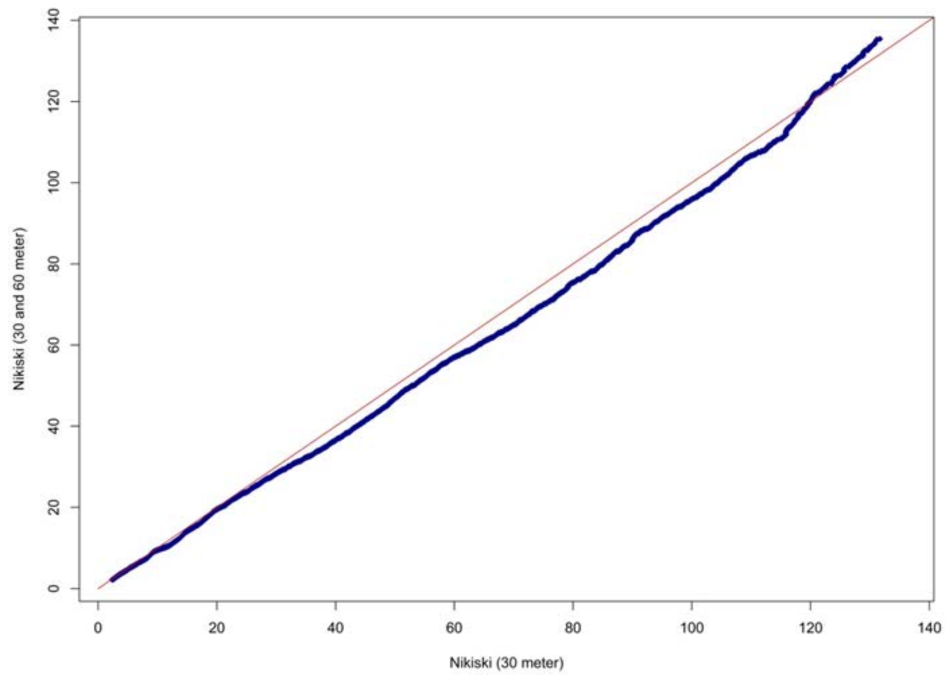
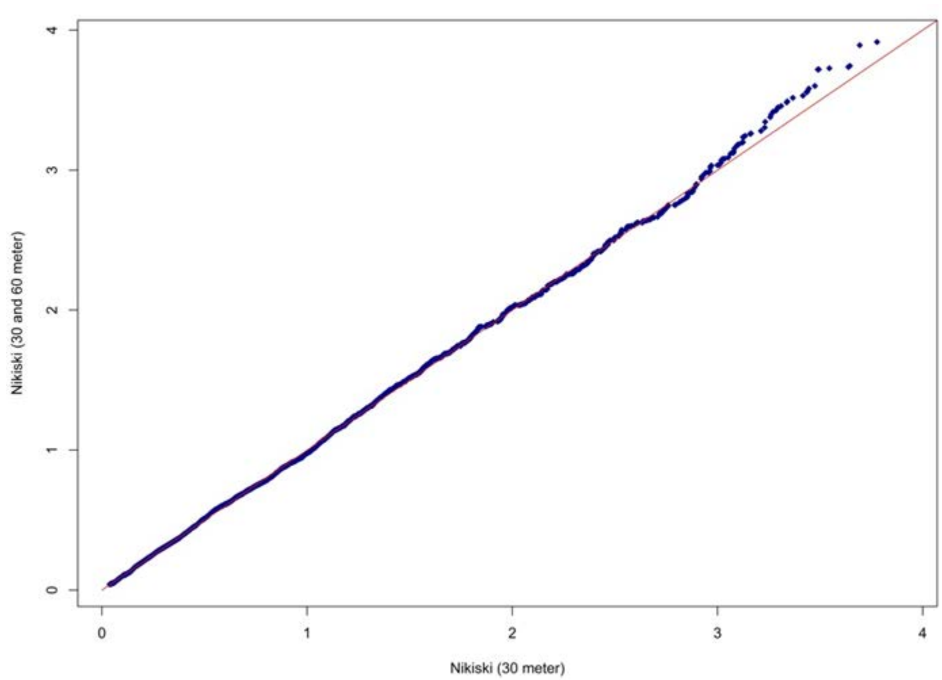


