Jordan Cove Energy Project L.P.

Resource Report No. 10

General Project Description

Jordan Cove Energy Project

March 2017

JCEP LNG TERMINAL PROJECT

Resource Report 10 – Alternatives

MINIMUM FILING REQUIREMENTS	See the Following Resource Report Section:
1. Address the "no action" alternative –18 CFR § 380.12(1)(1)	Section 10.1
2. For large projects, address the effect of energy conservation or energy alternatives to the project – 18 CFR § 380.12(1)(1)	Section 10.3.6
3. Identify system alternatives considered during the identification of the project and provide the rationale for rejecting each alternative – 18 CFR § 380.12(1)(1)	Section 10.2
4. Identify major and minor route alternatives considered to avoid impact on sensitive environmental areas (e.g., wetland, parks, or residences) and provide sufficient comparative data to justify the selection of the proposed route – 18 CFR § 380.12(1)(2)(ii)	Section 10.3
5. Identify alternative sites considered for the location of major new aboveground facilities and provide sufficient comparative data to justify the selection of the proposed site – 18 CFR § 380.12(1)(2)(ii)	Section 10.3

INFORMATION OFTEN MISSING AND RESULTING IN DATA REQUESTS	See the Following Resource Report Section:
1. Ensure that project objectives that serve as the basis for evaluating alternatives are consistent with the purpose and need discussion in Resource Report 1.	Section 10.0
2. Identify and evaluate alternatives identified by stakeholders.	
3. Clearly identify and compare the corresponding segments of route alternatives and route variations to the segments of the proposed route that they would replace if adopted.	N/A

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ACRONYMS

AGPA	Alaska Gasline Port Authority
BC	British Columbia, Canada
BLM	Bureau of Land Management
BOG	Boil-off Gas
BOP	Balance of Plant
BPA	Bonneville Power Administration
CBEMP	Coos Bay Estuary Management Plan
CFR	Code of Federal Regulations
CMR	Cold Mixed Refrigerant
DMR	Dual Mixed Refrigerant
DOE	U.S. Department of Energy
Dth/d	Dekatherms per Day
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FTA	Free Trade Agreement
GTN	Gas Transmission Northwest
HRSG	Heat Recovery Steam Generator
JCEP	Jordan Cove Energy Project, L.P.
LNG	Liquefied Natural Gas
m^3	Cubic Meter
MCHE	Main Cryogenic Heat Exchanger
mtpa	Million Tonnes Per Annum
MW	Megawatt
NFPA	National Fire Protection Association
NWP	Northwest Pipeline Company
PCGP	Pacific Connector Gas Pipeline
PHMSA	Pipeline and Hazardous Materials Safety Administration
RFP	Roseburg Forest Products Company
RM	River Mile
RV	Recreational Vehicle
SIGTTO	Society of International Gas Tanker and Terminal Operators
SMR	Single Mixed Refrigerant
SORSC	Southwest Oregon Regional Safety Center
SWORA	Southwest Oregon Regional Airport
TPP	Trans-Pacific Parkway
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
WMR	Warm Mixed Refrigerant

RESOURCE REPORT 10
ALTERNATIVES

10.0 INTRODUCTION

Jordan Cove Energy Project, L.P. ("JCEP") is seeking authorization from the Federal Energy Regulatory Commission ("FERC" or "Commission") under Section 3 of the Natural Gas Act to site, construct, and operate a natural gas liquefaction and liquefied natural gas ("LNG") export facility ("LNG Terminal"). Pacific Connector Gas Pipeline ("PCGP") proposes to construct and operate a new, approximately 235-mile-long, 36-inch natural gas transmission pipeline capable of transporting 1,200,000 dekatherms per day ("Dth/d") of natural gas and crossing through Klamath, Jackson, Douglas, and Coos Counties, Oregon. PCGP's associated pipeline ("Pipeline") and the LNG Terminal are referred to, collectively, as the "Project." This resource report addresses only the LNG Terminal alternatives.

The overall Project purpose and need is to construct a natural gas liquefaction and deep-water export terminal capable of receiving and loading ocean-going LNG carriers, that receives its natural gas supply from a point near the intersections of the GTN Pipeline system and Ruby Pipeline system in Malin, Oregon. The Pipeline receipt point in Malin is strategically located to give international customers in Asia access to abundant supplies of natural gas from two burgeoning natural gas supply basins – one in the U.S. Rocky Mountains (through the existing Ruby Pipeline) and a second in western Canada (through the existing GTN Pipeline). The LNG Terminal, on the bay side of the North Spit of Coos Bay, would support receipt, liquefaction, storage, and loading of LNG onto ocean-going LNG tankers for delivery to export markets. The Project is a market-driven response to the availability of these burgeoning and abundant natural gas supplies, giving those supplies an efficient and cost-effective outlet. The Project is also a market-driven response to the growth of international, particularly Asian, natural gas markets.

A complete discussion and detailed descriptions of the proposed LNG Terminal facilities, land requirements, proposed construction and operation procedures, and schedule are provided in Resource Report 1. The Project Location Map in Figure 1.1-1 in Resource Report 1 shows the proposed location for the LNG Terminal. A complete discussion and detailed description of the proposed Pipeline is included in the PCGP Resource Report 1.

This Resource Report 10 contains a discussion and evaluation of, the comparative merits of reasonable alternatives to the LNG Terminal that could achieve the LNG Terminal's overall purpose and need, as stated above. This resource report reflects alternatives addressed in the Final Environmental Impact Statement ("FEIS") in Docket No. CP13-483, as well as input on alternatives received from agency and stakeholder consultations during the preliminary stages of the development of the LNG Terminal and comments received during the public open house conducted by JCEP. The range of alternatives considered includes taking the no action (the "No Action Alternative"), utilizing existing or planned infrastructure to meet the purpose and need (the "System Alternatives"), using alternative LNG terminals at locations other than the Port of Coos Bay for the liquefaction and exportation of a like quantity of LNG (the "Site Alternatives"), and design alternatives for the proposed LNG Terminal (the "Design Alternatives").

Resource Report 10 is divided into four main sections, plus a references section. Section 10.1 describes the No Action Alternative; Section 10.2 describes the System Alternatives; and Section 10.3 describes the Site Alternatives and Design Alternatives, including a description of the Terminal Project site selection process and a discussion of alternative site configurations/layouts for the preferred site in the Oregon International Port of Coos Bay (the "Port"). Section 10.4 explains the basis for moving forward with the proposed Project as the preferred alternative. Section 10.5 lists references used in the preparation of this resource report.

This resource report is consistent with and meets or exceeds all applicable FERC filing requirements. A checklist showing the status of FERC filing requirements for Resource Report 10 (18 CFR § 380.12) is included at the start of this resource report.

Alternatives should be evaluated against the statement of purpose and need for the Project. As explained above, JCEP's purpose and need is to site and develop an LNG export terminal in a deepwater port capable of sourcing gas from an interconnect with the existing Ruby Pipeline and GTN pipline systems near Malin, Oregon.

Evaluation criteria for selecting alternatives include whether they:

- are technically and economically feasible, reasonable, and practical;
- offer a significant environmental advantage over the proposed action; and
- have the ability to meet the purpose and need of the Project.

With respect to the first criterion, it is important to recognize that not all conceivable alternatives are technically and economically feasible and practical. Some alternatives may be impracticable because they are unavailable and/or incapable of being implemented after taking into consideration costs, existing technologies, and the overall purpose of the Project.

10.1 NO ACTION ALTERNATIVE

10.1.1 No Action Alternative

In licensing and permitting situations, the No Action Alternative reflects the scenario in which the necessary federal permits and authorizations are not granted, and the proposed action is not undertaken. If the Commission selects the No Action Alternative and denies the authorizations for the Project, the Project will not be developed, and certain short- and long-term environmental impacts associated with the construction and operation would not occur.

