APPENDIX C.1 ENVIRONMENTAL INFORMATION FOR MAINLINE BLOCK VALVE AND CRACK ARRESTOR SPACING SPECIAL PERMIT

Mainline Block Valve

Environmental Information

The purpose of this Attachment is to augment the National Environmental Policy Act analysis presented in the Alaska LNG Project Federal Energy Regulatory Commission Resource Reports (FERC RR) with information that meets specific U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA) requirements for a special permit as described in 49 Code of Federal Regulations (CFR) § 190.341. The Special Permit Conditions for usage of alternative MLBV spacing, as well as this Attachment, are also addressed in the Alaska LNG FERC Resource Report 11.

I. Purpose and Need

Alaska LNG is proposing to build a Mainline pipeline (the pipeline or the Mainline) to transport natural gas to a proposed Liquefied Natural Gas (LNG) facility from a proposed gas treatment plant located on Alaska's North Slope. The Federal Energy Regulatory Commission (the FERC) is the lead Federal agency. The Federal Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) has authority over the design and operation of natural gas transmission pipelines under 49 CFR Part 192. 49 CFR Part 192 includes specific regulatory requirements for the design, construction, operation, and maintenance of natural gas pipelines to maintain safety. If required, special permits can be granted under 49 CFR § 190.341 for proposed deviations from the regulatory requirements. PHMSA imposes conditions on the grant of special permits to assure safety and environmental protection in accordance with § 190.341. PHMSA is required to comply with the National Environmental Policy Act (NEPA) in deciding whether to issue the special permit.

Alaska LNG is requesting a special permit from PHMSA to waive compliance with 49 C.F.R. § 192.179 only in Class 1 locations. Alaska LNG is proposing a MLBV spacing of 50 miles North of Fairbanks and 30 miles South of Fairbanks[1]. The purpose of MLBVs is to isolate a segment of pipeline in the event of failure to stop product flow to the release site. This provision determines the spacing of main line block values (MLBV) and states that:

[1] The average Class 1 MLBV spacing North of Fairbanks is about 42 miles, while the average spacing South of Fairbanks is about 24 miles.

> *Each transmission line, other than offshore segments, must have sectionalizing block valves spaced as follows, unless in a particular case the Administrator finds that alternative spacing would provide an equivalent level of safety:*
>
> *(4) Each point on the pipeline in a Class 1 location must be within 10 miles (16 kilometers) of a valve.*

In support of Alaska LNG's request, Alaska LNG has performed an engineering analysis in accordance with ASME B31.8. This analysis included a thermal radiation study to determine whether increasing MLBV spacing in Class 1 locations beyond the 49 CFR § 192.179 limits would result in an equivalent level of safety. A summary of those results has been published[2] and concluded that for valve spacing the "results indicate that increased valve spacing could be implemented in remote, low population density areas without affecting safety."

The rationale for this conclusion with regard to MLBV spacing is several fold. First, the gas outflow at a rupture would be the same using a MLBV spacing of 50 miles as it would be for 20 miles spacing (compliance with § 192.179) for the first 17 minutes after the rupture (due to identical choked flow conditions at pipe opening). Similarly, if ignited, the resultant thermal radiation from the gas would also be exactly the same for the first 17 minutes. Since injuries and fatalities have been found to generally occur within a short period of time (seconds to minutes) after gas has been released from the pipeline[3] the proposed SP scenario presents a risk factor to the public and structures that is identical to a § 192.179 compliant design during the period of time when injuries/damage is most likely to occur. This finding is consistent with a rupture scenario in remote Class 1 regions where other structures (e.g. buildings intended for human occupancy) are not impacted. Lastly, results of a rupture gas outflow analysis demonstrate that the average gas outflow of the pipeline system design with the SP Conditions results in 31% less outflow than a system that is compliant with 49 C.F.R. 192[4]. In summary, the remoteness of the pipeline indicates that there would be no difference in people impacted as compared to compliance with § 192.179 limits. The results of this work for Alaska LNG are consistent with

[2] Rothwell, B., Dessein, T. and Collard, A. 2016. Effect of Block Valve and Crack Arrestor Spacing on Thermal Radiation Hazards Associated with Ignited Rupture Incidents for Natural Gas Pipelines. Proceedings of the International Pipeline Conference, ASME International, New York, NY. Paper IPC2016-64604. September.

[3] Robert J. Eiber Consultant Inc, Kiefner and Associates: "Review of Safety Considerations for Natural Gas Pipeline Block Valve Spacing", ASME STP-PT-046, 2011.

[4] See Attachment 2: "Main Line Block Valve Spacing: Support for Special Permit Application"

previous studies that examined the results of NTSB and PHMSA incident databases and concluded the risk to the public is independent of valve spacing.[5,6]

Given these results, Alaska LNG is requesting a Special Permit from PHMSA to allow for increased MLBV spacing, in low risk, Class 1 locations. This Special Permit contains conditions that would require enhanced monitoring of MLBVs with equal or better activation time as compared to a design that is compliant to 49 C.F.R. Part 192. This would include a combination of Remote Controlled Valves (RCV) and Automatic Shutoff Valves (ASV)s, both with pressure set points that would initiate automatic closure. In addition, the RCVs would be capable of remote operation (closure and opening) along with pressure monitoring, both upstream and downstream of the valve that is reported to a Pipeline Control Center. Part 192 requirements would be met when in proximity to key infrastructure (e.g. TAPS, railroads, roadways and critical bridges), which were identified based on discussions with PHMSA and ADOT&PF. These Conditions (Attachment B) would ensure the pipeline has equal or greater safety than a pipeline constructed in accordance with Part 192.

II. Background and Site Description

Figures 1 and 2 show the proposed Mainline route from the proposed gas treatment plant located at Prudhoe Bay to the proposed LNG Plant site located on the Kenai Peninsula. The Mainline would be a 42-inch-diameter natural gas pipeline, approximately 807 miles in length, extending from the Alaska LNG's Gas Treatment Plant (GTP) on the North Slope to the Liquefaction Facility on the shore of Cook Inlet near Nikiski, including an offshore pipeline section crossing Cook Inlet. The onshore pipeline would be a buried pipeline with the exception of short above-ground special design segments, such as aerial water crossings and aboveground fault crossings. As presented in Table 1.3.2-1 of FERC Resource Report 1 (inserted below), the Mainline would originate in the North Slope Borough, traverse the Yukon-Koyukuk Census Area, the Fairbanks North Star Borough, the Denali Borough, the Matanuska-Susitna Borough, and the Kenai Peninsula Borough,

[5]Eiber, R., McGehee, W., Hopkins, P., Smith, T., Diggory, I., Goodfellow, G., Baldwin, T. R. and McHugh, D. 2000. Valve Spacing Basis for Gas Transmission Pipelines. Pipeline Research Council International, PRCI Report PR 249 9728. January.

[6] Eiber, R., and Kiefner, J. 2010. Review of Safety Considerations for Natural Gas Pipeline Block Valve Spacing. ASME Standards Technology, LLC. Columbus. July.

and terminate at the Liquefaction Facility. The Mainlines' proposed design has a maximum allowable operating pressure (MAOP) of 2,075 psig.

TABLE 1.3.2-1 (From FERC Resource Report 1)

Mainline Route Summary for a 42-inch Pipeline

Segment or Facility Name	Boroughs or Census Areas	Approximate Length (miles)
Mainline	North Slope Borough	184.4
	Yukon-Koyukuk Census Areas	303.8
	Fairbanks North Star Borough	2.4
	Denali Borough	86.8
	Matanuska-Susitna Borough	179.9
	Kenai Peninsula Borough	51.3
Total		**806.6**

The Mainline would include several types of aboveground pipeline facilities. The proposed design includes eight compressor stations, four meter stations, multiple pig launching/receiving stations, multiple Mainline block valves (MLBV), and five potential gas interconnection points. A list of compressor stations, heater station, and meter stations is provided in Table 1.3.2-6 of FERC Resource Report 1.

Approximately 36 percent of the Mainline route is collocated within 500 feet of an existing ROW to include TAPS and other pipelines, highways or major roads, utilities and railroads. Table 1.3.2-2 of FERC Resource Report 1 summarizes collocation of the Mainline route that are within 500 feet of highways, major roads, the Trans-Alaska Pipeline System (TAPS), other pipeline ROWs, utilities, and railroads. The Mainline crosses TAPS and its associated Fuel Gas Line 12 and 5 times, respectively, along with four railroad crossings. Design of the road and railroad crossings would be validated for applicability of the minimum wall thickness requirements for service loads on crossings in accordance with API RP 1102, using the appropriate design factor for the design class location, and comply with 49 CFR § 192.111. The minimum depth of cover would be four feet for road crossings as specified by the Alaska Administrative Code 17.AAC 15.211 "Underground Facilities" and 10 feet for railroad crossings, as specified in Alaska Railroad Corporation (ARRC) standards below travel surface (this exceeds the 49 CFR §192.327 requirement which requires a minimum of three feet at drainage ditches of public roads and railroads). Site-specific designs for major highway and railroad crossings are provided in Appendix H of the FERC application. Additional details on roads, railroads, pipelines, utilities, and power lines crossings can be found in FERC Resource Report 8.

Aerial crossings on pipeline specific bridges (i.e. bridges that carry only a pipeline) are located at Nenana River at Moody and Lynx Creek. The design factor for the pipeline at aerial crossings will comply with 49 CFR § 192.111.

Pipeline design standards in 49 CFR § 192.5(a)(1) are based on "class location units," which classify locations based on population density in the vicinity of an existing or proposed pipeline system. The lower the class location (1-4), the higher the design factor used to find the minimum required wall thickness for pressure containment, i.e. the required minimum thickness of the pipe increases as the Class location increases. 99% of the Mainline route is in Class 1, which is defined as having 10 or fewer buildings intended for human occupancy located within 220 yards on either side of any continuous 1-mile length of pipeline. On the Kenai Peninsula, near Nikiski, there is a Class 2 location that is about 2.6 miles long. Also on the Kenai Peninsula there is a potential Class 3 location as the Mainline nears the LNG Plant. In the Nenana Canyon region of Denali National Park (~MP 536) there is approximately a half a mile of Class 3. Additional details on class locations for the Mainline can be found in FERC Resource Report 11, Section 11.7.

There are 10 potential high consequence areas (HCA) along the Mainline as defined under 49 CFR § 192.903. This includes two HCAs that are based on the aforementioned Class 3 locations. The remaining HCAs are located in Class 1 locations, details of which can be found in FERC Resource Report 11, Section 11.7, Table 11.7.4-1 (shown below) and in the MLBV Attachment D.

TABLE 11.7.4-1

Potential HCA Takeoff Mainline Route Revision C2

From MP	To MP	Length (mi.)	Description
236.08	237.33	1.25	Marion Creek Campground
352.21	353.35	1.14	Hotspot Cafe
529.21	530.44	1.23	RV Park and Motel
535.54	537.74	2.20	Denali Riverside RV Park, McKinley Chalet Resort, Denali Rainbow Village and RV, Denali Princess Wilderness Lodge, Denali Crows Nest Cabins, Grand Denali Lodge, Denali Bluffs Hotel
551.34	552.27	0.93	Denali Perch Resort
565.77	567.23	1.46	DOT/PF Cantwell Station
629.75	631.35	1.60	Byers Lake Campground (73 units)
633.75	634.50	0.75	Trappers Creek Pizza Pub
797.71	799.28	1.57	Nikiski Middle/High School, Kenai Heliport, Commercial Buildings, Industrial Sites
803.39	806.05	2.66	Conoco Phillips Property and Tesoro Kenai Refinery
Total		14.79	

In addition, the pipeline route segments that are addressed in this Special Permit for Strain Based Design, (Strain Based Design segments), will be incorporated into the integrity management program, (IMP), and treated as a covered segment in a high consequence area, (HCA), in accordance with 49 CFR Part 192, Subpart O, and the Special Permit Conditions.

The construction right of way (ROW) width will vary depending on the type of terrain, the season of construction, and the ease of access from nearby roads. The permanent ROW width will be 50 feet plus the diameter of the pipeline, i.e. 53-1/2 feet. Greater details on construction ROW can be found in FERC Resource Report 1. The Mainline would be sited on land composed of more than 85 percent federal, State of Alaska, and borough land of various holdings, with the remainder on privately owned land (see Resource Report 8).

The proposed gas pipeline spans five physiographic regions including the Arctic Coastal Plain, Arctic Foothills, Brooks Range, Yukon-Tanana Upland, and Tanana-Kuskokwim Lowland. These regions host a variety of ecosystems including muskeg bogs, spruce upland forest, alpine and Arctic tundra, high brush, and bottomland spruce and poplar forests. The associated ecosystems support a variety of species which include grizzly and black bears, arctic foxes, seals, caribou, moose, small terrestrial mammals, birds, and anadromous fish. A variety of marine mammals inhabit the coastal waters in the Project area, including the bowhead whale, polar bear, beluga whale, ringed seal, bearded seal, Stellar sea lion, harbor seal, ribbon seal and spotted seal. Some of these species are critical subsistence resources for Alaska Native peoples.