Figure C13: Q-Q Plot Comparing Nikiski 30 Meter Winds and Nikiski 30 and 60 Meter Combined Winds $PM_{2.5}$ AERMOD-Predicted Impacts for Plant-Only Sources Taller than 20-Meters (units µg/m^3)



5 CONCLUSIONS

The results of dispersion modeling of emissions from all sources at the proposed Plant have been shown to be quite insensitive to the selection of meteorological input data. Only small differences in predicted maximum 1-hour NO_2, Annual NO_2, 24-hour $PM_{2.5}$, and Annual $PM_{2.5}$ concentrations were observed between model simulations that used multiple-level meteorological data from the Nikiski tower or the 8-meter data from the NWS station at Kenai. The modeling of Liquefaction Plant sources indicated that the Kenai 8-meter meteorological data provides equivalent results to those predicted with the Nikiski Tall Tower data. Except for the 24-hour results, the Kenai data results in insignificantly higher results. Based on an intercomparison of results obtained from the two levels of Nikiski measurements indicate that the differences are more likely the result of monitoring station location than monitoring height. All conclusions were found to be the same if the analysis was limited to the tall Plant stacks (over 20 meters tall) as opposed to when all Plant sources were modeled.

In consideration of the above findings, it is concluded that continuing operation of the Nikiski tall tower in support of permitting for the proposed Facility is not necessary to ensure an approvable dispersion modeling analysis that is based on impacts predicted with the Kenai NWS data.

6 REFERENCES

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Attachment D

Liquefaction Plant

Ambient Air Boundary for Offshore Sources

This document provides further justification for the ambient air boundary used around the Liquefaction Plant offshore sources.

1 AMBIENT AIR BOUNDARY FOR OFFSHORE SOURCES

Ambient air quality standards and increments only apply in ambient air locations, defined by the U.S. Environmental Protection Agency (USEPA) as "that portion of the atmosphere, external to buildings, to which the general public has access" (40 CFR 50.1, adopted by reference in AAC 46.14.90(2)). There are no physical barriers or fences that would preclude public access around the offshore sources associated with the Liquefaction Plant Marine Terminal. Thus, defining the ambient air boundary around these sources is more ambiguous than for sources located on land.

The following sections discuss the ambient air boundary used in the modeling supporting Resource Report No. 9 (Alaska LNG 2016) for the Liquefaction Plant and offshore sources associated with the Marine Terminal and its applicability to modeling required to support a Prevention of Significant Deterioration (PSD) permit application.

1.1. Ambient Air Boundary used in Resource Report No. 9 Modeling

Following Federal Energy Regulatory Commission (FERC) verbal recommendations, modeling supporting Resource Report No. 9 included all equipment located at the onshore Liquefaction Plant as well as emissions from marine vessel operations within 500 meters of the LNG carrier berths, which included two LNG carriers and tugboats supporting carrier movement and ice clearing activities.

Following FERC verbal recommendations, a 500-foot (152-meter) buffer zone around the docked LNG carriers, berths, and trestle was used as an ambient air boundary around the offshore sources. This buffer was not measured from the limit of the modeled tugs; therefore, the distance from the edge of tugs directly assisting the carriers to the nearest ambient boundary was less than 310 feet (94 meters). Tugs engaged in ice clearing activities were actually modeled outside the ambient boundary.

The 500-foot buffer zone was established for safety reasons including:

- avoidance of collisions with LNG carriers and tugboats,
- the risk of LNG leak and consequent pool fire, and
- the risk of fire and explosion on board the LNG carriers.