Under the No Action Alternative, the Project would not be constructed, and the Project's purpose and need would not be met. The environmental impacts caused by development of the Project would not occur. However, the selection of the No Action Alternative could result in the use or expansion of other existing or proposed LNG facilities and associated interstate natural gas pipeline systems, or the construction of new infrastructure to meet the purpose and need of this proposed Project (i.e., to make other sources of natural gas available for LNG export to Pacific Rim markets). Section 10.2 below examines LNG system alternatives. Any expansion of existing systems or construction of new facilities would result in additional environmental impacts associated with the expansion or construction of those alternative facilities.

10.1.2 Energy Alternatives

The purpose of the Project is to provide U.S.-produced LNG for export to foreign markets, particularly in the Pacific Rim. As a result, there are no domestic energy alternatives or energy conservation measures that would meet the Project's purpose and need. The Project will not displace alternative energy sources in the U.S. LNG exported to foreign markets can serve as a complement to intermittent renewable energy sources in those markets, and provide consuming nations with an alternative to fossil fuels that emit higher levels of carbon dioxide, such as coal (USDOE National Energy Technology Laboratory 2014).

10.2 SYSTEM ALTERNATIVES

System alternatives are alternatives that could make use of other existing or proposed pipelines and LNG facilities to meet the stated objectives of the proposed Project. Adoption of a system alternative could preclude the need to construct all or part of a project, although some modifications or additions to other existing systems may be required. These modifications would result in environmental impacts that could be less than, comparable to, or greater than those associated with the Project.

System alternatives were reviewed to evaluate the ability of other existing, modified, approved, planned, or proposed facilities to meet the stated objectives of the Project and to determine whether a system alternative exists that would have less significant adverse environmental impacts than those associated with the Project. The status identified for each system alternative (e.g., planned, proposed, or approved) is current as of the time of writing of this resource report, and is subject to change over time. By definition, implementation of a system alternative would make construction of all or some of the proposed facility unnecessary; conversely, infrastructure additions or other modifications to the system alternative may be required to increase capacity. Such modifications could result in environmental impacts that are less than, comparable to, or greater than those associated with construction and operation of the proposed facility.

1.

10.2.1 System Alternatives for LNG Export Terminals

Simply stated, U.S. East Coast and Gulf Coast projects cannot meet the Project's primary objective and purpose and need: to site and develop an LNG export terminal capable of sourcing gas from an interconnect with the existing Ruby Pipeline and GTN systems near Malin, Oregon, which allows the Project to source gas from the major production basins in the U.S. Rocky Mountains and western Canada. Therefore, U.S. East Coast, Gulf Coast, and West Coast site locations that are far removed from the proposed interconnection at Malin, Oregon, are not reasonable alternatives and are not carried forward in this analysis.

Other proposed or existing LNG export terminals on the West Coast of the U.S. and Canada would not satisfy the Project's purpose and need, and therefore are not mutually exclusive alternatives. There is both adequate gas supply in western Canada and the U.S. northern Rocky Mountains, as well as adequate demand in multiple Asian markets (Japan, Korea, China, etc.), to support more than one West Coast LNG project. For example, JCEP could deliver gas from the U.S. states of Wyoming, Utah, or Colorado or Canadian supplies to markets in Japan, while another facility could deliver Canadian gas to South Korea or China.

10.2.1.1 Existing LNG Export Terminals

There is only one existing LNG export terminal on the West Coast of North America, the Kenai LNG Plant located in Alaska. Although it has been and remains shuttered, ConocoPhillips Natural Gas Corporation sought new export authorizations from U.S. Department of Energy ("DOE"), and in 2016 DOE granted blanket two-year authorizations for exports both to Free Trade Agreement ("FTA") nations and to non-FTA nations. Because of its remote location, this facility cannot access the natural gas supplies from the western Canadian and the U.S. Rocky Mountain supply basins that would be exported by the Project. Moreover, it does not have sufficient capacity to serve the broader Asian markets that the Project would serve. In sum, the Kenai LNG Plant cannot meet the stated objectives of the Project and cannot be considered a reasonable system alternative.

10.2.1.2 LNG Export Terminal Projects Proposed or in Development

10.2.1.2.1 U.S. West Coast

Two projects have been proposed in Alaska: Alaska Gasline Port Authority ("AGPA") in Valdez and Alaska LNG in the Nikiski area of the Kenai Peninsula. Similar to the Kenai LNG Plant, the AGPA and Alaska LNG facilities could not access natural gas supplies from the western Canadian and U.S. Rocky Mountain supply basins. Therefore, even if these projects were ultimately developed, they would not meet the purpose and need of the proposed Project.

10.2.1.2.2 Canadian West Coast

The abundance of natural gas supplies in Alberta and British Columbia ("BC"), Canada, or more broadly from the Western Canadian Sedimentary Basin, has led to a proliferation of proposals for LNG export terminals in BC on the Canadian West Coast. Twenty LNG export projects are currently proposed, and 18 export licenses have been approved by the Canadian National Energy Board. Four environmental assessments have been completed by both the BC Environmental Assessment Office and the Canadian Environmental Assessment Agency, and four environmental assessments are currently in process. Specific detailed information on the individual projects is insufficient, because project sponsorship and commercial efforts have continued to be in flux. Most projects are perceived to be on the back burner due to high costs and the formidable environmental and construction-related challenges of constructing pipelines from the gas-producing regions to the coastal terminal locations over the Canadian Rockies. In addition, the processes of resolving issues with the First Nations have been and continue to be prolonged.

Although the Canadian West Coast LNG export projects may be considered system alternatives to the Project in terms of the Asian markets to be served, none will provide market outlets for the gas supplies from the U.S. Rocky Mountain supply basins. Thus, the Canadian West Coast projects cannot meet this significant Project objective, and are not reasonable alternatives that can meet the purpose and need of the proposed Project. In addition, no proposed Canadian project will be able to provide service in the same period as the Project.

10.3 LNG TERMINAL SITE ALTERNATIVES

FERC's site alternative evaluation consists of an environmental review of the proposed site location compared to proposed facilities at other identified feasible and reasonable alternative site locations to determine whether any alternative may offer significant environmental advantages.

10.3.1 Site Evaluation Criteria

Following are descriptions of the primary and secondary site evaluation criteria, all of which are necessary to identify the preferred site in light of the many regulations, constraints, and feasibility issues that must be considered when siting a facility of this nature. As described in Section 10.3, the evaluation criteria became more refined as more details were understood about the potential sites. For example, the fourth primary objective, as listed below, is to "use a site location in a port that is consistent with existing industrial land uses, meets all applicable regulations, accommodates industry standard LNG carriers, and minimizes community and environmental impacts." As the search reviewed local and site-specific scales, a more detailed understanding of "applicable regulations" was applied.

10.3.1.1 Primary Evaluation Criteria

JCEP's approach was to identify a site or sites that meet each of the primary objectives listed in Section 1.2.1 of Resource Report 1 and restated below:

1. Site and develop an LNG export terminal capable of sourcing gas from an interconnect with the existing Ruby Pipeline and GTN systems near Malin, Oregon;
2. Use a port location with a suitable and maintained depth for deep draft vessels;
3. Use a port location with sufficiently sized developable land that meets the requirements for an LNG terminal facility; and
4. Use a site location in a port that is consistent with existing industrial land uses, meets all applicable regulations, accommodates industry standard LNG carriers, and minimizes community and environmental impacts.