A detailed description of the Mainline ROW is included in Section 1.3.2.1 of FERC Resource Report 1. Supporting facilities are described in Section 1.3.2.1.3 and temporary construction infrastructure is described in Section 1.3.2.4 of FERC Resource Report 1. Baseline environmental conditions and the analysis of environmental effects resulting from construction and operation of the Mainline are addressed by individual resources as follows:

a) Resource Report 2 (Water Use and Quality).

b) Resource Report 3 (Fish, Wildlife and Vegetation).

c) Resource Report 4 (Cultural Resources).

d) Resource Report 5 (Socioeconomics).

e) Resource Report 6 (Geological Resources).

f) Resource Report 7 (Soils).

g) Resource Report 8 (Land Use, Recreation and Aesthetics).

h) Resource Report 9 (Air and Noise Quality).

The pipeline will traverse areas potentially subject to geotechnical hazards (geohazards). Broadly defined, a geohazard is a geological and/or environmental condition with the potential to cause distress or damage to civil works. Geohazards of particular interest for the Alaska LNG pipeline are time dependent, such as thaw settlement and frost heave. These are addressed in more detail in the Strain Based Design Special Permit Conditions and Environmental Information (Attachments 1 and 2 of the Strain Based Design Special Permit Application).

The pipeline will also traverse areas commonly used for outdoor recreation, sporting, and subsistence activities. It is possible that individuals could be in the vicinity of the pipeline even if there are 10 or fewer buildings intended for human occupancy located within 220 yards on either side of any continuous 1-mile length of pipeline. The State of Alaska issued 871,467 hunting, fishing, and trapping licenses in 2015.[7] However, as the engineering analysis has shown, the proposed action would not expose these individuals to any risk greater than a 49 C.F.R. 192 compliant design, but rather will employ mitigation measures to reduce risk to the public.

III. Alternatives

For PHMSA's NEPA assessment a No Action alternative reflects a pipeline design that would not require issuance of a Special Permit. The Proposed Action alternative reflects Alaska LNG's design for which a Special Permit with conditions related to increased spacing of MLBVs would be issued.

An applicant requesting a Special Permit from PHMSA has the option of building a pipeline which would not require PHMSA to issue a Special Permit. This would require the design, construction, and operation of a pipeline in-compliance with Part 192. The two alternatives are described below.

a. No Action Alternative – Design, construct, operate and maintain the pipeline in compliance with 49 CFR 192. This would require MLBVs to be placed at intervals defined by § 192.179, e.g. 20 miles in Class 1 locations.

b. Proposed Action Alternative – Design, construct, operate, and maintain the pipeline in compliance with the MLBV Spacing Special Permit Conditions.

i. *Explain what the special permit application asks for.*

Increase of MLBV spacing up to 50 miles North of Fairbanks and 30 miles South of Fairbanks from the requirement in 49 C.F.R. §192.179(a)(4), which is spacing up to 20 miles.

ii. *Cite regulation(s) for which special permit is sought in accordance with 49 CFR § 190.341:*

49 C.F.R. §§ 192.179(a)(4).

iii. *Explain/summarize how the design/operation/maintenance of the pipeline operating under the SP would differ from the pipeline in the no action alternative.*

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[7] http://www.adfg.alaska.gov/static/license/pdfs/2015_license_stamps_tags_issued.pdf

There will be two types of MLBVs utilized for line break detection and sectionalization: a remote controlled valves (RCV), that will be at all powered locations (i.e. compressor and heater stations), and automatic shut-off valves (ASV). The RCVs will automatically close based on either a pressure set point (60% of Maximum Operating Pressure[MOP]), or a decrease in operating pressure in ten (10) minutes that is greater than approximately 8.75%; as these conditions would likely indicate line break. Functionality could additionally be added to the RCVs to allow the pipelines gas control center to remotely close these valves in an emergency situation, when it has been deemed safe to do so. The ASVs will close based on the 60% of MOP set-point. Once activated, both types of valves will close in less than one (1) minute. These aforementioned requirements are intended to result in a reduction of valve closure actuation times as compared to a 49 C.F.R. Part 192 compliant design. Real time monitoring of the RCVs will be performed at the Alaska LNG Pipeline Control Center. Additional detail on the requirements for design, construction, and operation is provided in Section VII of this document and the Special Permit Conditions (Attachment B).

iv. ***Applicant*** *should include the pipeline stationing and mile posts (MP) for the location or locations of the applicable* ***special permit segment(s)***

The table below details the proposed location of the MLBVs.

MLBV #	MP	∆MP	Location Description	Valve Type
1	0.00	-	Gas Treatment Plant Meter Station (south fence line)	RCV
2	36.74	36.74	Stand-alone MLBV -Potential Station	ASV
3	75.97	39.23	Compressor Station - Sagwon	RCV
4	112.04	36.07	Stand-alone MLBV -Potential Station	ASV
5	148.51	36.47	Compressor Station - Galbraith Lake	RCV
6	194.09	45.58	Stand-alone MLBV -Potential Station	ASV
7	240.10	46.01	Compressor Station - Coldfoot	RCV
8	286.05	45.95	Stand-alone MLBV -Potential Station	ASV
9	332.64	46.59	Compressor Station - Ray River	RCV
10	377.95	45.31	Stand-alone MLBV -Potential Station	ASV
11	421.56	43.61	Compressor Station - Minto	RCV
12	444.90	23.34	Stand-alone MLBV	ASV
13	467.10	22.20	Stand-alone MLBV -Potential Station	ASV
14	492.96	25.86	Stand-alone MLBV	ASV
15	517.62	24.66	Compressor Station - Healy	RCV
16	534.79	17.17	Upstream of Class 3 Location at Glitter Gulch (valve moved 0.05 mi. northwest to Rev C-2 alignment)	ASV
17	538.79	4.00	Downstream of Class 3 Location	ASV
18	546.50	7.71	Stand-alone MLBV -Potential Station	ASV
19	572.23	25.73	Stand-alone MLBV	ASV
20	597.35	25.12	Compressor Station - Honolulu Creek	RCV
21	625.83	28.48	Stand-alone MLBV	ASV
22	648.16	22.33	Stand-alone MLBV -Potential Station	ASV
23	675.24	27.08	Compressor Station - Rabideux Creek	ASV
24	703.67	28.43	Stand-alone MLBV - Potential Deshka River Station	RCV
25	725.93	22.26	Stand-alone MLBV	ASV
26	749.11	23.18	Heater Station - Theodore River	RCV
27	766.01	16.90	Upstream of Cook Inlet Crossing	ASV
28	793.34	27.33	Downstream of Cook Inlet Crossing	ASV
29	799.85	6.51	Stand-alone MLBV (Potential Class 2 Location)	ASV
30	806.57	6.72	Kenai LNG Meter Station (north fence line)	RCV

v. *Mitigation Measures*

Additional mitigation measures are addressed in Section VII of this document and the Special Permit Conditions (Attachment B).

Remote Control Valves (RCVs) and Automatic Shutoff Valves (ASVs) used on the project are identical in terms of material and construction, only differing with respect to the logic systems within the valve actuator (a.k.a "operator) connected to the valves. In both cases, the valves used for RCVs and ASVs will be large diameter ball valves meeting API 6D requirements, and will be controlled by valve actuators. These valve actuators are gas-hydraulic powered, using the force of the gas within the pipeline to open/close the valves. The ASVs use mechanical systems to constantly compare the line pressure on either side of the valve to a pre-set value (proposed 60% MOP for the Alaska LNG pipeline), and should the line pressure drop below this set point, the valve will close. The use of purely mechanical and hydraulic systems for ASVs means they can operate with line break functionality without the need for electrical power.

Actuators on RCVs will include the same internal mechanical/hydraulic logic systems as the ASVs, but will additionally incorporate power controlled solenoids (switches) that will signal the valve to close the when a computer controlled system sends an alternate signal to the valve actuator based on different logic (proposed decrease in operating pressure in ten (10) minutes that is greater than approximately 8.75%, or possibly a signal from the oversight personnel at the pipeline gas control center).

IV. Environmental Impacts of Proposed Action and Alternatives

a. *Describe how a small and large leak/rupture to the pipeline could impact safety and the environment/human health.*

The following consideration of the potential impacts of small and large pipelines leaks/ruptures to the environment/human health apply equally to the proposed action and primary no-action alternatives, given that they both have a below-ground design basis.

i. Any discussion of the consequence of a leak or rupture must be put into the context of its probability. For the following reasons, it is highly unlikely that a leak or rupture will occurring over the Mainline Class 1 locations will impact the environment or human health for the following reasons:

a) Remoteness of the pipeline route: more than 99% of the Mainline route is in Class 1 location (801 miles of 806.6 miles). The frequency of incidents is significantly less for pipelines in Class 1 locations than in Class 2, 3 or 4[5] due to very low risk of mechanical damage.

b) Resilience to third party mechanical damage: given the remoteness of the pipeline and the high thickness of the pipeline, there is very low risk of mechanical damage. However, fracture mechanics calculations based on the mechanical properties of the pipe material and operating conditions of the pipe have shown that the pipe is very resistant to fracture, capable of withstanding a through wall thickness puncture of greater than 4” in length without rupturing.

c) Very low probability of corrosion damage: the Mainline will be transporting a dry, LNG specification gas, which contains no significant quantities of the species required to cause corrosion: water (<0.1 lbs/MMSCF), CO_2 (<50 ppmv) and H_2S (≤4 ppmv). With these low impurity contents, a corrosive liquid water phase will not form inside the pipeline. Therefore, the probability of internal corrosion is minimal. To ensure the integrity of the pipeline, the inline inspection program will comply with the robust requirements of 49 CFR § 192.620. External corrosion will be mitigated by using a high integrity coating, and with a cathodic protection system.

d) Compliance with Alternative MAOP requirements: the entire Mainline will be operated and maintained per 49 CFR § 192.620, which establishes robust operational requirements. Additionally, more than 615 miles of the total Mainline length, to include Alternative MAOP and SBD segments, will also comply with 49 CFR §§ 192.112 and 192.328, which, respectively, establish robust design and construction requirements.

e) Alaska LNG performed an engineering study that considered requirements from ASME B31.8 for block valve spacing, including consideration of “the amount of gas released due to repair and maintenance blowdowns, leaks, or ruptures.” The analysis results, that have been published[8], suggest “that increased valve spacing could be implemented in remote, low population density areas without affecting safety.” This conclusion is based on two

[8] Rothwell, B., Dessein, T. and Collard, A. 2016. Effect of Block Valve and Crack Arrestor Spacing on Thermal Radiation Hazards Associated with Ignited Rupture Incidents for Natural Gas Pipelines. Proceedings of the International Pipeline Conference, ASME International, New York, NY. Paper IPC2016-64604. September.

factors. First, as the thermal radiation analysis demonstrated, there is a negligible difference in the potential consequence to personnel in Class 1 locations, where there is an extremely low density of buildings intended for human occupancy. Second, block valves, and the associated spacing between them, do not prevent an incident from occurring. As such, increasing the valve spacing does not increase the probability of rupture. Incident prevention (decreasing probability of rupture) is better controlled through other practices, such as design for fracture resistance and control, and robust integrity management practices that include in-line inspections.

ii. A small leak from a buried pipeline would result in a gradual release of gas, with the total amount of gas being released dependent on the time it takes for the leak to be detected and fixed. Small leaks would primarily be identified through mass balance systems incorporated in gas pipeline control and pipeline inspection programs that are not impacted by valve spacing. Gas from a small leak would permeate through the backfill material (soil) before dissipating into the air. Small gas pipeline leaks may result in some impacts to, or loss of, surrounding vegetation. This localized browning of vegetation can facilitate identification of small underground leaks during right of way inspection, which will be performed at intervals not exceeding 45 days, but a least 12 times each calendar year (per 49 CFR § 192.620(d)(4)). Other visual techniques are available including inspection of snow pack (seasonal). The rate at which gas is lost, and total volume of gas lost from a small leak is independent of valve spacing, and is more contingent on identification timelines; therefore the environmental impacts from a small leak are the same in both the proposed action and non-action case.

iii. A rupture would result in the rapid release of a large volume of natural gas resulting in significant damage to the pipeline and would create a trench or crater in the immediate vicinity of the rupture. If an ignition source is present, an intense fire or explosion would result. For a fire resulting from a rupture; the damage due to the fire would depend on the extent of the combustible materials in the vicinity (infrastructure, vegetation), and local environmental conditions (e.g., rain, snow cover, etc.). The probability for human injury or fatality and property damage is relatively small for this largely remote pipeline, and decreases as distance from the rupture increases. The pipeline will be sectionalized with mainline block valves and the gas released during a rupture scenario would be limited to the inventory between valves; this amount of inventory would determine the duration of the intense fire. The spacing between the block valves is the subject of this Special Permit. Large ruptures would be easily detectable through monitoring of pressure and flow conditions at pipeline facilities.

b. *Submit an explanation of **delta/difference** in safety and possible effects to the environment between the 49 CFR Part 192 baseline (Code baseline) and usage of the special permit conditions for MLBV spacing mitigation measures.*

   i. The anticipated differences in effects for individual resources between the No Action alternative and the Proposed Action alternative are discussed below. References are made to FERC Resource Reports, where applicable, for further detailed information and analysis of impacted resources. The basis for the FERC Resource Reports is the Proposed Action Alternative; however, the associated environmental impact analysis is also applicable to the No Action alternative, given both alternatives are based on below ground design and installation, and both follow an identical route.