The set-back distance of 500 feet (152 meters) was considered a reasonable safety zone considering the maneuvering of the two LNG carriers into the berths as well as the maneuvering of four tugboats that would be in the vicinity of the carriers while assisting their docking and undocking.

1.2. ADEC Guidance

The *ADEC Modeling Review Procedures Manual* (ADEC 2016) indicates that the exemption of the public from ambient air is generally meant for the atmosphere over land and that offshore sources are not expected to use a physical barrier to limit public access. ADEC further indicates that stationary sources located in the Cook Inlet "typically use a 100-meter set-back distance as their ambient boundary". ADEC notes that this range "represents a common sense set-back distance for safely navigating around objects", since the strong currents in the Cook Inlet can cause considerable drifting.

It should be noted that ADEC guidance indicates that emissions from marine vessels that do not directly support shore-side activities are generally not included as part of the stationary source emissions that are modeled for a construction permit application (ADEC 2016). This is a considerably smaller inventory than Liquefaction Plant and Marine Terminal emissions modeled in support of FERC Resource Report No. 9 and being submitted as part of the Construction Permit Application. The Liquefaction Plant ambient air quality impact analysis includes the following emissions that do not directly support shore-side activities: 1) all tugboat emissions, and 2) emissions from the LNG carriers while transiting and maneuvering. These emissions are not required to be included in construction permit modeling even though they were required to be included in the Resource Report No. 9 modeling. Therefore, ADEC guidance regarding the ambient boundary for offshore sources should be viewed from the context of the more inclusive emissions inventory modeled as compared to what is strictly required as part of the stationary source requiring a construction permit.

1.3. Ambient Air Boundary for use in Construction Permit Modeling

Given that the modeling being submitted as part of the Construction Permit Application used an ambient boundary seemingly larger than ADEC recommendations, additional discussion is warranted. ADEC guidance argues that 100 meters is a reasonable ambient boundary around vessels. If only the docked (stationary) LNG carriers are considered the set-back distance to the ambient boundary used in the modeling would seem large. However, it is not when considering that in addition to the emissions strictly required to be modeled for PSD (i.e., the docked carriers), emissions from tugboats involved in maneuvering the carriers and ice clearing activities, and the maneuvering modes of the LNG carriers were also included in the modeling. The additional maneuvering tugboats and LNG carrier modes modeled justify a larger set-back distance than one established based on the position of the docked and stationary carriers alone. Considering that the arguments used to justify 100 meters can be sensibly applied to all modeled vessels, in this case, the ambient boundary set-back distance should be measured from the modeled tugs. From this perspective, the set-back distance used to establish the ambient boundary of 152-meters from the docked carrier is less than what ADEC suggests and consistent with guidance for the Cook Inlet.

While the 152-meter ambient boundary used in the modeling supporting Resource Report No. 9 is consistent with ADEC guidance considering all the emission units and scenarios that were modeled, supplemental modeling was performed to demonstrate that compliance is also demonstrated assuming a set-back distance of 100 meters from the docked LNG carriers when only including sources directly supporting shore-side activities. The tugboats were excluded from this supplemental modeling as they do not directly support shore-side activities and thus are not a part of the stationary PSD source (ADEC 2016). While neither the LNG carrier transit emissions nor the maneuvering emissions directly support shore-side activities, they were conservatively included in the supplemental modeling because of the difficulty associated with breaking them out of the modeling. With the exception of excluding the tugs, the modeled source inventory for the supplemental analysis was identical to that used in the cumulative Resource Report No. 9 modeling.

Results of the supplemental modeling are shown below in Table D1 and Table D2, which are identical to cumulative modeling results documented in Table 7-3 and 7-4 on pages 74 and 75 of Appendix D to Resource Report No. 9. Thus, NAAQS/AAAQS and PSD Class II Increment compliance is demonstrated whether a 152-meter ambient boundary is modeled (including tugboat emissions), or a 100-meter ambient boundary is modeled (excluding tugboat emissions). Both of which align with ADEC guidance regarding the ambient boundary for offshore sources in construction permit modeling.