10.3.1.2 Secondary Evaluation Criteria

As the search reviewed the potential sites, a more specific review of regulations and site constraints was applied. The following secondary evaluation criteria were applied:

1. Channel depth – There must be a minimum existing channel depth of 36 feet mean lower low water.
2. Human population density near the site and along the LNG vessel transit route – Locating an LNG terminal or any major industrial facility within a populated area is not

favorable. Consequently, the distance from and relative densities of populated areas near industrial sites can be used to differentiate between potential site locations. The LNG carrier transit route from the LNG terminal to the open sea will likely pass populated areas. The number of areas passed, the distance of the areas from the center of the channel, and the density of the populated areas passed can be used to differentiate port locations for an LNG terminal.

3. LNG vessel transit distance – The distance, and hence the duration of the LNG carrier transit, from the LNG terminal to the open sea, given the potential safety and security zones around the carrier and the geometry of the channel, could potentially limit other uses of the channel. Locations with relatively short duration transits from potential LNG terminal sites are more favorable than those requiring lengthy transits.
4. Impacts to recreational waterway users – Most ports have a recreational fleet component. What differentiates one site from another are the size and location of the recreational fleet relative to the potential LNG terminal site and ship transit route, which will, in turn, determine the degree of potential effect that the introduction of additional deep draft ship traffic will have on the recreational users of the waterway. Ports that have recreational fleets located nearby the port entrance, thus minimizing potential interaction with deep draft ship transit, would be preferable to those where the recreational fleet has longer interactions with the deep draft ships in the channel or where the fleet is berthed upstream of the LNG terminal location and therefore would be required to pass the terminal while in transit to the open ocean.
5. Impacts to commercial fishing industries – Most ports have a commercial fishing fleet component. What differentiates one port from another are the size and location of the commercial fishing fleet relative to the potential LNG terminal site and ship transit route, which will, in turn, determine how much of a potential effect the introduction of LNG carrier traffic will have on the commercial fishing users of the waterway. Ports with commercial fishing fleets located nearby the port entrance, thus minimizing potential interaction with deep draft ship transit, would be preferable to those where the commercial fishing fleet has longer interactions with the deep draft ships in the channel or where the fleet is berthed upstream of the LNG terminal location and would therefore be required to pass the terminal while in transit to the open ocean.
6. Presence/absence of existing deep draft vessel traffic – Ports with a history of handling deep draft vessel traffic and extra capacity for traffic are preferable to those ports with a limited history of deep draft vessel traffic or with current traffic levels that are consistent with port resources. Ports that are able to readily accommodate additional deep draft ship calls are preferable, because the deep draft ship traffic in these ports will readily fit into the ship movement pattern without significant disruption of existing and anticipated future commercial vessel traffic.
7. Compatibility with land use/zoning – Ports that have industrial areas, existing brownfield sites, or areas that have already been designated as “marine dependent industrial” under current Estuary Management Plans would be preferable.

8. Land ownership – Ports where land ownership within the port is entirely controlled by private industrial landowners and where parcels owned by each of these companies are of sufficient size to site an LNG terminal without securing property from adjacent landowners were considered preferable. The consolidation of land ownership into one or at most two private industrial property owners simplifies the acquisition of a developable site. Ports where property would need to be acquired from multiple landowners in order to establish a suitably sized parcel for use as the Project site were considered less favorable.

Presence or absence of environmentally sensitive areas – Two components are involved in the application of this criterion: the general surroundings of the port and transit route from the port, and the types of sites (brownfield versus greenfield) within the port. The ports with fewer environmentally sensitive areas (parks, recreation areas, wetlands, shellfish beds, seagrass beds, etc.) and more potential brownfield sites were considered preferable.

10.3.2 Screening Sites to the Preferred Port

Ports in the analysis area that might have the potential for receiving gas from the Malin Hub and accommodating an LNG terminal were inventoried and screened for suitability using the primary and secondary evaluation criteria. The list of viable ports is shown in Figure 10.3-1.

JCEP applied a scoring system using the secondary evaluation criteria to four ports near Malin to evaluate the qualitative characteristics of the sites. For example, while it may be acceptable to have LNG vessels transit beneath highway bridges, it is more desirable to have a vessel transit route without bridges or other obstructions. The basis for the values in the scoring system and the scoring results are presented in Table 10.3-1. The scoring results are:

1. Coos Bay, Oregon................... 38
2. Astoria, Oregon 28
3. Wauna, Oregon....................... 26
4. Port Westward, Oregon........... 22

TABLE 10.3-1 Scoring Summary of Candidate Ports				
	Candidate Ports			
Criteria	**Coos Bay**	**Port Westward**	**Wauna**	**Astoria**
Population Density Near Site	3	3	3	1
Population Density Along LNG Ship Transit Route	3	1	1	1
LNG Ship Transit Distance	5	3	3	5
Compatibility With Existing Port Users	5	3	3	3
Impact on Recreational Waterway Users	3	3	3	3
Impact on Commercial Fishing	3	3	3	3
Existing Deep Draft Vessel Traffic	5	1	1	3
Compatibility With Land Use/ Zoning	3	1	1	1
Land Ownership	5	1	5	5
Environmentally Sensitive Areas	3	3	3	3
TOTAL	38	22	26	28

Based upon this analysis, Coos Bay was determined to be the preferred port compared to the other candidate ports. Qualities that make Coos Bay the preferred port include:

1. The Coos Bay candidate port has no residences within one (1) mile of the sites considered;
2. The route of vessel transit for Coos Bay is sparsely populated; during outbound transit, there are no residences on the entire length of shoreline on the starboard side and limited low-density population on the port side;
3. Transit time in Coos Bay was significantly less than for Columbia River ports;
4. Existing users of the Port of Coos Bay are supportive and presently involved in product export;
5. Coos Bay area has a long history of natural resource-based industrial operations;
6. The LNG Terminal is consistent with the Port's long-term industrial goals;
7. There would be minimal disturbance to recreational and commercial fisheries due to shorter transit times and the fisheries being berthed at Charleston Marina, which is located downstream of the LNG terminal at River Mile ("RM") 1.5.
8. There would be little or no disruption to existing deep draft vessel traffic; and
9. There is available land of adequate size with few or no zoning changes.

Although not applied as a screening criterion for the selection of the LNG Terminal location, the length of the necessary new pipeline infrastructure that must be built to interconnect to the existing natural gas pipeline network does have a significant impact on the economic viability of the potential site. The Project's LNG Terminal requires the construction of the approximately 235-mile-long Pipeline to allow access to a reliable, uninterruptible transportation network to deliver the natural gas supplied from within the U.S. Rocky Mountains and the Western Canadian Sedimentary Basin, the two largest sources of natural gas supply located within 1,000 miles of the North American Pacific coastline. The eastern terminus of the Pipeline at Malin, Oregon, interconnects to the Ruby Pipeline and GTN systems, each of which has existing capacity or inherent expansion capacity to allow 100 percent of the Project's capacity to be supplied from either source. In other words, the Project has access to 200 percent of its supply requirements. If either the Ruby pipeline or the GTN pipeline were to be removed from service, the remaining upstream system would be able to meet 100 percent of the Project's natural gas needs.