      1. Human Health and Safety

      The differences are negligible because as discussed previously, the impact to human health and safety with respect to the rupture and ignition event are similar with respect to the proposed action and no action cases for increased valve spacing. For the initial 17 minutes of a pipeline rupture, assuming ignition occurs, the thermal radiation released following gas ignition is identical between the 20 and 50 miles spacing cases due to the identical gas flow rate from the pipeline. As stated previously, it is within the initial period (seconds to minutes) immediately following pipeline rupture when the majority of injuries and fatalities occur, as this is when the thermal radius is at its largest, quickly dropping after the initial rupture. With this initial period being equal in the proposed action and no action scenario, there are no differential safety risks.

      With respect to the impacts of the total rupture event (including the timeline beyond the initial 17-minute window discussed above), the published rupture analysis report evaluating the impact of increased sectionalizing valve spacing further outlines that the total threshold thermal dosage (accumulated amount of damaging heat) is equivalent in all sectionalizing valve spacing cases examined.

2. Air Quality

There would be no significant difference in emissions between the No Action and Proposed Action alternatives. The majority of heavy equipment required for construction in either alternative will be the same, including equipment such as brushers and bulldozers for the clearing and leveling of the ROW, trucks for transporting pipe, and sidebooms and welding trucks for pipe placement and welding.

In the unlikely event of a pipeline rupture or leak large enough to depressurize the pipeline and trigger valve closure, there would be an incremental increase of greenhouse gas emissions for the Proposed Action alternative, relative to the No Action alternative without the improved valve closure requirements. As shown in the supporting documentation, in the unlikely event of a rupture, the proposed action would result in 31% less average gas outflow for the system per segment than minimum compliance with 49 C.F.R. 192. This result highlights the importance of more responsive valve functionality (RCV and ACV) defined in the SP Conditions, which positively offsets larger pipeline segments due to longer MLBV spacing. The lower gas outflow also results in shorter duration of an ignited rupture and less total thermal radiation than a system designed in compliance with 49 C.F.R. 192.

Should there be an operational requirement to evacuate a pipeline section, (i.e. for maintenance reasons), there would be a similar incremental increase of greenhouse gas emissions based on the Proposed Action alternative design if the gas were directly vented, due to the increased volume between MLBVs that sectionalize the line. However, for operational events the project would employ several emissions reduction strategies, such as the following examples: gas drawdown strategies, voiding the pipeline of as much gas as possible before blowdown is initiated, and use of passive blocks (e.g. stopples) to significantly limit the volume of gas released to atmosphere. These emissions reduction strategies would likely result in no difference to greenhouse gas emissions between the Proposed Action and No Action alternatives.

O&M activities to maintain the pipeline for the No Action and proposed Action alternatives would require similar equipment and personnel.

A reduced number of block valves for the Project Action alternative would reduce the fugitive emissions sources of greenhouse gases.

Detailed description of air emissions, including greenhouse gas emissions, from pipeline construction and operations are contained in FERC Resource Report 9 (Air and Noise Quality).

3. Aesthetics

There would likely be a reduced aesthetics impact with the Proposed Action compared to the No Action alternative as an increased MLBV spacing would result in fewer valves, and as such fewer overall above ground pipeline facilities.

4. Biological Resources (including vegetation, wetlands, and wildlife)

There would be no difference in impacts to vegetation, wetlands and wildlife between the between the No Action and Proposed Action alternatives. Pipeline will be below ground, and follow the same route.

FERC Resource Report 3 (Fish, Wildlife and Vegetation) contains descriptions of vegetation and wildlife resources, and potential impacts associated with the Mainline route. FERC Resource Report 2 contains a detailed analysis of wetlands affected by the Mainline route, and mitigation of impacts.

5. Resilience and Adaptation

The potential effects of a changing climate on Mainline design and operation are not expected to differ between the No Action and Proposed Action alternatives. Project design criteria incorporated consideration of a range of variable site conditions that could occur based upon historic information and future conditions. Mitigations are integrated into the design where appropriate or required for facility integrity and safe operations. Opportunities for resilience and adaptation to potential weather effects have been considered in the design of the Mainline. For example, geothermal modeling would be used to assess potential changes in ground temperatures that could be caused by longer-term geothermal impacts of pipeline construction, operations and changes in climate. Other resilience and adaptation design considerations for the Mainline are addressed in Resource Report No. 1.

FERC Resource Report 9 (Air and Noise Quality) discusses greenhouse gas emissions from the Project.

6. Cultural Resources

There would be no difference in the effect on Cultural Resources between the No Action and Proposed Action Alternatives. Construction activities have the potential to affect cultural resources. Ground-clearing activities under both cases would be similar. The FERC is conducting the Section 106 consultation process with stakeholders; that process will lead to the development of a Programmatic Agreement that would address management and recovery of known cultural resources and any discovered during project implementation. The Programmatic Agreement would apply to both the No Action and Proposed Action alternatives to mitigate effects on these resources. FERC Resource Report 6 (Cultural Resources) addresses cultural resources affected by the Project, and associated mitigations.

7. Environmental Justice

Since both pipeline designs would be sited in the same footprint, there would be no difference in effects on environmental justice resulting from construction or operation of the pipeline between the No Action and Proposed Action alternatives.

8. Geology, Soils and Mineral Resources

There would be minimal difference in the effect on Geology, Soils and Mineral Resources between the No Action and Proposed Action Alternatives. Construction activities have the potential to affect soils in a localized manner with minimal effect on regional geology or mineral resources. Construction activities that could contribute to erosion include clearing and grading, excavation trenching, stockpile management, backfilling, and the development of gravel pads. Most erosion effects are effectively managed through the use of erosion and sediment control measures, including:

a) The use of winter construction in areas of inundated and frozen ground conditions;

b) Use of settlement basins, silt fences, and other Best Management Practices (BMP) for storm water control;

c) Use of engineered flow diversions and slope breakers to control water flow on slopes and around water courses; and

d) Installation of trench breakers to address storm and groundwater flow through the trench backfill or during construction.

Operations and maintenance activities along the pipeline right-of-way to meet Part 192 would be similar for the No Action and Proposed Action alternatives. All O&M excavations would be conducted as authorized under the applicable ROW authorization. As the land management agencies responsible for lands along the pipeline route, ROWs would be issued by one, or both, of the Bureau of Land Management and Alaska Department of Natural Resources. All excavations and other applicable activities would be permitted through the appropriate Federal and State agencies for both of these alternatives. Both alternatives would have similar impacts on soil resources.

FERC Resource Report 7 (Soils), contains a more detailed discussion of impacts to soils and erosion resulting from the pipeline construction and the potential mitigation measures to address those impacts. FERC also has a standard Upland Erosion Control, Revegetation and Maintenance Plan, to which the Alaska LNG Project has proposed alternative measures that will be subject to FERC approval.

9. Indian Trust Assets

No Indian Trust Assets or Native allotments are located within the pipeline route.

10. Land Use, Subsistence, and Recreation

There would be minimal difference in the effect on Land Use, Subsistence, and Recreation between the No Action and Proposed Action Alternatives. During construction, land use in the form of subsistence activities and recreation for both alternatives could be altered in the immediate vicinity of activities. The pipeline's remote location combined with the relatively small width of the ROW would generally limit the extent of displacement by users to the active construction zones. Construction activities would be timed to avoid potential use conflicts with portions of the trail used during the annual Iditarod sled-dog race.

After construction the ROW would be graded and revegetated to a stable condition in accordance with the FERC approved Alaska LNG Upland Erosion Control, Revegetation and Maintenance Plan; Alaska LNG Wetland & Waterbody Construction & Mitigation Procedures; and the associated Alaska LNG Project Restoration Plan. No long term linear access along the pipeline alignment is proposed. However, under either alternative, PHMSA regulations will require that the pipeline ROW is brushed to prevent the growth of large vegetation over and around the pipeline to maintain a clearly defined ROW.

As shown in the supporting documentation in Attachment D, in the unlikely event of a rupture, the proposed action would result in 31% less average gas outflow for the system per segment than compliance with 49 C.F.R. 192. This result highlights the importance of more responsive valve functionality (RCV and ACV) defined in the SP Conditions, which positively offsets larger pipeline segments due to longer MLBV spacing. The lower gas outflow would result in shorter duration of an ignited rupture and less total thermal radiation than a system designed in compliance with 49 C.F.R. 192.

FERC Resource Report 8 (Land Use, Recreation and Aesthetics) considers potential effects to land use and recreation activities. FERC Resource Report 5 (Socioeconomics) considers potential impacts to subsistence.

11. Noise

During normal operations there would be no difference in Noise Impacts. The difference in Noise Impacts during blow down events between the No Action and Proposed Action Alternatives should be minimal.

12. Water Resources

There would be no difference in impacts to water resources between the No Action and the Proposed Action Alternatives. For both alternatives, stabilization techniques, including gravel blankets, riprap, gabions, or geosynthetics, would be used to stabilize the channel bed and stream banks at stream crossings. The majority of rivers and streams along the pipeline route would be crossed by an open-cut method during winter months; during these months the flows of rivers and streams are lowest, and disturbance of the channel and stream bank can be minimized. Burial depths for crossings have been based on site specific calculations to avoid the potential for scour. Watercourse crossing methods for each watercourse crossing are the same for both alternatives.

FERC Resource Report 2 (Water Use and Quality) contains a detailed discussion regarding the management of water during construction and operation of the pipeline, as well as impacts to ground, surface water flow and quality resulting from the construction and operation of the pipeline.

c. *Describe safety protections provided by the special permit conditions.*

Several factors were taken into consideration. First, the Mainline route has been characterized for location of dwellings and structures in accordance with 49 CFR § 192.5 and 99% of the Mainline route is in Class 1, which is defined as having 10 or fewer buildings intended for human occupancy located within 220 yards on either side of any continuous 1-mile length of pipeline. This route characterization has also determined that there are more than 700 miles of pipeline route crossing areas with no inhabited dwellings. Attachment 1 contains a list of mile posts where there are identified sites and structures that potentially could have human occupancy within 220 yards of the ROW. Given the geographic remoteness, robust size and grade of line pipe, unlikelihood of internal corrosion, and monitoring conditions, there is an extremely low probability that the pipeline will rupture.

Second, Alaska LNG prepared and presented a paper discussing whether increasing the MLBV spacing would impact pipeline safety. The paper compared the hazards in terms of the volume of natural gas released over time, the potential for damage to surrounding structures, and the life safety risk to personnel and the public. A summary of those results has been published in 2016[9] and concluded that “these results indicate that increased valve spacing could be implemented in remote, low population density areas without affecting safety.”

[9] Rothwell, B., Dessein, T. and Collard, A. 2016. Effect of Block Valve and Crack Arrestor Spacing on Thermal Radiation Hazards Associated with Ignited Rupture Incidents for Natural Gas Pipelines. Proceedings of the International Pipeline Conference, ASME International, New York, NY. Paper IPC2016-64604. September.

Third, the Special Permit Conditions, which are summarized in Section VII, result in less time between rupture and valve actuation, improved valve monitoring, and ensure more robust pipe is placed in proximity to key infrastructure (e.g. key bridges identified by ADOT&PF).

d. *Explain the basis for the particular set of alternative mitigation measures used in the special permit conditions. Explain whether the measures will ensure that a level of safety and environmental protection equivalent to compliance with existing regulations is maintained.*

The basis for the mitigation measures is the aforementioned engineering analysis, combined with consultation with US DOT PHMSA and ADOT&PF. More details on these measures is provided in Section VII. These measures help ensure that no significant environmental impact will result from increasing the MLBV spacing.

e. *Discuss how the special permit would affect the risk or consequences of a pipeline leak, rupture or failure (positive, negative, or none). This would include how the special permits preventative and mitigation measures (conditions) would affect the consequences and socioeconomic impacts of a pipeline leak, rupture or failure.*

Previous studies have examined the results of NTSB and PHMSA incident databases and concluded the risk to the public is independent of valve spacing.[10,11] This is attributed to the fact that "the injuries and fatalities on gas transmission pipelines generally occur during the first 30 seconds after gas has been released from a pipeline." These results are consistent with the findings of the Project's engineering analysis[2].

f. *Discuss any effects on pipeline longevity and reliability such as life-cycle and periodic maintenance including integrity management. Discuss any technical innovations as well.*

The Proposed Alternative would result in reduced MLBV maintenance, with no overall impacts on pipeline longevity and reliability. Implementation of the conditions will

[10] Eiber, R., McGehee, W., Hopkins, P., Smith, T., Diggory, I., Goodfellow, G., Baldwin, T. R. and McHugh, D. 2000. Valve Spacing Basis for Gas Transmission Pipelines. Pipeline Research Council International, PRCI Report PR 249 9728. January.