2 REFERENCES

Alaska Department of Environmental Conservation (ADEC). 2016. ADEC Modeling Review Procedures Manual. May 12, 2016.

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.

Table D1: Cumulative NAAQS/AAAQS Air Quality Compliance Analysis – Normal Operations

Air Pollutant	Averaging Period	AERMOD-Predicted Concentration (μg/m³)	Maximum 1-Hour Fumigation Concentration (μg/m³)	Ambient Background Concentration (μg/m³)	Total Concentration (μg/m³)	NAAQS (μg/m³)	AAAQS (μg/m³)
Sulfur Dioxide (SO_2)	1-Hour [a]	63.4	5.7	5.0	74.1	196	196
	3-Hour [b]	50.6	5.7	5.0	61.3	1,300	1,300
	24-Hour [b]	32.0	5.7	2.4	40.1	NA	365
	Annual [d]	0.6	5.7	0.0	6.3	NA	80
Carbon Monoxide (CO)	1-Hour [b]	2,721	78.3	1,145	3,945	40,000	40,000
	8-Hour [b]	1,071	78.3	1,145	2,294	10,000	10,000
Nitrogen Dioxide (NO_2)	1-Hour [c]	149.5	Included [h]	32.3	181.8	188	188
	Annual [d]	20.4	34.1	2.60	57.1	100	100
Particulate Matter less than 10 Microns (PM_{10})	24-Hour [f]	23.9	5.0	40	68.9	150	150
Particulate Matter less than 2.5 Microns ($PM_{2.5}$)	24-Hour [e]	6.4	5.0	12	23.4	35	35
	Annual [g]	2.8	5.0	3.7	11.4	12	12

Abbreviations:

NA = not applicable

μg/m³ = micrograms per cubic meter

Notes:

[a] Value reported is the 99th percentile of the annual distribution of daily maximum values averaged over the 5-year period.

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

[c] Value reported is the 98th percentile of the annual distribution of daily maximum values averaged over the 5-year period.

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

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

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

[g] Value reported is the annual mean concentration, averaged over the 5-year period.

[h] Hourly fumigation concentration was modeled in AERMOD through use of background concentration file. Thus, the resulting AERMOD concentration includes fumigation.

Table D2: Comparison of Cumulative Model-Predicted Concentrations to Increment Thresholds – Normal Operations

Air Pollutant	Averaging Period	AERMOD-Predicted Concentration ($\mu g/m^3$)	Maximum 1-Hour Fumigation Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	Class II Increments ($\mu g/m^3$)
Sulfur Dioxide (SO_2)	1-Hour [a]	NA	NA	NA	NA
	3-Hour [b]	39.6	5.7	45.4	512
	24-Hour [b]	17.5	5.7	23.3	91
	Annual [c]	0.6	4.9	5.5	20
Carbon Monoxide (CO)	1-Hour [a]	NA	NA	NA	NA
	8-Hour [a]	NA	NA	NA	NA
Nitrogen Dioxide (NO_2)	1-Hour [a]	NA	NA	NA	NA
	Annual [c]	12.5	Included [d]	12.5	25
Particulate Matter less than 10 Microns (PM_{10})	24-Hour [b]	24.7	5.0	29.7	30
	Annual [c]	2.7	5.0	7.7	17
Particulate Matter less than 2.5 Microns ($PM_{2.5}$)	24-Hour [b]	8.7	Included [d]	8.7	9
	Annual [c]	1.3	Included [d]	1.3	4

Abbreviations:

NA = not applicable

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

Notes:

[a] Neither USEPA nor ADEC have established increment thresholds for 1-hour NO_2, 1-hour SO_2, 1-hour CO, or 8-hour CO.

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

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

[d] Hourly fumigation concentration was modeled in AERMOD through use of background concentration file. Thus, the resulting AERMOD concentration includes fumigation.