The circumstances at the three lower-ranking short-listed sites (Wauna, Port Westward, and Astoria) are quite different. These potential sites are clustered near the mouth of the Columbia River, and the current natural gas supply system serving this area is the Northwest Pipeline Company ("NWP") system. The NWP system connects to gas supplies from both the U.S. Rocky Mountains and Canada, but from two disparate points. The NWP system snakes its way from the Four Corners area of the southwestern U.S. to the U.S./Canada border at Sumas, Washington. In so doing, it follows a route north along the Utah-Colorado border, swings into southwest Wyoming, then essentially follows I-84 through Idaho and eastern Oregon, through the Columbia River Gorge, and then follows I-5 from near Vancouver, Washington, to the Canadian border at Sumas, Washington. Because the capacity of the existing NWP system in the critical stretch between its interconnection with the GTN system east of the Columbia River Gorge and the interconnection with the Canadian natural gas system at Sumas is fully subscribed, new pipelines would need to be built along this entire distance in order to allow the flow of the approximately 1.2 million Dth/d supply needed to operate the LNG Terminal at capacity. This would entail building a new parallel pipeline to the existing NWP system for a minimum of nearly 400 miles, and even such a pipeline might not provide the redundancy of supply that is available to the Project at Coos Bay. Additional pipeline improvements to the NWP system back to Opal, Wyoming, might be necessary to establish the capability to provide 100 percent supply from either the Canadian basin or U.S. Rocky Mountain basin. The difference in the length of pipeline that would need to be constructed (approximately 235 miles for the Project versus nearly 400 miles for the other four short-listed locales) provides a crude measure of the relative environmental impact of each. On that basis alone, the selection of Coos Bay outranked the other locations as the preferred site for the Project.

10.3.2.1 Coos Bay Terminal Alternatives

10.3.2.2 Logistical Constraints

Several logistical constraints within Coos Bay affect the siting of an LNG facility: navigation restrictions, berth types, zoning, land ownership, airport approach zones, and vapor exclusion zones. All of these constraints can be tied directly to the secondary evaluation criteria and are discussed below.

10.3.2.3 Navigation Restrictions

JCEP identified the existing railroad bridge at RM 9.2 as a transit navigation restriction, due to width restrictions. Therefore, all of the Coos Bay site alternatives focused on the lower bay (i.e., land west of the railroad bridge).

10.3.2.3.1 Berth Types

Upon selecting Coos Bay as the preferred port, JCEP considered multiple types of LNG berthing structures that could be constructed in the bay. Based on discussions with U.S. Coast Guard (“USCG”) and in consideration of the Society of International Gas Tanker and Terminal Operators’ (“SIGTTO”) document titled, “Site Selection and Design for LNG Ports and Jetties with Views on Risk Limitation During Port Navigation and Cargo Operations, Information Paper No. 14,” and published in 1997 (Appendix A.10), a dock that extends into the bay would not likely be approved by USCG due to the proximity to the federal navigation channel, the risk of having an LNG vessel break free from the dock during storm events and tidal surges, the risk of having other vessels strike the LNG vessel, and other security and safety concerns. Similarly, a channel side structure or offshore loading platform would not provide the level of isolation from the open channel needed to safely secure an LNG vessel. Therefore, a slip was determined to be the only feasible design alternative. Further, to safely maneuver LNG vessels for mooring and transit, the slip would need to be a nominal size of 1,300 feet deep by 800 feet wide.

10.3.2.3.2 Zoning

JCEP only considered parcels zoned as Water-Dependent shorelands, with the adjacent portion of Coos Bay designated as Development Aquatic. The designation of Water-Dependent shorelands specifically allows for upland facilities that require access to marine facilities. Within the Coos Bay Estuary Management Plan (“CBEMP”) it is only Water-Dependent shorelands zone that allows for in-water structures to be built in the adjacent water zoning. To paraphrase, zoning for a marine berth is only available adjacent to uplands that are zoned Water-Dependent.

This criterion limited available land for the Project site to the north shore of the upper half of lower Coos Bay.

10.3.2.3.3 Land Ownership

JCEP eliminated from consideration all federally owned land and parcels of land in the lower bay that were less than 200 acres in size, or parcels that could not readily be combined with others to equal 200 or more acres. While 200 acres is a seemingly arbitrary number, it reflects JCEP's recognition that a site of ideal shape establishes the absolute minimum plot size. The 200-acre minimum assumes that the site geometry is perfectly suited for an LNG liquefaction facility of the Project's proposed capacity. In reality, the minimum amount of real estate estimated to be required at the screening level is normally many multiples greater than the theoretical minimum parcel size. Property boundary geometries are dictated by the required thermal radiation and vapor exclusion zones mandated in National Fire Protection Association ("NFPA") 59A (Standard for the Production, Storage, and Handling of Liquefied Natural Gas), which is incorporated in the Regulations of the Pipeline and Hazardous Materials Safety Administration ("PHMSA") applicable to LNG facilities.

JCEP arrived at the 200-acre minimum parcel size as follows: For a nominal tank diameter of 267 feet, as proposed here, the minimum area required to contain the 1,600 British thermal units per hour per square foot zone would be a circle approximately 960 feet in diameter, requiring approximately 17 acres per tank. The land required to accommodate the flare without impacting surface use is approximately 7 acres, the land for a fire water pond is about 5 acres, and containment trenches with vapor exclusion zone are another 5 acres. The upland facilities, including the liquefaction facilities, require at least 15 acres, as well as another 8 acres for office space, shops, parking, minimal storage areas, and meter runs. An additional 35 acres is required for a slip to be built. The total of this minimum acreage amounts to just over 100 acres. In the screening process, JCEP used a multiplier of 2.0 to account for: (1) the shape factor; (2) the inability to secure the perfect parcel; and (3) the need to purchase parcels that may be available but where the owner is unwilling to subdivid property in order to sell JCEP only the land that is wanted for the terminal. Hence, a minimum 200-acre parcel size was used as a site screening criterion.

10.3.2.3.4 Airport Approach Zones

JCEP must consider approach zones for the Southwest Oregon Regional Airport ("SWORA"), which is located in the vicinity of Coos Bay. While a slip in and of itself may not conflict with operations within an approach zone, a moored LNG vessel likely would because of the overall air draft of the LNG vessel. As demonstrated in Figure 10.3-2, the preferred site does not lie within an approach zone.

10.3.2.4 Siting Considerations

In selecting a specific site(s), priority must first be given to the water-dependent activity, which for this project involves providing safe harbor for the LNG vessels that will call on the terminal. Because a slip (as opposed to a dock, trestle, or offshore platform, none of which are preferred by USCG) is the preferred configuration, priority is given to siting a slip and access channel that connects the facility to the federal navigation channel.

The liquefaction facilities (including the storage tanks) are a water-dependent use because, as demonstrated below, the liquefaction facilities must be constructed close to the berth where

LNG vessels will be moored for loading. There are significant safety, logistical, and cost advantages to constructing the liquefaction facilities in proximity to the slip. The LNG storage tanks must be connected to the marine terminal via multiple large-diameter cryogenic LNG pipelines that are located aboveground. Because LNG is a supercooled gas, the liquefaction facilities, including the LNG storage tanks, must be located close to the LNG vessel loading terminal to keep piping as short as practicable due to the use of special cryogenic metallurgy and the need to minimize regasification of the LNG before it is loaded on the LNG vessels. These pipelines provide the delivery of LNG from the LNG storage tanks to the LNG vessel during loading and the return of boil-off gas ("BOG") from the LNG vessel back to the LNG storage tank in a closed loop system. The greater the length of the interconnecting LNG and BOG pipelines, the greater the amount of real estate needed. Since a vapor dispersion zone and security zone of approximately 500 feet in width are required to isolate the LNG/BOG lines from adjacent property boundaries, every 85 feet of additional distance between the LNG storage tanks and the LNG marine terminal results in the impact of an additional 1 acre of real estate.

Three other significant appurtenant facilities to the LNG facility are the Southwest Oregon Regional Safety Center ("SORSC"), Jordan Cove fire station, and construction camp. These facilities are not water-dependent. The Jordan Cove fire station is required to be sited such that a four-minute response time to the terminal could be achieved by all fire trucks in the station. Siting the fire station in the access and utility corridor achieved the four-minute response time while avoiding any interference from railroads. The construction camp has no such requirement; however, proximity to the facility clearly has advantages. The SORSC is sited on South Dunes in a location that eliminates any wetland impacts. Alternatives analyses for these facilities are included in Sections 10.3.4 and10.3.5.