[11] Eiber, R., and Kiefner, J. 2010. Review of Safety Considerations for Natural Gas Pipeline Block Valve Spacing. ASME Standards Technology, LLC. Columbus. July.

require enhanced monitoring at Remote Controlled MLBV (RCV), and more stringent valve actuation criteria than what is required by Part 192.

g. *Discuss how the special permit would impact human safety.*

There would be no impact on human safety with the Special Permit.

h. *Discuss whether the special permit would affect land use planning.*

Special permit status would not change land use planning processes, given that the Proposed Action and No Action alternatives would both be premised a below-ground basis. The ROW authorization requirements, and other land use planning notification processes would be the same with or without a special permit.

i. *Discuss any pipeline facility, public infrastructure, safety impacts and/or environmental impacts associated with implementing the special permit. In particular, discuss how any environmentally sensitive areas could be impacted.*

Implementation of the Special Permit will reduce the number of MLBVs and associated footprint by about half. The Special Permit will require a more robust pipeline design within proximity of key bridges resulting in a positive impact to public infrastructure. There is no impact to environmentally sensitive areas.

V. Consultation and Coordination

a. *Please list the name, title and company of any person involved in the preparation of this document.*

Preparers: Alaska LNG LLC – Rick Noecker (PHMSA Filing Coordinator), Mario Macia (Pipeline Technology Lead), Norm Scott (ERL Advisor); Michael Baker International – Keith Meyer (Senior Pipeline Advisor).

b. *Please provide names and contact information for any person or entity you know will be impacted by the special permit. PHMSA may perform appropriate public scoping. The applicant's assistance in identifying these parties will speed the process considerably.*

Adjacent landowners/land managers potentially impacted:

Cook Inlet Region, Inc.
Jason Brune
Sr. Director, Land and Resources

PO Box 93330
Anchorage
AK 99509
(907) 263-5104

Bureau of Land Management
Earle Williams
Chief, Branch of realty and Conveyance Services
BLM Alaska State Office222 W. 7th Avenue #13
Anchorage
AK 99513-7504
(907) 271-5762

Alaska Department of Natural Resources
Jason Walsh
State Pipeline Coordinator
3651 Penland Parkway
Anchorage
AK 99508
(907) 269-6419

Alaska Dept. of Transportation & Public Facilities
David T Bloom
Gasline Liaison
2301 Peger Road
Fairbanks, AK 99709
(907) 451-5497

Brooke Merrell
Transportation Planner
United States National Park Service, Alaska Regional Office
240 W 5th Ave
Anchorage
AK 99501
(907) 644-3397

Don Striker
Superintendent
Denali National Park and Preserve
PO Box 9

Denali Park AK 99755-0009
(907) 683-9532

c. *If you have engaged in any stakeholder or public communication regarding this request, please include information regarding this contact.*

Alaska LNG has been active in stakeholder engagement throughout Alaska. As well, Federal, State and Local agency engagement is ongoing. In 2015 and 2016, Alaska LNG held one on one as well as multiagency engagement meetings to cover pipeline design construction and routing. Additionally, there have been over 20 engagement meetings between Alaska LNG and PHMSA. The MLBV Spacing Special Permit was a topic of discussion at multiple meetings. Additionally, an overview of this Special Permit was provided at a joint meeting with PHMSA and FERC on 19 April 2016.

PHMSA has participated in scoping and public outreach lead by FERC related to the Alaska LNG FERC Resource Reports. Details of the public outreach, which included both members of tribal entities and the general public, are provided in Sections 1.9 and Appendix D of the FERC Resource Report 1.

VI. Bibliography

Applicant to document information submitted, if they consulted a book, website, or other document to answer the question, please provide a citation.

Please see footnotes within this document.

VII. Conditions: Example of what special permit (SP) conditions address

a) Spacing will only be increased beyond Part 192 limits in Class 1 locations. The maximum spacing north of Fairbanks will be 50 miles, while the maximum spacing south of Fairbanks would be 30 miles.

b) MLBVs will be placed as reasonably possible to the start and end Mileposts in Class 2, 3 and 4 locations and will not exceed the spacing requirements of § 192.179.

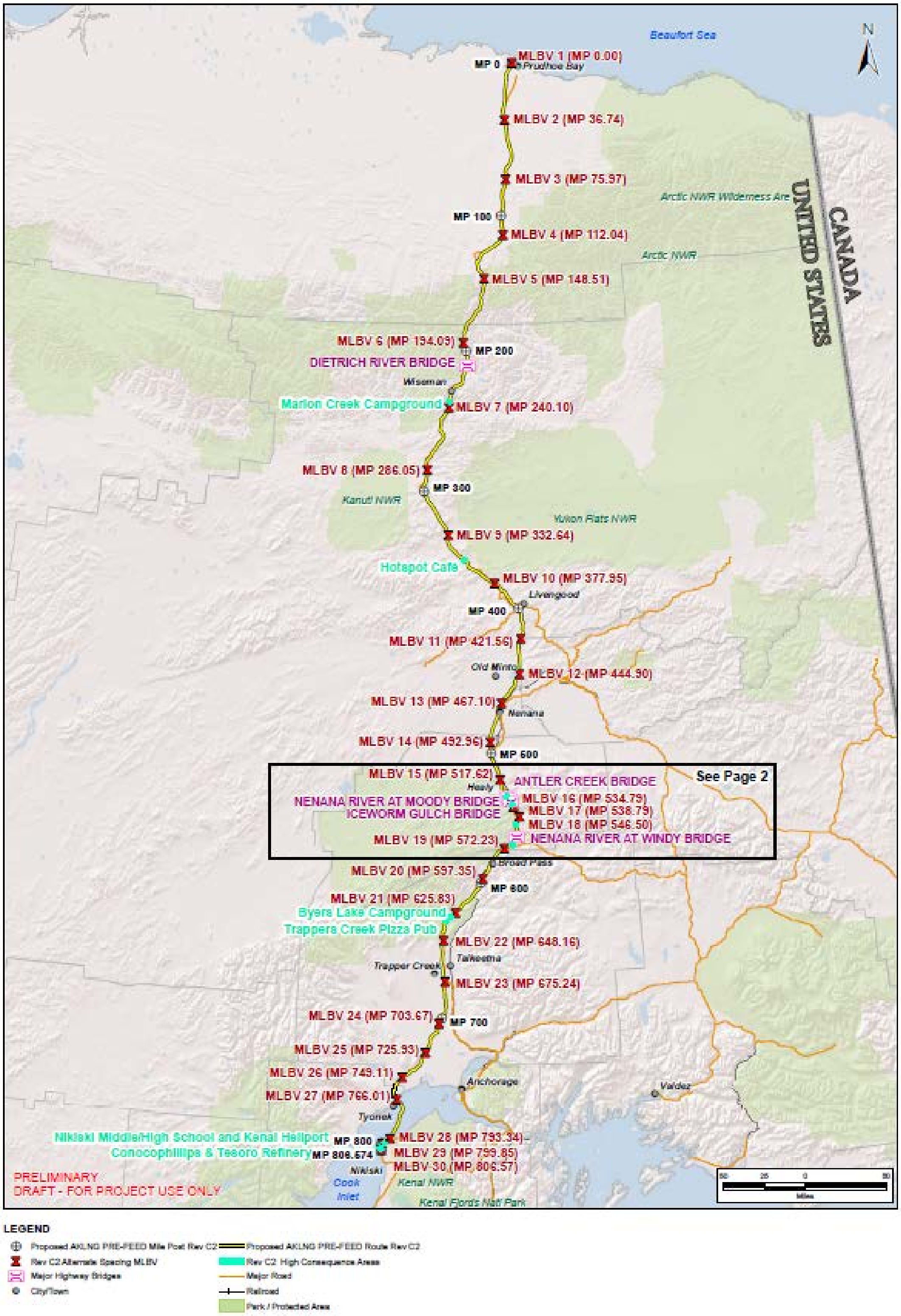
c) An engineering analysis must be performed to confirm that the number and location of MLBVs proposed in the Special Permit account for the criteria in Section 846.1.1 of ASME B31.8.

d) Enhanced valve closure criteria that will initiate valve closure when either of the following conditions occurs:

- Pressure drops to 60% of Maximum Operating Pressure (MOP) of that particular Pipeline Segment.
- Decrease in operating pressure in ten (10) minutes is greater than 8.75%.
- Valve closure within 36 minutes of rupture detection.

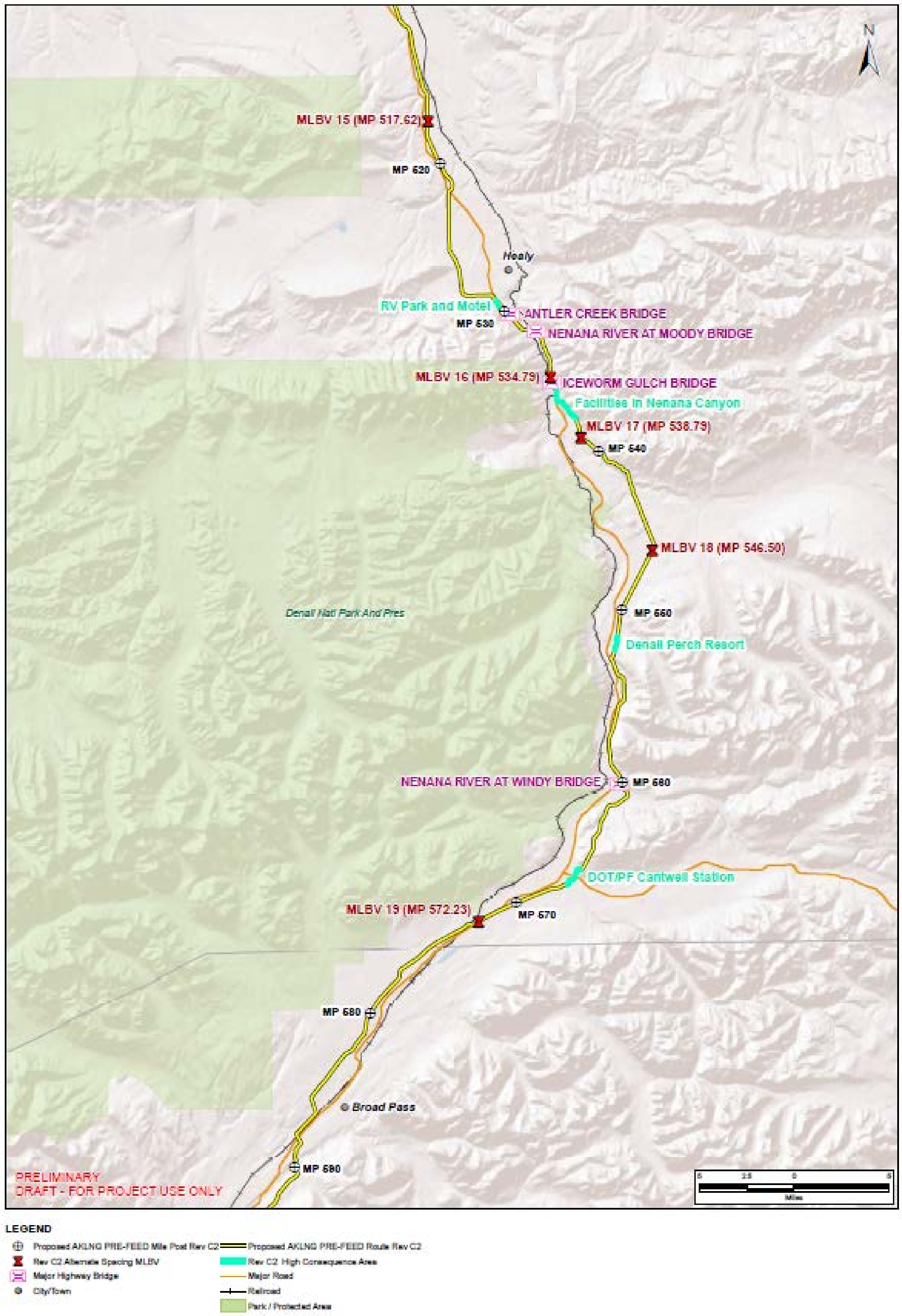
e) Real time monitoring at the Pipeline Control Center of MLBVs located at compressor, heater and metering stations (RCVs).

f) In High Consequence Areas (c.f. §192.905) in Class 1 and 2 locations, sectionalizing block valves spacing must comply with the requirements of §192.179, or pipe capable of intrinsic arrest, or crack arrestors spaced every eight pipe lengths must be installed from the start to end Mile Posts of the HCA.



Beaufort Sea
N
MP 0
MLBV 1 (MP 0.00)
Prudhoe Bay
MLBV 2 (MP 36.74)
MLBV 3 (MP 75.97)
Arctic NWR Wilderness Are
UNITED STATES
CANADA
MP 100
MLBV 4 (MP 112.04)
Arctic NWR
MLBV 5 (MP 148.51)
MLBV 6 (MP 194.09)
MP 200
DIETRICH RIVER BRIDGE
Wiseman
Marion Creek Campground
MLBV 7 (MP 240.10)
MLBV 8 (MP 286.05)
MP 300
Kanuti NWR
Yukon Flats NWR
MLBV 9 (MP 332.64)
Hotspot Cafe
MLBV 10 (MP 377.95)
Livengood
MP 400
MLBV 11 (MP 421.56)
Old Minto
MLBV 12 (MP 444.90)
MLBV 13 (MP 467.10)
Nenana
MLBV 14 (MP 492.96)
MP 500
MLBV 15 (MP 517.62)
Healy
ANTLER CREEK BRIDGE
See Page 2
NENANA RIVER AT MOODY BRIDGE
ICEWORM GULCH BRIDGE
MLBV 16 (MP 534.79)
MLBV 17 (MP 538.79)
MLBV 18 (MP 546.50)
MLBV 19 (MP 572.23)
NENANA RIVER AT WINDY BRIDGE
Broad Pass
MLBV 20 (MP 597.35)
MP 600
MLBV 21 (MP 625.83)
Byers Lake Campground
Trappers Creek Pizza Pub
MLBV 22 (MP 648.16)
Talkeetna
Trapper Creek
MLBV 23 (MP 675.24)
MLBV 24 (MP 703.67)
MP 700
MLBV 25 (MP 725.93)
MLBV 26 (MP 749.11)
Anchorage
Valdez
MLBV 27 (MP 766.01)
Tyonek
Nikiski Middle/High School and Kenai Heliport
Conocophillips & Tesoro Refinery
MP 800
MP 806.574
MLBV 28 (MP 793.34)
MLBV 29 (MP 799.85)
MLBV 30 (MP 806.57)
Nikiski
Cook Inlet
Kenai NWR
Kenai Fjords Nat'l Park
PRELIMINARY
DRAFT - FOR PROJECT USE ONLY
Miles
LEGEND
Proposed AKLNG PRE-FEED Mile Post Rev C2
Rev C2 Alternate Spacing MLBV
Major Highway Bridges
City/Town
Proposed AKLNG PRE-FEED Route Rev C2
Rev C2 High Consequence Areas
Major Road
Railroad
Park / Protected Area

Figure 1: Mainline Route Map



N
MLBV 15 (MP 517.62)
MP 520
Healy
RV Park and Motel
ANTLER CREEK BRIDGE
MP 530
NENANA RIVER AT MOODY BRIDGE
MLBV 16 (MP 534.79)
ICEWORM GULCH BRIDGE
Facilities in Nenana Canyon
MLBV 17 (MP 538.79)
MP 540
MLBV 18 (MP 546.50)
Denali Natl Park And Pres
MP 550
Denali Perch Resort
NENANA RIVER AT WINDY BRIDGE
MP 560
DOT/PF Cantwell Station
MLBV 19 (MP 572.23)
MP 570
MP 580
Broad Pass
MP 590
PRELIMINARY
DRAFT - FOR PROJECT USE ONLY
Miles
LEGEND
Proposed AKLNG PRE-FEED Mile Post Rev C2
Rev C2 Alternate Spacing MLBV
Major Highway Bridge
City/Town
Proposed AKLNG PRE-FEED Route Rev C2
Rev C2 High Consequence Area
Major Road
Railroad
Park / Protected Area

Figure 2: Mainline Route Map (Nenana Canyon detail)

Attachment 1 – Identified Sites and Structures within Class 1 locations

Mile Post	Offset Distance	Direction	Type	Comments
174.78	363	Left	Structure	DOT/PF Garage
174.85	288	Left	Structure	
174.86	296	Left	Structure	
174.86	335	Left	Structure	
174.87	542	Left	Structure	
175.12	571	Left	Structure	
236.12	494	Left	Structure	
236.12	542	Left	Structure	
236.13	547	Left	Structure	
352.79	603	Left	Associated Structure to Identified Site	Hotspot Cafe
352.80	638	Left	Identified Site	Hotspot Cafe
358.41	619	Right	Structure	
438.83	215	Left	Structure	
439.20	514	Left	Structure	
439.26	607	Left	Structure	
469.64	589	Left	Structure	
470.71	302	Right	Structure	
470.71	412	Right	Structure	
471.86	75	Left	Structure	
471.95	352	Right	Structure	
471.96	252	Left	Structure	
471.97	418	Left	Structure	
471.97	399	Right	Structure	
471.97	208	Left	Structure	
471.98	242	Left	Structure	
472.04	535	Right	Structure	
472.33	564	Right	Structure	
472.34	651	Right	Structure	
472.35	577	Right	Structure	
472.37	597	Right	Structure	
504.87	269	Left	Structure	
513.06	307	Left	Structure	
513.09	366	Left	Structure	
523.45	585	Right	Structure	
526.82	359	Left	Structure	
529.54	497	Right	Structure	
556.31	542	Right	Structure	
556.46	587	Right	Structure	
556.48	332	Right	Structure	
556.51	177	Right	Structure	
560.07	554	Right	Structure	Denali Fly Fishing Guides
566.35	607	Right	Identified Site	DOT/PF Cantwell Station
566.47	651	Right	Structure	
566.49	511	Left	Structure	
566.50	473	Right	Structure	
566.69	394	Right	Structure	
566.69	604	Right	Structure	
566.74	654	Right	Structure	
588.74	660	Right	Structure	
588.78	337	Right	Structure	
608.64	345	Left	Structure	
608.67	212	Right	Structure	
608.69	126	Left	Structure	
634.17	523	Right	Structure	
658.27	533	Left	Structure	
664.68	581	Left	Structure	
664.78	385	Right	Structure	
665.03	476	Right	Structure	
727.78	171	Right	Structure	

APPENDIX C.2 ENVIRONMENTAL INFORMATION FOR MLBV AND CA SPACING SPECIAL PERMIT

Appendix C

Environmental Information for MLBV and CA Spacing Special Permit

Crack Arrestor Spacing

Environmental Information

The purpose of this Attachment is to augment the National Environmental Policy Act analysis presented in the Alaska LNG Project Federal Energy Regulatory Commission Resource Reports (FERC RR) with information that meets specific U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA) requirements for a special permit as described in 49 Code of Federal Regulations (CFR) § 190.341. The Special Permit Conditions for usage of alternative Crack Arrestor spacing, as well as this Attachment, are also addressed in the Alaska LNG FERC Resource Report 11.

I. Purpose and Need

Alaska LNG is proposing to build a Mainline pipeline (the pipeline or the Mainline) to transport natural gas to a proposed Liquefied Natural Gas (LNG) facility from a proposed gas treatment plant located on Alaska's North Slope. The Federal Energy Regulatory Commission (the FERC) is the lead Federal agency. The Federal Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) has authority over the design and operation of natural gas transmission pipelines under 49 CFR Part 192. 49 CFR Part 192 includes specific regulatory requirements for the design, construction, operation, and maintenance of natural gas pipelines to maintain safety. If required, special permits can be granted under 49 CFR § 190.341 for proposed deviations from the regulatory requirements. PHMSA imposes conditions on the grant of special permits to assure safety and environmental protection in accordance with § 190.341. PHMSA is required to comply with the National Environmental Policy Act (NEPA) in deciding whether to issue the special permit.

Alaska LNG is requesting that PHMSA waive the requirements for crack arrestor (CA) spacing of every 320 feet for those Mainline segments subject to 49 C.F.R. 192.112(b). Alaska LNG is proposing CA spacing of 1,600 ft.

In support of Alaska LNG's request, Alaska LNG has performed an engineering analysis in accordance with ASME B31.8. This study evaluated the thermal radiation effects of increasing crack arrestor (CA) spacing from the eight pipe length (320 feet) requirement in §192.112(b)(2)(iii), to 1,600 feet. This same study evaluated the effect of increasing MLBV spacing in Class 1 locations beyond the 49 CFR § 192.179 limits. A summary of those results has been published[1] and concluded that increasing CA spacing up to 1,600 feet had no impact on the thermal dosage, (i.e., cumulative heat exposure), of a person in the vicinity of the pipeline and

[1] Rothwell, B., Dessein, T. and Collard, A. 2016. Effect of Block Valve and Crack Arrestor Spacing on Thermal Radiation Hazards Associated with Ignited Rupture Incidents for Natural Gas Pipelines. Proceedings of the International Pipeline Conference, ASME International, New York, NY. Paper IPC2016-64604. September.

that for valve spacing the "results indicate that increased valve spacing could be implemented in remote, low population density areas without affecting safety,"

Given these results, Alaska LNG is requesting a Special Permit from PHMSA to allow for increased CA spacing, in low risk, Class 1 locations. This Special Permit contains Conditions (Attachment B) that would ensure the pipeline has equal or greater safety than a pipeline constructed in accordance with Part 192.

II. Background and Site Description

Figure 1 shows the proposed Mainline route from the proposed gas treatment plant located at Prudhoe Bay to the proposed LNG Plant site located on the Kenai Peninsula. The Mainline would be a 42-inch-diameter natural gas pipeline, approximately 807 miles in length, extending from the Alaska LNG's Gas Treatment Plant (GTP) on the North Slope to the Liquefaction Facility on the shore of Cook Inlet near Nikiski, including an offshore pipeline section crossing Cook Inlet. The onshore pipeline would be a buried pipeline with the exception of short above-ground special design segments, such as aerial water crossings and aboveground fault crossings. As presented in Table 1.3.2-1 of FERC Resource Report 1 (inserted below), the Mainline would originate in the North Slope Borough, traverse the Yukon-Koyukuk Census Area, the Fairbanks North Star Borough, the Denali Borough, the Matanuska-Susitna Borough, and the Kenai Peninsula Borough, and terminate at the Liquefaction Facility. The Mainlines' proposed design has a maximum allowable operating pressure (MAOP) of 2,075 psig.

TABLE 1.3.2-1 (From FERC Resource Report 1)

Mainline Route Summary for a 42-inch Pipeline

Segment or Facility Name	**Boroughs or Census Areas**	**Approximate Length (miles)**
Mainline	North Slope Borough	184.4
	Yukon-Koyukuk Census Areas	303.8
	Fairbanks North Star Borough	2.4
	Denali Borough	86.8
	Matanuska-Susitna Borough	179.9
	Kenai Peninsula Borough	51.3
Total		**806.6**

The Mainline would include several types of aboveground pipeline facilities. The proposed design includes eight compressor stations, four meter stations, multiple pig launching/receiving stations, multiple Mainline block valves (MLBV), and five potential gas interconnection points. A list of compressor stations, heater station, and meter stations is provided in Table 1.3.2-6 of FERC Resource Report 1.

Appendix C

Environmental Information for MLBV and CA Spacing Special Permit

Approximately 36 percent of the Mainline route is collocated within 500 feet of an existing ROW to include TAPS and other pipelines, highways or major roads, utilities and railroads. Table 1.3.2-2 of FERC Resource Report 1 summarizes collocation of the Mainline route that are within 500 feet of highways, major roads, the Trans-Alaska Pipeline System (TAPS), other pipeline ROWs, utilities, and railroads. The Mainline crosses TAPS and its associated Fuel Gas Line 12 and 5 times, respectively, along with four railroad crossings. Design of the road and railroad crossings would be validated for applicability of the minimum wall thickness requirements for service loads on crossings in accordance with API RP 1102, using the appropriate design factor for the design class location, and comply with 49 CFR § 192.111. The minimum depth of cover would be four feet for road crossings as specified by the Alaska Administrative Code 17.AAC 15.211 “Underground Facilities” and 10 feet for railroad crossings, as specified in Alaska Railroad Corporation (ARRC) standards below travel surface (this exceeds the 49 CFR §192.327 requirement which requires a minimum of three feet at drainage ditches of public roads and railroads). Site-specific designs for major highway and railroad crossings are provided in Appendix H of the FERC application. Additional details on roads, railroads, pipelines, utilities, and power lines crossings can be found in FERC Resource Report 8.