10.3.2.5 Potential Sites

Most of the industrial land in Coos Bay is located in the upper bay. Access to the upper bay would require the LNG vessels to transit through the swinging railroad bridge that crosses Coos Bay at RM 9.2. The swinging railroad bridge cannot accommodate LNG vessels because the bridge opening width is too small. As a consequence, the only sites deemed suitable were those located in the lower bay.

The lower bay is defined as the portion of Coos Bay that lies to the west of the swinging railroad bridge. The east shoreline of the lower bay is composed of the Cities of North Bend and Coos Bay. There is no significant parcel of industrial real estate located on the east shore of Coos Bay. The North Spit comprises the west shore of the lower bay. The majority of the North Spit property that abuts Coos Bay is zoned Water-Dependent Industrial in the CBEMP. The remaining property abutting the lower bay is owned by the Bureau of Land Management ("BLM") and is designated for recreational use. The southernmost 2 miles of North Spit shoreline running from the north jetty entrance of Coos Bay to RM 5 encompass the majority of the BLM holdings on the North Spit. The BLM also operates a boat launch at approximately RM 6. The U.S. Forest Service also owns large amounts of land on the North Spit, but none abutting the bay.

Figure 10.3-2 depicts the general property ownership on the North Spit, and also illustrates other constraints such as wetlands, zoning, and runway approach zones. Ten potential sites were identified for consideration in this analysis, as discussed below.

10.3.2.6 Site 1, Oregon Dunes Sand Park

The Oregon Dunes Sand Park is an approximately 28-acre site located north of the Trans-Pacific Parkway ("TPP") that currently functions as an RV park. The site is zoned Industrial but is too small to accommodate the LNG export terminal. It is separated from the larger parcels to the south by the TPP, which is a county facility and the only vehicular access to the North Spit. Because the TPP separates the site from the larger parcels to the south, it is not practical to aggregate it with those parcels. Further, the shoreline access for this site is upstream of the railroad swing bridge, so LNG vessels cannot access it. For these reasons, JCEP determined that the site is not a feasible alternative for the LNG Terminal.

10.3.2.7 Site 2, South Dunes Site (Formerly Weyerhaeuser Linerboard Mill Site)

The South Dunes Site is an approximately 136-acre site located south of the TPP and adjacent to the rail line crossing Coos Bay. This brownfield site is zoned Industrial and is the former location of the Weyerhaeuser Linerboard Mill. The South Dunes Site includes several wetlands in its interior and along its perimeter and shoreline. While the site has many desirable features, its proximity to the swinging railroad bridge would severely constrain LNG vessel maneuvering and berthing at the site. In addition to the concerns about vessel safety, the railroad bridge is part of the critical infrastructure for the Coos Bay area. If a vessel were to collide with the bridge, it could put the bridge out of commission and thereby significantly impact the economy of the Coos Bay area. For this reason, JCEP determined that it is not a practical alternative for the LNG Terminal. However, JCEP has acquired the South Dunes Site for the auxiliary guard house, SORSC building, administration building, pipeline metering station, and construction camp.

10.3.2.8 Site 3, Roseburg Forest Products

Roseburg Forest Products Company ("RFP") owns 214 acres of industrial developed property west of Jordan Cove Road. RFP operates a chip export facility at this site and is not interested in selling or leasing adequate property to JCEP for siting an LNG terminal. Additionally, the site does not have sufficient real estate to accommodate two 160,000 m^3 full-containment LNG storage tanks, while maintaining thermal and vapor exclusion zones within the site property. Initial modeling runs indicated that, although two tanks could be physically located within the RFP parcel, the vapor dispersion zone required to establish property lines for ownership and control would extend beyond the parcel that JCEP would have the right to control. The site is also constrained by the presence of runway approach zones. Therefore, this site is not a feasible alternative for the LNG Terminal.

10.3.2.9 Site 4, Ingram Yard (Formerly Henderson Ranch Site)

Ingram Yard, located immediately to the west of the RFP site, features approximately 218 acres of land zoned for water-dependent development. Ingram Yard is relatively free of wetlands in its interior and provides an opportunity to connect to the federal navigation channel via a new access channel. As described below, Ingram Yard is the preferred location for the slip and LNG Terminal. JCEP has acquired Ingram Yard.

10.3.2.10 Site 5, Panhandle Parcel

The Panhandle Parcel is owned by the Port of Coos Bay. The parcel includes approximately 133 acres north of the TPP, most of which is zoned for conservation. The area that is zoned for

Water-Dependent development features approximately 80 acres of high-quality freshwater wetlands. Because of the zoning and presence of significant high quality wetlands, the site is not a practical alternative for the LNG Terminal.

10.3.2.11 Site 6, Henderson Property

The Henderson Property is owned by the Port of Coos Bay. The parcel includes approximately 300 acres immediately west of Ingram Yard. The area is zoned for water-dependent development, but features approximately 170 acres of high quality wetlands (i.e., Henderson Marsh). Although the site is zoned for water-dependent development, the presence of significant high quality wetlands led JCEP to conclude that the site is not a practical alternative for the LNG Terminal.

10.3.2.12 Site 7, Lagoon Site

The 319-acre Lagoon Site is owned by the Port and lies west of the TPP. The majority of the site is zoned for conservation, and the portion of the site zoned for water-dependent development features approximately 274 acres of wetlands. Further, the site has no shoreline access and lies on the opposite side of the TPP from the bay. The limited footprint of land zoned for water-dependent development, the presence of extensive wetlands, and the lack of shoreline access led JCEP to conclude that the site is not a feasible alternative for the LNG Terminal.

10.3.2.13 Site 8, Southport

The Southport Property is located near the south end of the TPP. Southport Lumber operates a small dimension lumber mill on this 64-acre parcel, which is zoned for water-dependent and non-water-dependent use. The parcel is constrained by the presence of wetlands, existing development, and its small size, and is within the runway approach zone for SWORA. For these reasons, JCEP determined that this site is not a feasible alternative for the LNG Terminal.

10.3.2.14 Site 9, DB Western

DB Western operates a small industrial fabrication facility on this approximately 40-acre site at the terminus of the TPP. The property is zoned for water-dependent development. The site is constrained by its small size and its overlap with the SWORA runway approach zone. Given these constraints, the site is not a feasible alternative for the LNG Terminal.

10.3.2.15 Site 10, Port Industrial Site

The Port owns additional property at the terminus of the TPP. A combination of tax lots includes approximately 280 acres, some of which extends into the bay. The TPP runs through the northern half of the site, which is zoned for water-dependent and non-water-dependent uses, as well as conservation. Portions of the water-dependent-zoned land are constrained by approximately 15 acres of wetlands. The site also lies within the SWORA runway approach zone. For these reasons, JCEP concluded that the site is not a practical alternative for the LNG Terminal.

10.3.2.16 Discussion of Potential Sites

Sites 1 through 3 and 5 through 10 are not feasible or practical alternatives for the LNG Terminal for a variety of reasons, including inadequate size, unavailability, presence of significant wetland resources, conflicts with SWORA runway approach zones, and inability to comply with NFPA 59A thermal radiation and vapor dispersion exclusion zone requirements, all of which can be linked directly to a primary or secondary evaluation criterion. Site 4, Ingram Yard, is the only viable site for the terminal.

To further illustrate this point, Figures 10.3-3, 10.3-4, and 10.3-5 depict the preferred site configuration at Ingram Yard, and then overlaid on Sites 8, 9, and 10 aggregated, and the South Dunes Site, respectively. The purpose of these figures is to provide a graphical, qualitative comparative analysis of these three configurations to show, generally, the spatial limitations of the sites and the relative impacts resulting from the slip and access channel at each of the three locations. It is understood that certain features, such as the storage tanks or liquefaction train, would need to be "best fit" to each site for a true spatial analysis.

The preferred configuration, shown in Figure 10.3-3, optimizes the location of the slip and access channel compared to the configurations in Figures 10.3-4 and 10.3-5. The slip location in Figure 10.3-4 is controlled by the TPP and the rail line; the slip cannot disrupt these facilities that serve properties to the south. Impacts to the estuarine environment are slightly greater than those of the preferred alternative; moving the slip to the southern end of the aggregated site would significantly increase impacts to estuarine resources because the access channel would need to be much larger to connect to the federal navigation channel. Figure 10.3-5 depicts a slip and access channel at the South Dunes Site. Clearly, this configuration would result in significantly more impacts to the estuarine resources between the shoreline and the federal navigation channel.

10.3.2.17 Conclusion for the Preferred Site Alternative

Ingram Yard is the only viable site for the slip and access channel within Coos Bay and would also result in the least impact to mudflats, vegetated shallows, and wetlands. Siting the LNG liquefaction facilities close to the slip is the most logical and preferred configuration, because Ingram Yard is of sufficient size to accommodate the storage tanks and comply with NFPA 59A thermal radiation and vapor dispersion exclusion zone requirements. While it is possible that the storage tanks might be arranged to fit on the South Dunes Site, preliminary modeling suggests that doing so would violate NFPA 59A. Therefore, the liquefaction facilities, including the LNG storage tanks must be located at Ingram Yard, which fully occupy the site. In addition, gas conditioning will be located at Ingram Yard to avoid hydrocarbon processing in the access and utility corridor and South Dunes Site. The access and utility corridor will connect the LNG Terminal to South Dunes infrastructure; the corridor contains operations building, firewater storage, warehouses, firewater pumps, lube oil, paint, compressed gas storage, and backup generation. In consideration of all these factors, the preferred alternative is the only reasonable alternative that fulfills the Project's purpose and need.

10.3.3 Alternative Marine Slip Design

The U.S. Army Corps of Engineers ("USACE") suggested that JCEP examine the possibility of a smaller marine slip at the LNG Terminal. The USACE believes that the size of the marine slip could be reduced because the USCG's Waterway Suitability Assessment and Letter of Recommendation limited the size of LNG vessels calling on the LNG Terminal to no larger than 148,000 m^3 in capacity. The USCG determined that an 800-foot slip width would be needed in order to be able to move an LNG vessel off of the LNG berth on the east side of the slip if an incident within the LNG Terminal upland facilities that might threaten the safety of the LNG vessel at berth were to occur. Having the 800-foot slip width provides the flexibility needed for tugs to move the LNG vessel away from a potential hazard at the terminal or at the LNG loading dock to the relative safety of the west side of the slip. Therefore, JCEP is currently proposing a single loading berth with a layby berth and access channel that solely supports LNG operations.

10.3.4 LNG Storage Tank Design Alternatives

Whether the LNG storage tanks should be reduced in height or placed underground for greater safety and to reduce their visual impacts was considered. Tanks with lower heights would be less of an obstruction to aircraft landing or taking off from SWORA, whose runways are located about 1.1 miles from the LNG storage tank locations for the Project.

The height of the proposed LNG storage tanks cannot be lowered because doing so could not meet PHMSA requirements. The required 320,000 m^3 in total LNG storage capacity necessary for the economic viability of the Project established the tank aspect ratio (height/diameter). The tank diameter was set by the maximum acceptable radiation isopleth that can be contained within JCEP's property lines. If a shorter tank were to be used, it would need to be of a greater diameter in order to hold the required 160,000 m^3 of LNG per tank. However, increasing the diameter of an LNG tank would enlarge the radiation isopleth so that it would extend beyond the JCEP property boundary. To meet PHMSA requirements, the potential vapor released from a loss of tank containment must be contained within land owned or controlled by JCEP. Increasing the number of LNG storage tanks from two to three creates the same radiation problem due to requirements for tank spacing and the limitations of real estate owned or controlled by JCEP. The two 160,000 m^3 LNG storage tanks have been designed to fit within the long and narrow Ingram Yard terminal site.

While burying tanks is an established technique in many parts of the world, local soils and geologic conditions determine the feasibility of such an approach at the LNG Terminal. In the case of the Ingram Yard tract, the geotechnical investigation, which was performed to identify surface and subsurface soils conditions, indicated that the water table is about 10 feet below the existing ground surface. With the thickness of the tank foundation slab established at approximately 5 feet, any burying of the tank below the present design configuration would cause the foundation to be below the water table and would therefore raise serious engineering and environmental problems. The groundwater would need to be continually pumped from the subsurface area in the vicinity of the LNG tanks to avoid the potential for contact with the underground tank heat coils, resulting in potential disruptions to groundwater flow as well as an additional water discharge from the Project. If groundwater was not kept away from the heat coils, he high heat transfer coefficient of water would result in an excessive amount of power being used to energize the heat coils. The mobility of the water would greatly exacerbate this problem because, as the water was warmed, it would flow away from the heat coils as a result of the natural groundwater migration pattern in this area. The warmed water would then be replaced by cold water, resulting in still greater power consumption requirements. Therefore, burying the tanks would not offer a significant environmental advantage over JCEP's currently proposed design.

10.3.5 SORSC and Jordan Cove Fire Station Alternatives

The SORSC building would house the Jordan Cove security center, USCG, Coos County emergency management, Port of Coos Bay, and emergency planners from the state, the county, the Cities of North Bend and Coos Bay, and North Bay Rural Fire Department. The SORSC will be located on the South Dunes Site. The Jordan Cove fire station will be located in the access and utility corridor. The Jordan Cove fire station needs to be on the North Spit and within or near the LNG Terminal for the following reasons:

- The Jordan Cove fire station has to be relatively close to the location of any potential incident in order to comply with State of Oregon standards for response to industrial fire incidents. All local existing emergency response facilities are purposed for protection of the public, and many utilize volunteer fire fighters rather than the industrial fire fighters required to man an industrial fire brigade. JCEP conducted many meetings with local emergency response personnel, and it became clear that finding a location that would meet emergency response time requirements could be achieved only by siting the Jordan Cove fire station in the access and utility corridor.
- The Jordan Cove fire station's corridor location places it on the west side of the existing north-south mainline of the Coos Bay Rail Link railroad tracks and to the south of the North Spit rail spur that services the Southport Lumber mill. This requirement is necessary to ensure that access between the Jordan Cove fire station and the LNG Terminal would not be compromised by a train blocking road crossings. The local agencies pointed out to JCEP that a passing train could block access for ambulance, fire, and law enforcement personnel.
- The Jordan Cove fire station needs to be located so that it would not interfere with the existing use of the railroad by the RFP wood chip facility. RFP currently brings a number of trains into its property via a rail spur that comes off the main line, which moves north and south. If the Jordan Cove fire station were located elsewhere, for instance on the South Dunes Site, emergency services could be blocked as they would be with the main line as described above.
- The site needs to be able to meet the State of Oregon fire response criteria for having equipment and personnel on the scene of an incident in four minutes. The location needs to be close but not too close to the liquefaction facilities. The criteria were established using NFPA standards for industrial facilities.
- Although local and State of Oregon emergency response personnel identified a need to have the Jordan Cove fire station be located close to the liquefaction facilities, they deemed it essential that there be a separation of these two facilities.
- The SORSC and Jordan Cove fire station sites need to be located where access to the LNG Terminal would not be disrupted in the event of a tsunami. The JCEP facilities are being designed to resist the design earthquake and resultant tsunami. This preparation means that all areas of the SORSC, Jordan Cove fire station, the LNG Terminal, and the connecting corridors between them must be at an elevation and of a structural integrity to survive a tsunami, maintain functionality and retain access.
- The SORSC building would house the Jordan Cove security center and must be located in a location approved by the state and local agencies. The South Dunes Site allows security personnel to properly respond to any potential security breach. The primary security watch is within the SORSC building, and having the SORSC building within the site security boundaries is critical to establishing and maintaining successful security of the facility perimeter.