Aerial crossings on pipeline specific bridges (i.e. bridges that carry only a pipeline) are located at Nenana River at Moody and Lynx Creek. The design factor for the pipeline at aerial crossings will comply with 49 CFR § 192.111.

Pipeline design standards in 49 CFR § 192.5(a)(1) are based on “class location units,” which classify locations based on population density in the vicinity of an existing or proposed pipeline system. The lower the class location (1-4), the higher the design factor used to find the minimum required wall thickness for pressure containment, i.e. the required minimum thickness of the pipe increases as the Class location increases. 99% of the Mainline route is in Class 1, which is defined as having 10 or fewer buildings intended for human occupancy located within 220 yards on either side of any continuous 1-mile length of pipeline. On the Kenai Peninsula, near Nikiski, there is a Class 2 location that is about 2.6 miles long. Also on the Kenai Peninsula there is a potential Class 3 location as the Mainline nears the LNG Plant. In the Nenana Canyon region of Denali National Park (~MP 536) there is approximately a half a mile of Class 3. Additional details on class locations for the Mainline can be found in FERC Resource Report 11, Section 11.7.

There are 10 potential high consequence areas (HCA) along the Mainline as defined under 49 CFR § 192.903. This includes two HCAs that are based on the aforementioned Class 3 locations. The remaining HCAs are located in Class 1 locations, details of which can be found in FERC Resource Report 11, Section 11.7, Table 11.7.4-1 (shown below).

Appendix C

Environmental Information for MLBV and CA Spacing Special Permit

TABLE 11.7.4-1

Potential HCA Takeoff Mainline Route Revision C2

From MP	To MP	Length (mi.)	Description
236.08	237.33	1.25	Marion Creek Campground
352.21	353.35	1.14	Hotspot Cafe
529.21	530.44	1.23	RV Park and Motel
535.54	537.74	2.20	Denali Riverside RV Park, McKinley Chalet Resort, Denali Rainbow Village and RV, Denali Princess Wilderness Lodge, Denali Crows Nest Cabins, Grand Denali Lodge, Denali Bluffs Hotel
551.34	552.27	0.93	Denali Perch Resort
565.77	567.23	1.46	DOT/PF Cantwell Station
629.75	631.35	1.60	Byers Lake Campground (73 units)
633.75	634.50	0.75	Trappers Creek Pizza Pub
797.71	799.28	1.57	Nikiski Middle/High School, Kenai Heliport, Commercial Buildings, Industrial Sites
803.39	806.05	2.66	Conoco Phillips Property and Tesoro Kenai Refinery
Total		14.79	

In addition, the pipeline route segments that are addressed in this Special Permit for Strain Based Design, (Strain Based Design segments), will be incorporated into the integrity management program, (IMP), and treated as a covered segment in a high consequence area, (HCA), in accordance with 49 CFR Part 192, Subpart O, and the Special Permit Conditions.

The construction right of way (ROW) width will vary depending on the type of terrain, the season of construction, and the ease of access from nearby roads. The permanent ROW width will be 50 feet plus the diameter of the pipeline, i.e. 53-1/2 feet. Greater details on construction ROW can be found in FERC Resource Report 1. The Mainline would be sited on land composed of more than 85 percent federal, State of Alaska, and borough land of various holdings, with the remainder on privately owned land (see Resource Report 8).

The proposed gas pipeline spans five physiographic regions including the Arctic Coastal Plain, Arctic Foothills, Brooks Range, Yukon-Tanana Upland, and Tanana-Kuskokwim Lowland. These regions host a variety of ecosystems including muskeg bogs, spruce upland forest, alpine and Arctic tundra, high brush, and bottomland spruce and poplar forests. The associated ecosystems support a variety of species which include grizzly and black bears, arctic foxes, seals, caribou, moose, small terrestrial mammals, birds, and anadromous fish. A variety of marine mammals inhabit the coastal waters in the Project area, including the bowhead whale, polar bear, beluga whale, ringed seal, bearded seal, Stellar sea lion, harbor seal, ribbon seal and spotted seal. Some of these species are critical subsistence resources for Alaska Native peoples.

A detailed description of the Mainline ROW is included in Section 1.3.2.1 of FERC Resource Report 1. Supporting facilities are described in Section 1.3.2.1.3 and temporary construction infrastructure is described in Section 1.3.2.4 of FERC Resource Report 1. Baseline environmental conditions and the analysis of environmental effects resulting from construction and operation of the Mainline are addressed by individual resources as follows:

a) Resource Report 2 (Water Use and Quality).

b) Resource Report 3 (Fish, Wildlife and Vegetation).

c) Resource Report 4 (Cultural Resources).

d) Resource Report 5 (Socioeconomics).

e) Resource Report 6 (Geological Resources).

f) Resource Report 7 (Soils).

g) Resource Report 8 (Land Use, Recreation and Aesthetics).

h) Resource Report 9 (Air and Noise Quality).

The pipeline will traverse areas potentially subject to geotechnical hazards (geohazards). Broadly defined, a geohazard is a geological and/or environmental condition with the potential to cause distress or damage to civil works. Geohazards of particular interest for the Alaska LNG pipeline are time dependent, such as thaw settlement and frost heave. These are addressed in more detail in the Strain Based Design Special Permit Conditions and Environmental Information (Attachments B and C of the Strain Based Design Special Permit Application).

The pipeline will also traverse areas commonly used for outdoor recreation, sporting, and subsistence activities. It is possible that individuals could be in the vicinity of the pipeline even if there are 10 or fewer buildings intended for human occupancy located within 220 yards on either side of any continuous 1-mile length of pipeline. The State of Alaska issued 871,467 hunting, fishing, and trapping licenses in 2015.[2] However, as the engineering analysis has shown, the proposed action would not expose these individuals to any risk greater than a 49 C.F.R. 192 compliant design, but rather will employ mitigation measures to reduce risk to the public.

III. Alternatives

For PHMSA's NEPA assessment a No Action alternative reflects a pipeline design that would not require issuance of a Special Permit. The Proposed Action alternative reflects Alaska LNG's

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[2] http://www.adfg.alaska.gov/static/license/pdfs/2015_license_stamps_tags_issued.pdf

design for which a Special Permit with conditions related to increased spacing of CAs would be issued.

An applicant requesting a Special Permit from PHMSA has the option of building a pipeline which would not require PHMSA to issue a Special Permit. This would require the design, construction, and operation of a pipeline in-compliance with Part 192. The two alternatives are described below.

a. No Action Alternative – Design, construct, operate and maintain the pipeline in compliance with 49 CFR 192. This would require crack arrestors to be placed at 320-foot intervals for those Mainline segments subject to 49 C.F.R. 192.112(b).

b. Proposed Action Alternative – Design, construct, operate, and maintain the pipeline in compliance with the CA Spacing Special Permit Conditions.

i. *Explain what the special permit application asks for.*

Increase in CA Spacing up to 1,600 feet from the requirement in § 192.112(b), which is spacing every 320 feet.

ii. *Cite regulation(s) for which special permit is sought in accordance with 49 CFR § 190.341:*

49 C.F.R. §§ 192.112(b).

iii. *Explain/summarize how the design/operation/maintenance of the pipeline operating under the SP would differ from the pipeline in the no action alternative.*

In the unlikely event of a rupture, fracture control measures are required to ensure that the propagating fracture would arrest within a limited distance. Table 11.7.2-13 (duplicated below) illustrates the fracture control strategy that was selected for the different segments of the Mainline. In all but two design cases, a fracture that is propagating in the longitudinal direction of the pipe would self-arrest. This feature is known as intrinsic arrest, and meets the requirements of § 192.112(b)(2)(iii). Where intrinsic arrest is not feasible, mechanical crack arrestors would be used. This is needed in two design cases, grade X80 with 0.8 DF and 0.72 DF. This SP addresses these two design cases. In addition to applicable requirements under 49 C.F.R. Part 192, a pipeline utilizing the CA spacing special permit would require a fracture control plan (FCP). This FCP would require that the pipeline would have sufficient strength and toughness so that a rupture would not initiate unless a through wall thickness penetration exceeded four (4) inches in length. The minimum toughness required by the Alaska LNG fracture control plan is based on a method developed by Battelle in the late 1960s and early 1970s[3,4]. This method was originally validated against 92 burst tests on pipe vessels containing axial, through-wall flaws, which showed the analytical predictions to be extremely accurate[5]. This method can be used to calculate the toughness required to prevent an unstable fracture as a function of the length of a through-wall flaw and is used by the pipeline industry to specify toughness requirements for pipelines.

TABLE 11.7.2-13 (from FERC Resource Report 11)

Fracture Control: Fracture Initiation

Section	Grade	Class Location	Design Factor	Wall thickness (in)	L_{crit} (in)	
					Pipe Body	Seam Weld/HAZ
Strain-Based (Type 2)	X70M	1	0.72	0.86	8.7	7.5
		2	0.6	1.03	11.4	9.0
		3	0.5	1.24	15.4	11.8
Conventional (Type 1)	X80M	1*	0.8	0.68	5.9	5.1
		1	0.72	0.75	7.5	6.5
		2	0.6	0.90	10.6	9.7
		3	0.5	1.08	13.4	10.2

Notes: * - utilizing Alternative MAOP

The FCP would also require that the pipeline be able to stop a propagating fracture within eight (8) pipe lengths (320 feet) through either crack arrestors, or intrinsic arrest, per the requirements of 49 C.F.R. 192.112(b)(3), when in proximity to key infrastructure (e.g. key bridges and TAPS).

Additional detail on the requirements for design, construction, and operation is provided in Section VII of this document and the Special Permit Conditions (Attachment B).

iv. ***Applicant*** *should include the pipeline stationing and mile posts (MP) for the location or locations of the applicable* ***special permit segment(s)***

The proposed CA SP segments are not continuous but are wholly within the state of Alaska and entirely within Class 1 locations. The CA SP will apply to the onshore Mainline Alternative MAOP segments. (The CA SP segments below are the same as those identified in the SP Application for use of the 3LPE coating).

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[3] J. Kiefner, "Fracture Initiation," American Gas Association, New York, USA, 1969.
[4] J. Kiefner, W. Maxey, R. Eiber and A. Duffy, "Failure Stress Levels of Flaws in Pressurized Cylinders," ASTM STP 536, Philadelphia, PA, USA, 1973.
[5] A. Rothwell and D. Horsley, "Evolution and Current Status of Fracture control Design for Gas Pipelines," Canberra, Australia, 2007.

Appendix C

Environmental Information for MLBV and CA Spacing Special Permit

SP Segments	
Milepost (MP)	
Start (MP)	**End (MP)**
0.00	535.99
536.49	766.00
793.00	798.65
801.27	803.78
806.25	806.57

v. *Mitigation Measures*

Additional mitigation measures are addressed in Section VII of this document and the Special Permit Conditions (Attachment B).

IV. Environmental Impacts of Proposed Action and Alternatives

a. Describe how a small and large leak/rupture to the pipeline could impact safety and the environment/human health.

The following consideration of the potential impacts of small and large pipelines leaks/ruptures to the environment/human health apply equally to the proposed action and primary no-action alternatives, given that they both have a below-ground design basis.

i. Any discussion of the consequence of a leak or rupture must be put into the context of its probability. For the following reasons, it is highly unlikely that a leak or rupture occurring in the Mainline Class 1 locations will impact the environment or human health for the following reasons:

a) Remoteness of the pipeline route: more than 99% of the Mainline route is in Class 1 location (800.98 miles of 806.57 miles). The frequency of incidents is significantly less for pipelines in Class 1 locations than in Class 2, 3 or 4 due to very low risk of mechanical damage.

b) Resilience to third party mechanical damage: given the remoteness of the pipeline and the high thickness of the pipeline, there is very low risk of mechanical damage. However, fracture mechanics calculations based on the mechanical properties of the pipe material and operating conditions of the pipe have shown that the pipe is very resistant to fracture, capable of withstanding a through wall thickness puncture of greater than 4” in length without rupturing.

c) Very low probability of corrosion damage: the Mainline will be transporting a dry, LNG specification gas, which contains no significant quantities of the species required to cause corrosion: water (<0.1 lbs/MMSCF), CO_2 (<50 ppmv) and H_2S (≤4 ppmv). With these low impurity contents, a corrosive liquid water phase will not form inside the pipeline. Therefore, the probability of internal corrosion is minimal.