- The SORSC will need to be at an elevated site (to be above tsunami inundation), which also enhances the interoperable communications managed from the SORSC. JCEP is required to ensure interoperable communications with local emergency agencies and for communications around the facility. This communications ability would require Ultra High Frequency, Very High Frequency, and cellular signals. The elevated area facilitates radio signal operation.

Based upon the above criteria, only seven potential sites for the SORSC and Jordan Cove fire station were identified as being potentially suitable. The locations of these seven potential sites are shown in Figure 10.3-6.

Site A is directly to the east of Jordan Cove Road and to the west of Wetland E on the South Dunes Site. This site had been previously disturbed by the former owner of the property (Weyerhaeuser) and contains some minor wetlands (Wetlands A and B). JCEP proposes to compensate for impacts on wetlands associated with the construction and operation of the buildings through a combination of wetland creation and enhancement.

Site B is located on the South Dunes Site and essentially comprises Wetland E that lies outside of the secured battery limits of the facility. Because most of this site is wetland, it would need to be filled with excess sand removed from the marine slip and access channel. Although Site B could function as a suitable substitute for the preferred Site A, it would result in a significant increase in the amount of wetlands impacted.

Site C is located on the western flank of the Henderson Property, on the south and east side of the TPP, about 0.5 mile south of the Ingram Yard tract. This location was deemed to be potentially suitable for the SORSC and Jordan Cove fire station facilities because there is a north/south-oriented sand dune on the western flank of this parcel. Locating Site C any closer to the LNG Terminal would create three unsatisfactory conditions. First, the buildings would be located too close to facilities that store LNG and refrigerants. Second, siting the SORSC and Jordan Cove fire station on the eastern portion of Henderson Property would violate the objective of having a sand dune provide a buffer between the SORSC and the liquefaction facilities. Third, placing the SORSC on the eastern portion of Henderson Property would also require the filling of Henderson Property to raise the location of the buildings out of tsunami inundation.

Unlike the eastern portion of the Henderson Property, Site C (on the western flank of Henderson Property) does have the advantage of being elevated above the tsunami inundation zone without a need for fill. However, a new road would have to be built from Site C that would connect the building complex to the western entrance of the LNG Terminal. During a tsunami event, both the TPP and the Coos Bay Rail Link would most likely be inundated. To ensure connectivity between the SORSC and Jordan Cove fire station at Site C and the LNG Terminal, fill would need to be placed in the Henderson Property to create the required elevated corridor road. This placement of fill is a particularly sensitive issue because the primary direction of tsunami inundation will be from the northwest of the LNG Terminal site. This location could place the SORSC and Jordan Cove fire station directly in the path of a tsunami. For these reasons, Site C was rejected as the preferred location for the SORSC.

Site D, the eastern end of the access and utility corridor, has the advantage of safe distance from the LNG Terminal and yet also has quick, unhindered emergency access. However, the corridor location is limited in space and would place the SORSC within LNG Terminal security;

the latter is a non-starter because the SORSC needs public access. In addition, the corridor location will require some filling to raise the location out of tsunami inundation.

Site E is located on the South Dunes Site but does not have guaranteed direct LNG Terminal access due to railroad infrastructure. The site would also require a bridge to the access and utility corridor. In addition, the South Dunes location will require some filling to raise the location out of tsunami inundation.

Site F, on the northern South Dunes would result in no wetland impact. The site is accessible either from Jordan Cove Road to the west (by crossing the railroad spur) or from the TPP, crossing two railroad lines. The northern South Dunes location will be at a height safe from the design earthquake and resultant tsunami.

Site G, on the western side of the access and utility corridor, has the advantage of proximity to the LNG Terminal. This location provides the guaranteed ability to respond within the required 4 minutes while maintaining sufficient separation from the terminal.

In Docket No. CP13-483, the SORSC building with an integrated fire station was proposed at Site A. With the removal of the South Dunes Power Plant, additional real estate became available. Moving the SORSC building away from Site A (to minimize the impact to wetlands) was considered. However, Sites E and F are ill-suited for housing the fire department due to the access issues created by rail lines and the 4-minute response requirement.

Ultimately, the proposal is to split the SORSC and Jordan Cove fire station locations, respectively, on Sites F and G. This proposal meets the requirements for the fire station, actually improving the response time to a fire, while also minimizing environmental impacts, maintaining access to both the fire station and the SORSC building with respect to railroads, and reducing the proximity of non-essential personnel to LNG Terminal operation.

The SORSC is best suited to Site F, which places it outside of LNG Terminal security and does not disturb wetlands. In addition, there is more real estate, and consequently more layout flexibility, and nearby public-road access.

The Jordan Cove fire station is best suited to Site G. This location does not disturb wetlands, has the best plant access, and, with limited fill, it can be raised out of tsunami inundation.

10.3.6 Workforce Housing Alternatives

JCEP proposes to provide temporary housing for the required construction workforce. A temporary workforce housing camp will be located at the South Dunes Site. Additional temporary workforce housing will be provided by recreational vehicles ("RVs") located off-site. Several alternative locations for the temporary workforce housing camp were considered, and alternatives for RV sites are currently being evaluated.

The following locations were considered as alternative sites for the temporary workforce housing camp:

- Port-owned land on the North Spit;
- D.B. Western Site on the North Spit;
- Mill Casino;
- Myrtlewood facility;
- Former Kentuck Slough Golf Course;

- Former International Paper Site; and
- North Point Site.

Port-owned land and the D.B. Western site on the North Spit were eliminated from consideration for this facility, because they may be better suited as potential construction laydown areas, and the Port land contains wetlands. The Mill Casino in Coos Bay and the Myrtlewood facility along Highway 101 near Hauser are too small for the construction camp, but are instead proposed as off-site commuter parking lot locations. The former Kentuck Slough golf course, now owned by JCEP, contains wetlands and will be used for the Kentuck Project.

The former International Paper site near Gardiner was also evaluated. This site contains 200 acres, which is large enough to accommodate the camp. However, it is 25 miles from the LNG Terminal, resulting in longer commuting time for workers and the introduction of daily workforce traffic between the former International Paper site and the LNG Terminal.

In Docket No. CP13-483, JCEP proposed to locate the temporary workforce housing camp at the North Point Site because of its relative proximity to the LNG Terminal. At 50 acres, the North Point Site is large enough to accommodate the camp. It is currently zoned for industrial use and is near existing utilities. This location contains some wetlands, no agricultural land, no forest, no known archaeological sites, and no habitat for threatened and endangered species. Ultimately, however, JCEP has eliminated the site from consideration as a potential location for the temporary workforce housing camp in favor of a location closer to the LNG Terminal in an effort to reduce impacts on the community, reduce wetland impacts, and remove daily workforce traffic from Highway 101.

The South Dunes Site was selected for the temporary workforce housing camp location primarily due to its proximity to the LNG Terminal, although, due to the limited availability of land for housing at the site, additional temporary workforce housing will be provided off-site in RVs. Fill (which will impact some freshwater wetlands) is required to raise facilities above the inundation level expected from the design-level tsunami, but otherwise there are minimal environmental impacts associated with construction at the site. The location is zoned for industrial use and the site will have an electrical substation and utilities.