To ensure the integrity of the pipeline, the in-line inspection program will comply with the robust requirements of 49 CFR § 192.620. External corrosion will be mitigated by using a high integrity coating, and with a cathodic protection system.

d) Compliance with Alternative MAOP requirements: the entire Mainline will be operated and maintained per 49 CFR § 192.620, which establishes robust operational requirements. Additionally, more than 615 miles of the total Mainline length, to include Alternative MAOP and SBD segments, will also comply with 49 CFR §§ 192.112 and 192.328, which, respectively, establish robust design and construction requirements.

e) Alaska LNG performed an engineering study that considered the crack arrestor spacing. The analysis results, that have been published[6], suggest "that increased valve spacing could be implemented in remote, low population density areas without affecting safety." The thermal radiation analysis demonstrated there is a negligible difference in the potential consequence to personnel in Class 1 locations, where there is an extremely low density of buildings intended for human occupancy. Incident prevention (decreasing probability of rupture) is better controlled through other practices, such as design for fracture resistance and control, and robust integrity management practices that include in-line inspections.

ii. A small leak from a buried pipeline would result in a gradual release of gas, with the total amount of gas being released dependent on the time it takes for the leak to be detected and fixed. Small leaks would primarily be identified through mass balance systems incorporated in gas pipeline control and pipeline inspection programs that are not impacted by CA spacing. Gas from a small leak would permeate through the backfill material (soil) before dissipating into the air. Small gas pipeline leaks may result in some impacts to, or loss of, surrounding vegetation. This localized browning of vegetation can facilitate identification of small underground leaks during right of way inspection, which will be performed at intervals not exceeding 45 days, but a least 12 times each calendar year (per 49 CFR § 192.620(d)(4)). Other visual techniques are available including inspection of snow pack (seasonal). The rate at which gas is lost, and total volume of gas lost from a small leak is independent of CA spacing, and is more contingent on identification timelines; therefore, the environmental impacts from a small leak are the same in both the proposed action and non-action case.

iii. A rupture would result in the rapid release of a large volume of natural gas resulting in significant damage to the pipeline and would create a trench or crater in the immediate

[6] Rothwell, B., Dessein, T. and Collard, A. 2016. Effect of Block Valve and Crack Arrestor Spacing on Thermal Radiation Hazards Associated with Ignited Rupture Incidents for Natural Gas Pipelines. Proceedings of the International Pipeline Conference, ASME International, New York, NY. Paper IPC2016-64604. September.

vicinity of the rupture. If an ignition source is present, an intense fire or explosion would result. For a fire resulting from a rupture; the damage due to the fire would depend on the extent of the combustible materials in the vicinity (infrastructure, vegetation), and local environmental conditions (e.g., rain, snow cover, etc.). The probability for human injury or fatality and property damage is relatively small for this largely remote pipeline, and decreases as distance from the rupture increases. The pipeline will be sectionalized with mainline block valves and the gas released during a rupture scenario would be limited to the inventory between valves; this amount of inventory would determine the duration of the intense fire. The spacing between the block valves is the subject of another Special Permit. Large ruptures would be easily detectable through monitoring of pressure and flow conditions at pipeline facilities.

b. *Submit an explanation of **delta/difference** in safety and possible effects to the environment between the 49 CFR Part 192 baseline (Code baseline) and usage of the special permit conditions for CA spacing mitigation measures.*

i. The anticipated differences in effects for individual resources between the No Action alternative and the Proposed Action alternative are discussed below. References are made to FERC Resource Reports, where applicable, for further detailed information and analysis of impacted resources. The basis for the FERC Resource Reports is the Proposed Action Alternative; however, the associated environmental impact analysis is also applicable to the No Action alternative, given both alternatives are based on below ground design and installation, and both follow an identical route.

1. Human Health and Safety

The differences are negligible because as discussed previously, the impact to human health and safety with respect to the rupture and ignition event are similar with respect to the proposed action and no action cases for increased spacing. The published rupture analysis report evaluating the impact of increased CA spacing further outlines that the total threshold thermal dosage (accumulated amount of damaging heat) is equivalent for CA spacings up to 1,600ft.

2. Air Quality

There would be no significant difference in emissions between the No Action and Proposed Action alternatives. The majority of heavy equipment required for construction in either alternative will be the same, including equipment such as brushers and bulldozers for the clearing and leveling of the ROW, trucks for transporting pipe, and sidebooms and welding trucks for pipe placement and welding. During the construction process, fewer installations of CAs could result in fewer emissions, but would not significantly affect overall emissions.

O&M activities to maintain the pipeline for the No Action and proposed Action alternatives would require similar equipment and personnel. This comparison would apply equally to pollutant and greenhouse emissions.

In the unlikely event of a pipeline rupture or leak large enough to depressurize the pipeline and trigger valve closure, there would be no incremental increase of greenhouse gas emissions for the Proposed Action alternative, relative to the No Action alternative.

Detailed description of air emissions, including greenhouse gas emissions, from pipeline construction and operations are contained in FERC Resource Report 9 (Air and Noise Quality).

3. Aesthetics

There would be no difference in visual effects between the No Action and Proposed Action alternatives as a result of the CA spacing. Both alternatives will be below ground, and follow the same route.

4. Biological Resources (including vegetation, wetlands, and wildlife)

There would be no difference in impacts to vegetation, wetlands and wildlife between the between the No Action and Proposed Action alternatives. Both alternatives will be below ground, and follow the same route.

FERC Resource Report 3 (Fish, Wildlife and Vegetation) contains descriptions of vegetation and wildlife resources, and potential impacts associated with the Mainline route. FERC Resource Report 2 contains a detailed analysis of wetlands affected by the Mainline route, and mitigation of impacts.

5. Resilience and Adaptation

The potential effects of a changing climate on Mainline design and operation are not expected to differ between the No Action and Proposed Action alternatives. Project design criteria incorporated consideration of a range of variable site conditions that could occur based upon historic information and future conditions. Mitigations are integrated into the design where appropriate or required for facility integrity and safe operations. Opportunities for resilience and adaptation to potential weather effects have been considered in the design of the Mainline. For example, geothermal modeling would be used to assess potential changes in ground temperatures that could be caused by longer-term geothermal impacts of pipeline construction, operations and changes in climate. Other resilience and adaptation design considerations for the Mainline are addressed in Resource Report No. 1.

FERC Resource Report 9 (Air and Noise Quality) discusses greenhouse gas emissions from the Project.

6. Cultural Resources

There would be no difference in the effect on Cultural Resources between the No Action and Proposed Action Alternatives. Construction activities have the potential to affect cultural resources. Ground-clearing activities under both cases would be similar. The FERC is conducting the Section 106 consultation process with stakeholders; that process will lead to the development of a Programmatic Agreement that would address management and recovery of known cultural resources and any discovered during project implementation. The Programmatic Agreement would apply to both the No Action and Proposed Action alternatives to mitigate effects on these resources. FERC Resource Report 6 (Cultural Resources) addresses cultural resources affected by the Project, and associated mitigations.

7. Environmental Justice

Since both pipeline designs would be sited in the same footprint, there would be no difference in effects on environmental justice resulting from construction or operation of the pipeline between the No Action and Proposed Action alternatives.

8. Geology, Soils and Mineral Resources

There would be no difference in the effect on Geology, Soils and Mineral Resources between the No Action and Proposed Action Alternatives. Construction activities have the potential to affect soils in a localized manner with minimal effect on regional geology or mineral resources. Construction activities that could contribute to erosion include clearing and grading, excavation trenching, stockpile management, backfilling, and the development of gravel pads. Most erosion effects are effectively managed through the use of erosion and sediment control measures, including:

a) The use of winter construction in areas of inundated and frozen ground conditions;

b) Use of settlement basins, silt fences, and other Best Management Practices (BMP) for storm water control;

c) Use of engineered flow diversions and slope breakers to control water flow on slopes and around water courses; and

d) Installation of trench breakers to address storm and groundwater flow through the trench backfill or during construction.

Operations and maintenance activities along the pipeline right-of-way performed to meet Part 192 would be similar for the No Action and Proposed Action alternatives. All O&M excavations would be conducted as authorized under the applicable ROW authorization. As the land management agencies responsible for lands along the pipeline route, ROWs would be issued by one, or both, of the Bureau of Land Management and Alaska Department of Natural Resources. All excavations and other applicable activities would be permitted through the appropriate Federal and State agencies for both of these alternatives. Both alternatives would have similar impacts on soil resources.

FERC Resource Report 7 (Soils), contains a more detailed discussion of impacts to soils and erosion resulting from the pipeline construction and the potential mitigation measures to address those impacts.

9. Indian Trust Assets

No Indian Trust Assets or Native allotments are located within the pipeline route.

10. Land Use, Subsistence, and Recreation

There would be no difference in the effect on Land Use, Subsistence, and Recreation between the No Action and Proposed Action Alternatives. During construction, land use in the form of subsistence activities and recreation for both alternatives could be altered in the immediate vicinity of activities. The pipeline's remote location combined with the relatively small width of the ROW would generally limit the extent of displacement by users to the active construction zones. Construction activities would be timed to avoid potential use conflicts with portions of the trail used during the annual Iditarod sled-dog race.

After construction the ROW would be graded and revegetated to a stable condition in accordance with the FERC approved Alaska LNG Upland Erosion Control, Revegetation and Maintenance Plan; Alaska LNG Wetland & Waterbody Construction & Mitigation Procedures; and the associated Alaska LNG Project Restoration Plan. No long term linear access along the pipeline alignment is proposed. However, under either alternative, PHMSA regulations will require that the pipeline ROW is brushed to prevent the growth of large vegetation over and around the pipeline to maintain a clearly defined ROW.

FERC Resource Report 8 (Land Use, Recreation and Aesthetics) considers potential effects to land use and recreation activities. FERC Resource Report 5 (Socioeconomics) considers potential impacts to subsistence.

11. Noise

During normal operations there would be no difference in Noise Impacts.

12. Water Resources

There would be no difference in impacts to water resources between the No Action and the Proposed Action Alternatives. For both alternatives, stabilization techniques, including gravel blankets, riprap, gabions, or geosynthetics, would be used to stabilize the channel bed and stream banks at stream crossings. The majority of rivers and streams along the pipeline route would be crossed by an open-cut method during winter months; during these months the flows of rivers and streams are lowest, and disturbance of the channel and stream bank can be minimized. Burial depths for crossings have been based on site specific calculations to avoid the potential for scour. Watercourse crossing methods for each watercourse crossing are the same for both alternatives.

FERC Resource Report 2 (Water Use and Quality) contains a detailed discussion regarding the management of water during construction and operation of the pipeline, as well as impacts to ground, surface water flow and quality resulting from the construction and operation of the pipeline.

c. *Describe safety protections provided by the special permit conditions.*

Several factors were taken into consideration. First, the Mainline route has been characterized for location of dwellings and structures in accordance with 49 CFR § 192.5 and 99% of the Mainline route is in Class 1, which is defined as having 10 or fewer buildings intended for human occupancy located within 220 yards on either side of any continuous 1-mile length of pipeline. This route characterization has also determined that there are more than 700 miles of pipeline route crossing areas with no inhabited dwellings. Attachment 1 contains a list of mile posts where there are identified sites and structures that potentially could have human occupancy within 220 yards of the ROW. Given the geographic remoteness, robust size and grade of line pipe, unlikelihood of internal corrosion, and monitoring conditions, there is an extremely low probability that the pipeline will rupture.

Second, Alaska LNG prepared and presented a paper discussing whether increasing the MLBV and CA spacing would impact pipeline safety. The paper compared the hazards in terms of the volume of natural gas released over time, the potential for damage to surrounding structures, and the life safety risk to personnel and the public. A summary of those results has been published in 2016[7] and concluded that “these results indicate that

[7] Rothwell, B., Dessein, T. and Collard, A. 2016. Effect of Block Valve and Crack Arrestor Spacing on Thermal Radiation

increased valve spacing could be implemented in remote, low population density areas without affecting safety." This same study also evaluated the thermal radiation effects of increasing crack arrestor spacing from 320 feet, to 3,200 feet. The 320 feet spacing corresponds to 8 pipe lengths that are each 40 feet in length. It was found that there was no effect on the area exposed to key thermal radiation dosages for people for crack arrestor spacings up to 1,600 feet. The conclusions from the report have been reached by comparing the total threshold thermal dosage (the total accumulated amount of damaging heat) that various receptors (humans, trees/wooden structures) would be subjected to during a pipeline rupture and ignition event[8]. The report outlines that for both people and resources, the total thermal dosage is largely identical, differing only in cases where CA spacing exceeds 1,600ft. This is largely because the largest radius around the rupture is exposed to the largest amount of thermal radiation during the period when gas flows, and therefore thermal release profiles, are identical. Both the thermal intensity and impacted radius drop sharply in the minutes following the initial event. As a result, the thermal intensity required to cause fatality, injury, or resource damage, falls to radii well within areas already impacted by significant thermal dosages. This means that in spite of increased duration of intense heat from the burning of natural gas, the total damaging heat (thermal dosage) is similar in effect.