10.3.7 Electric Power Alternatives

The LNG Terminal would need electrical power for the LNG Terminal, the access and utility corridor, and facilities on the South Dunes Site. JCEP plans to obtain limited power from the regional electric grid for the SORSC and temporary construction activities. With the exception of the SORSC, the site will be black-start capable and will not have the means or infrastructure, or need to import or export power. The liquefaction trains will be combustion-turbine direct-drive and not motor drive. Approximately 60 megawatts (“MW”) Balance of Plant (“BOP”) power will be required for site operations. Below, other alternatives for electric power are discussed.

10.3.7.1 Existing Electric Power Infrastructure

The Bonneville Power Administration (“BPA”) is the sole source of wholesale power to the region’s various electric cooperatives. JCEP’s investigation came to the conclusion that the local public utility system could not meet the power needs for the LNG Terminal. Therefore, JCEP planned to construct and operate its own source of power in order to achieve operational reliability. Only the SORSC would be connected to the local distribution company, PacifiCorp, for its electricity.

10.3.7.2 South Dunes Power Plant

The South Dunes Power Plant would have been located adjacent to the LNG Terminal on about 58 acres of land owned by JCEP, at the former site of the Menasha-Weyerhaeuser linerboard mill, which closed in 2003 and has been since demolished. The LNG Terminal would, however, have also been connected to the local distribution company, PacifiCorp, to provide power during times when the South Dunes Power Plant may have been temporarily shut down. In addition, JCEP could have sold excess electricity generated from the South Dunes Power Plant, above that needed for liquefaction and other terminal operations, back to the grid for local consumption. Like the direct-drive compressors, which were incorporated into the proposed Project, the South Dunes Power Plant and electric-drive compressors would have provided operational reliability for the terminal processes.

The South Dunes Power Plant would have produced a nominal 420 MW of electrical power as well as process steam for feed gas conditioning. The electric line between the power plant and the LNG Terminal would have been located within JCEP's access and utility corridor. The plant would have used six highly efficient gas turbines with heat recovery steam generators ("HRSGs") for combined cycle efficiency. In addition, HRSGs would provide steam for two steam turbines. Water would be injected into combustion turbines for additional power. The direct-drive option detailed in Resource Report 1 was ultimately selected due to efficiency and layout simplicity . Direct drive has approximately 25 MW less motor, generator, and transmission losses than those associated with motor-driven compression. This has a direct correlation with reduced emissions. In addition, direct drive eliminates the need for hydrocarbon processing equipment on South Dunes Site and a 115 kV transmission line in the access and utility corridor. Under the current proposal, only buildings are located on South Dunes. Overall, this reduces the physical and environmental footprint.

10.3.7.3 Balance of Plant Power

With a direct-drive combustion-turbine black start LNG facility, 60 MW BOP power is required for operations. This is considerably less overall power than the electric drive option. Electrical power would be generated via a total of three 30 MW steam turbine generators. In normal operation, two generators will be running with one generator in standby for reliability purposes. The steam is efficiently generated by HRSGs using direct-drive combustion-turbine exhaust. A black-start auxiliary boiler would be used to generate steam for power when gas turbines are not in operation. The BOP generation system would not be connected to the local grid, and would not import or export power.

Use of the direct-drive technology and BOP power instead of motor-drive technology and the South Dunes Power Plant: (1) eliminates process equipment from the South Dunes Site, which results in a single, compact and consolidated facility process area at Ingram Yard; (2) eliminates the need for a railroad spur bridge; (3) reduces the combustion-turbine count from six to five; (4) eliminates power losses due to system inefficiencies of approximately 25MW; and (5) eliminates water injection. The use of the proposed direct-drive technology and BOP power, compared to the use of the South Dunes Power Plant, reduces Project environmental impacts as well by reducing emissions, water consumption, and the total facility footprint. Elimination of the South Dunes Power Plant also addresses agency and public concerns.

10.3.8 Liquefaction System Alternatives

The Project's target LNG production capacity of 7.8 mtpa can be achieved via several natural gas liquefaction technologies. These technologies can be generally categorized as follows:

- Nitrogen Expander Processes: This category includes single and dual expander technologies, with nitrogen used as the refrigerant. This technology has, generally, lower efficiency than mixed refrigerant processes and is more suitable for small-scale productions.
- Mixed Refrigerant Processes: This category includes single, dual, and pre-cooled mixed refrigerant cycles in which a mixture of hydrocarbons and nitrogen is used as refrigerant for liquefying natural gas. These processes have, generally, higher efficiencies compared to expander cycles and are more suitable for medium- to large-scale productions.
- Cascade Processes: In cascade processes, natural gas is chilled and liquefied in successively colder heat exchangers that use propane, ethylene, and methane as refrigerants. The cascade processes offer a comparable efficiency to dual and pre-cooled mixed refrigerant cycles, but have a higher equipment count.

Based on the characteristics of natural gas liquefaction technologies described above, as well as on commercial and real estate considerations, JCEP has considered, in depth, two viable mixed refrigerant processes and related train configurations. The Black & Vetch PRICO® Process, which utilizes five liquefaction trains to produce 7.8 mtpa of LNG, was selected as the preferred technology and is described as part of the proposed Project in Resource Report 1. JCEP also considered APCI's optimized Dual Mixed Refrigerant ("DMR") process, utilizing a single liquefaction train, as an alternative to the Black & Vetch PRICO® Process, which is a Single Mixed Refrigerant ("SMR") process. Both liquefaction designs fit on the Ingram Yard site. While meeting industry spacing requirements, the DMR layout is denser than the SMR design, this is largely due to gas-treatment boosting, BOP power generation design, and total equipment count.

10.3.8.1 Dual Mixed Refrigerant

Theoretically, DMR processes offer higher efficiency compared to SMR configurations; however, this did not prove to be the case in the DMR process evaluated for LNG Terminal. The DMR process is more complex in nature due to the presence of an additional mixed refrigerant cycle. The DMR process is suitable for larger production capacities and minimizes hydrocarbon inventories compared to the SMR process for an equivalent overall throughput capacity. DMR technology provides enhanced control capability over process parameters than do SMR processes; however, it is less cost-effective for smaller scale facilities, such as the LNG Terminal.

The APCI optimized DMR process can produce up to 7.8 mtpa of LNG in a single train arrangement. This process utilizes two mixed refrigerant circuits: The Warm Mixed Refrigerant ("WMR") circuit for pre-cooling and the Cold Mixed Refrigerant ("CMR") circuit for liquefaction and sub-cooling. Figure 10.3-7 depicts the APCI DMR liquefaction process. The typical mixture for WMR is mainly ethylene, propane, and methane, while the mixture for CMR includes mainly nitrogen, methane, ethylene, and propane.

In the DMR process, treated natural gas is pre-cooled before being liquefied in the Main Cryogenic Heat Exchanger ("MCHE"). The natural gas is liquefied and sub-cooled within the MCHE by the CMR. Pressure reduction is used to evaporate refrigerant and sub-cool the LNG product.

Ultimately, SMR was selected by the Project. Both processes met project emissions, plot space, process safety, production, availability, and regulatory requirements. SMR was ultimately selected due to lower equipment count, simplicity, and efficiency.

REFERENCES

U.S. Department of Energy (USDOE), National Energy Technology Laboratory. 2014. Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States (Document No. DOE/NTL-2014/1649). Issued May 29, 2014. Available online at http://energy.gov/fe/downloads/life-cycle-greenhouse-gas-perspective-exportingliquefied-natural-gas-united-states. Accessed August 2016.

FIGURES

APPENDICES

APPENDIX A.10
Site Selection and Design for LNG Ports and Jetties (SIGTTO 1997)

To be provided in a later draft