Third, the Special Permit Conditions, which are summarized in Section VII, ensure additional focus on fracture control, especially in proximity to key infrastructure (e.g. key bridges identified by ADOT&PF).

d. *Explain the basis for the particular set of alternative mitigation measures used in the special permit conditions. Explain whether the measures will ensure that a level of safety and environmental protection equivalent to compliance with existing regulations is maintained.*

   The basis for the mitigation measures is the aforementioned engineering analysis, combined with consultation with US DOT PHMSA and ADOT&PF. These measures help ensure that no significant environmental impact will result from increasing the CA spacing.

e. *Discuss how the special permit would affect the risk or consequences of a pipeline leak, rupture or failure (positive, negative, or none). This would include how the special permits preventative and mitigation measures (conditions) would affect the consequences and socioeconomic impacts of a pipeline leak, rupture or failure.*

Hazards Associated with Ignited Rupture Incidents for Natural Gas Pipelines. Proceedings of the International Pipeline Conference, ASME International, New York, NY. Paper IPC2016-64604. September.

[8] The concepts of threshold dosage can be observed at any camp fire. Logs must be placed within a certain proximity (thermal radiation intensity) of the fire for them to begin burning (ignition). Logs that are too far away from the fire to ignite may absorb a large amount of thermal radiation over time, but they will never burn.

Previous studies have examined the results of NTSB and PHMSA incident databases and concluded the risk to the public is independent of valve spacing.[9,10] This is attributed to the fact that "the injuries and fatalities on gas transmission pipelines generally occur during the first 30 seconds after gas has been released from a pipeline." These results are consistent with the findings of the Project's engineering analysis and apply to increased crack arrestor spacing

Ruptures may result in longer pipeline fracture lengths in Class 1 Alternative MAOP pipeline segments with the Proposed Alternative. However, a through wall penetration of at least four (4) inches in length would be required to initiate a rupture, which is highly unlikely given the remoteness of the Mainline.

f. *Discuss any effects on pipeline longevity and reliability such as life-cycle and periodic maintenance including integrity management. Discuss any technical innovations as well.*

There would be no impact on pipeline longevity and reliability with the Special Permit.

g. *Discuss how the special permit would impact human safety.*

There would be no impact on human safety with the Special Permit.

h. *Discuss whether the special permit would affect land use planning.*

Special permit status would not change land use planning processes, given that the Proposed Action and No Action alternatives would both be premised a below-ground basis. The ROW authorization requirements, and other land use planning notification processes would be the same with or without a special permit.

i. *Discuss any pipeline facility, public infrastructure, safety impacts and/or environmental impacts associated with implementing the special permit. In particular, discuss how any environmentally sensitive areas could be impacted.*

There is no impact to environmentally sensitive areas.

V. Consultation and Coordination

a. *Please list the name, title and company of any person involved in the preparation of this document.*

Preparers: Alaska LNG LLC – Rick Noecker (PHMSA Filing Coordinator), Mario Macia (Pipeline Technology Lead), Norm Scott (ERL Advisor); Michael Baker International – Keith Meyer (Senior Pipeline Advisor).

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[9] Eiber, R., McGehee, W., Hopkins, P., Smith, T., Diggory, I., Goodfellow, G., Baldwin, T. R. and McHugh, D. 2000. Valve Spacing Basis for Gas Transmission Pipelines. Pipeline Research Council International, PRCI Report PR 249 9728. January.
[10] Eiber, R., and Kiefner, J. 2010. Review of Safety Considerations for Natural Gas Pipeline Block Valve Spacing. ASME Standards Technology, LLC. Columbus. July.

Appendix C

Environmental Information for MLBV and CA Spacing Special Permit

b. *Please provide names and contact information for any person or entity you know will be impacted by the special permit. PHMSA may perform appropriate public scoping. The applicant's assistance in identifying these parties* will speed the process considerably.

Adjacent landowners/land managers potentially impacted:

Cook Inlet Region, Inc.
Jason Brune
Sr. Director, Land and Resources
PO Box 93330
Anchorage
AK 99509
(907) 263-5104

Bureau of Land Management
Earle Williams
Chief, Branch of realty and Conveyance Services
BLM Alaska State Office222 W. 7th Avenue #13
Anchorage
AK 99513-7504
(907) 271-5762

Alaska Department of Natural Resources
Jason Walsh
State Pipeline Coordinator
3651 Penland Parkway
Anchorage
AK 99508
(907) 269-6419

Alaska Dept. of Transportation & Public Facilities
David T Bloom
Gasline Liaison
2301 Peger Road
Fairbanks, AK 99709
(907) 451-5497

Brooke Merrell
Transportation Planner
United States National Park Service, Alaska Regional Office
240 W 5th Ave
Anchorage
AK 99501

(907) 644-3397

Don Striker
Superintendent
Denali National Park and Preserve
PO Box 9
Denali Park AK 99755-0009
(907) 683-9532

c. *If you have engaged in any stakeholder or public communication regarding this request, please include information regarding this contact.*

Alaska LNG has been active in stakeholder engagement throughout Alaska. As well, Federal, State and Local agency engagement is ongoing. In 2015 and 2016, Alaska LNG held one on one as well as multiagency engagement meetings to cover pipeline design construction and routing. Additionally, there have been over 20 engagement meetings between Alaska LNG and PHMSA. The MLBV and CA spacing Special Permit were a topic of discussion at multiple meetings. Additionally, an overview of this Special Permit was provided at a joint meeting with PHMSA and FERC on 19 April 2016.

PHMSA has participated in scoping and public outreach lead by FERC related to the Alaska LNG FERC Resource Reports. Details of the public outreach, which included both members of tribal entities and the general public, are provided in Sections 1.9 and Appendix D of the FERC Resource Report 1.

VI. Bibliography

Applicant to document information submitted, if they consulted a book, website, or other document to answer the question, please provide a citation.

Please see footnotes within this document.

VII. Conditions: Example of what special permit (SP) conditions address

a) Produce a fracture control plan and ensure that the critical length of a through wall thickness penetration that would result in a rupture is greater than or equal to four (4) inches.

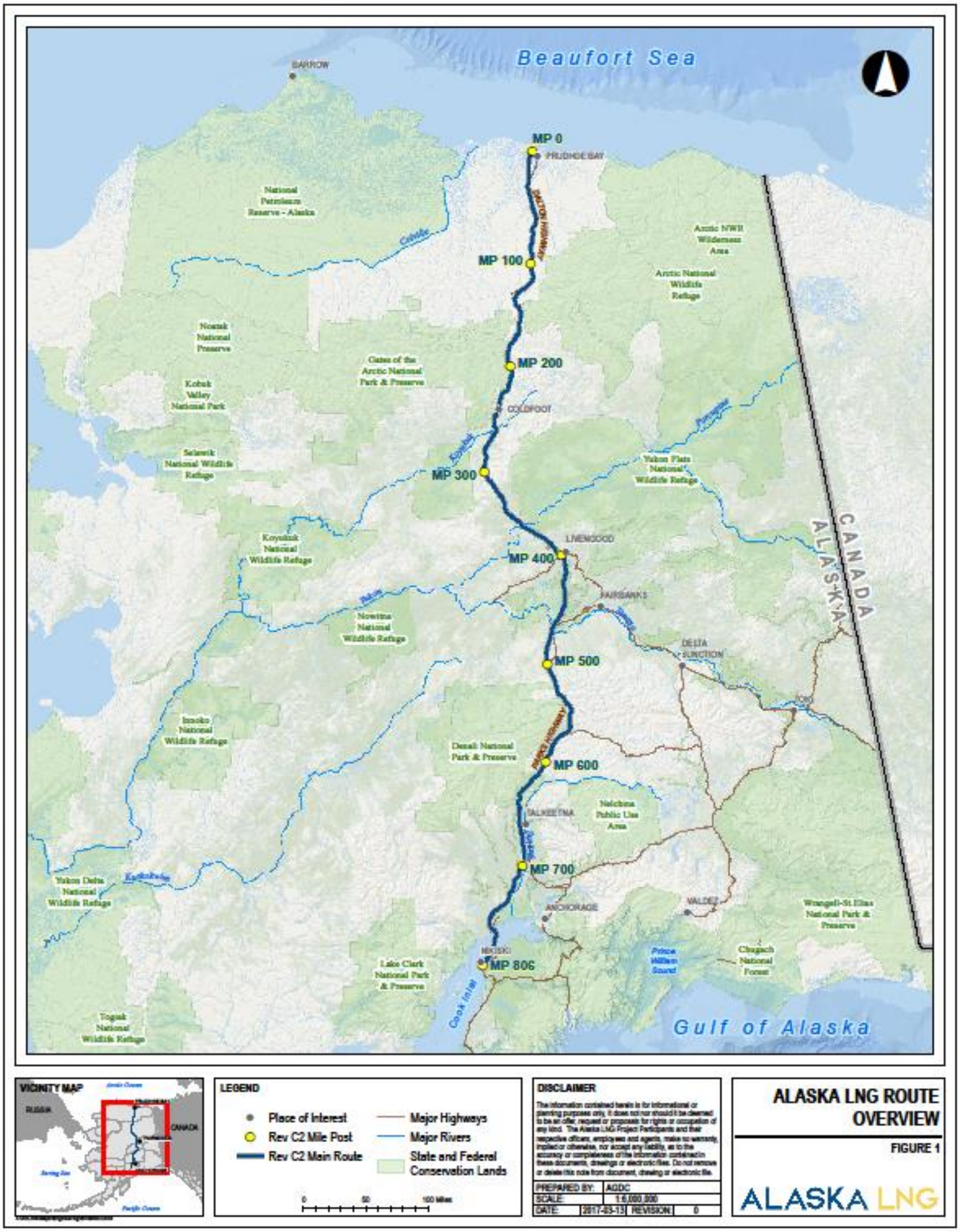
b) Compliance with the Fracture Control Requirements § 192.112 without the use of crack arrestors in Strain Based Design segments (Attachment 1 of Strain Based Design Special Permit Application) and in proximity of key bridges, as defined by ADOT&PF and PHMSA.

c) In High Consequence Areas (c.f. §192.905) in Class 1 and 2 locations, sectionalizing block valves spacing must comply with the requirements of §192.179, or pipe capable of intrinsic arrest, or crack arrestors spaced every eight pipe lengths must be installed from the start to end Mile Posts of the HCA.

d) CA destructive testing to demonstrate compliance with the Fracture Control requirements.

Appendix C

Environmental Information for MLBV and CA Spacing Special Permit



Appendix C

Environmental Information for MLBV and CA Spacing Special Permit

Figure 1: Mainline Route Map

Appendix C

Environmental Information for MLBV and CA Spacing Special Permit

Attachment 1 – Identified Sites and Structures within Class 1 locations

Appendix C

Environmental Information for MLBV and CA Spacing Special Permit

Mile Post	Offset Distance	Direction	Type	Comments
174.78	363	Left	Structure	DOT/PF Garage
174.85	288	Left	Structure	
174.86	296	Left	Structure	
174.86	335	Left	Structure	
174.87	542	Left	Structure	
175.12	571	Left	Structure	
236.12	494	Left	Structure	
236.12	542	Left	Structure	
236.13	547	Left	Structure	
352.79	603	Left	Associated Structure to Identified Site	Hotspot Cafe
352.80	638	Left	Identified Site	Hotspot Cafe
358.41	619	Right	Structure	
438.83	215	Left	Structure	
439.20	514	Left	Structure	
439.26	607	Left	Structure	
469.64	589	Left	Structure	
470.71	302	Right	Structure	
470.71	412	Right	Structure	
471.86	75	Left	Structure	
471.95	352	Right	Structure	
471.96	252	Left	Structure	
471.97	418	Left	Structure	
471.97	399	Right	Structure	
471.97	208	Left	Structure	
471.98	242	Left	Structure	
472.04	535	Right	Structure	
472.33	564	Right	Structure	
472.34	651	Right	Structure	
472.35	577	Right	Structure	
472.37	597	Right	Structure	
504.87	269	Left	Structure	
513.06	307	Left	Structure	
513.09	366	Left	Structure	
523.45	585	Right	Structure	
526.82	359	Left	Structure	
529.54	497	Right	Structure	
556.31	542	Right	Structure	
556.46	587	Right	Structure	
556.48	332	Right	Structure	
556.51	177	Right	Structure	
560.07	554	Right	Structure	Denali Fly Fishing Guides
566.35	607	Right	Identified Site	DOT/PF Cantwell Station
566.47	651	Right	Structure	
566.49	511	Left	Structure	
566.50	473	Right	Structure	
566.69	394	Right	Structure	
566.69	604	Right	Structure	
566.74	654	Right	Structure	
588.74	660	Right	Structure	
588.78	337	Right	Structure	
608.64	345	Left	Structure	
608.67	212	Right	Structure	
608.69	126	Left	Structure	
634.17	523	Right	Structure	
658.27	533	Left	Structure	
664.68	581	Left	Structure	
664.78	385	Right	Structure	
665.03	476	Right	Structure	
727.78	171	Right	Structure	
764.94	648	Left	Structure	
797.13	487	Left	Structure	
797.20	204	Right	Structure	