



Cheniere Energy, Inc.  
700 Milam Street, Suite 800  
Houston, Texas 77002  
phone: 713.375.5000  
fax: 713.375.6000

September 3, 2010

Ms. Kimberly D. Bose, Secretary  
Federal Energy Regulatory Commission  
888 First Street, N.E.  
Washington, D.C. 20426

**Re: Sabine Pass Liquefaction, LLC and Sabine Pass LNG, L.P.  
Docket No. PF10-24-000  
Initial Draft of Resource Report 1 and 10**

Dear Ms. Bose:

On July 26, 2010, Sabine Pass Liquefaction, LLC and Sabine Pass LNG, L.P. (collectively "Sabine Pass") submitted a request that the Staff of the Federal Energy Regulatory Commission ("Commission") initiate a National Environmental Policy Act ("NEPA") pre-filing review of the proposed Liquefaction Project located in Cameron Parish, Louisiana. On August 4, 2010, the Director of the Office of Energy Projects granted Sabine Pass' request for use of the NEPA pre-filing process. In accordance with the Commission's regulations and its NEPA pre-filing review procedures, 18 C.F.R. § 153.12 (2010), Sabine Pass hereby submits for electronic filing its pre-filing Initial Draft Resource Reports 1 and 10.

Should you have any questions about this filing, please feel free to contact the undersigned at (713) 375-5000.

Thank you,

/s/ Karri Mahmoud

Karri Mahmoud  
Sabine Pass Liquefaction, LLC  
Sabine Pass LNG, L.P.

cc: Ms. Maggie Suter – Federal Energy Regulatory Commission  
Mr. Michael Donnelly – Ecology and Environment  
Ms. Lisa Tonery – Fulbright and Jaworski

### **Certificate of Service**

I hereby certify that I have this day served the foregoing document upon each person designated on the official service list compiled by the Secretary in this proceeding.

Dated at Houston, Texas this 3rd day of September, 2010.

/s/ *Karri Mahmoud*

Karri Mahmoud

Sabine Pass Liquefaction, LLC

Sabine Pass LNG, L.P.



*Sabine Pass Liquefaction, LLC*

*Initial Draft Resource Report 1 — General Project Description*

*Docket No. PF10-24-000*

*September 3, 2010*

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## ACRONYMS AND ABBREVIATIONS

AEO 2010	Annual Energy Outlook 2010
ARI	Advanced Resources International, Inc.
ARI Report	<i>U.S. Natural Gas Resources and Productive Capacity</i> report
Bcf/d	billion cubic feet per day
BOG	boil-off gas
CFR	Code of Federal Regulations
CI	Chief Inspector
CMMS	computerized maintenance management system
EI	Environmental Inspector
EIA	U.S. Energy Information Administration
EU	European Union
FERC	Federal Energy Regulatory Commission
GTG-5	LM2500+ gas turbine generator
LNG	liquefied natural gas
LPDES	Louisiana Pollution Discharge Elimination System
m <sup>3</sup>	cubic meters
MIT	Massachusetts Institute of Technology
MIT Study	The Future of Natural Gas report
MMBtu	million British thermal units
MSL	mean sea level
mtpa	million metric tonnes of LNG per annum
NATO	North Atlantic Treaty Organization
NCI	Navigant Consulting, Inc.
NCI Report	<i>Market Analysis for Sabine Pass LNG Export Project</i> report
O&M	operations and maintenance
PCB	polychlorinated biphenyls
Plan	FERC's <i>Upland Erosion Control, Revegetation, and Maintenance Plan</i>
Potential Gas Committee	Potential Gas Committee of the Colorado School of Mines
Procedures	FERC's <i>Wetland and Waterbody Construction and Mitigation Procedures</i>
Project	Liquefaction Project
Sabine Pass	Sabine Pass Liquefaction, LLC and Sabine Pass LNG, L.P.
SPLNG Terminal	Sabine Pass LNG Import Terminal
SH	State Highway
Tcf	trillion cubic feet
U.S.	United States

## 1.0 PROJECT DESCRIPTION

### 1.0 INTRODUCTION

This draft resource report provides a general project description of the natural gas liquefaction and export plant (“Liquefaction Project” or “Project”) proposed by Sabine Pass Liquefaction, LLC and Sabine Pass LNG, L.P. (collectively referred to as “Sabine Pass”), to be located at the existing Sabine Pass liquefied natural gas (“LNG”) Import Terminal in Cameron Parish, Louisiana (“SPLNG Terminal”). Specifically, this report addresses certain additional facilities to be constructed and operated at the existing SPLNG Terminal, which was previously approved by the Federal Energy Regulatory Commission (“FERC”) in the following dockets:

- CP04-47-000 - December 21, 2004.
- CP05-396-000 - June 15, 2006.
- CP04-47-001 and CP05-396-001 - May 29, 2009.

When completed, the Liquefaction Project will be capable of processing an average of approximately 2.6 billion cubic feet per day (“Bcf/d”) of pipeline quality natural gas (including fuel and inerts) from the Creole Trail Pipeline, which interconnects with the SPLNG Terminal. Sabine Pass will liquefy the natural gas, store the LNG, and export approximately 16 million metric tonnes of LNG per annum (“mtpa”)<sup>1</sup> via LNG carriers.

This Draft Resource Report 1 describes the facilities associated with the Liquefaction Project, the purpose and need for the Project, land requirements, construction procedures, operation procedures, Project schedule, compliance with regulations and codes, and permits that will be obtained. Draft Resource Report 10 describes the “No Action” alternative as well as possible system and facility siting alternatives. The remaining resource reports will be provided at a later date. Resource Reports 2 through 9 will describe the resources at the SPLNG site, the potential impacts on those resources from construction and operation of the Project, and measures proposed to mitigate those impacts. Resource Report 11 will describe the design, construction, operation, and maintenance measures to maximize Project reliability and minimize potential hazards to the public from failure of Project components as a result of accidents or natural catastrophes. Resource Report 12, pertaining to polychlorinated biphenyls (“PCB”), is not applicable, as the Project does not involve the removal, replacement, or abandonment of PCB-contaminated facilities. Engineering and design information in Resource Report 13 will provide a detailed description of the liquefaction facilities for the Project.

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<sup>1</sup> mtpa is a rating that accounts for fuel, planned and unplanned shutdowns, production variations due to temperature, LNG composition changes, boil off, and other factors over a calendar year. Sixteen mtpa of LNG is approximately equivalent to 2.2 Bcf/d of vaporized natural gas.



## **1.1 PROPOSED FACILITIES**

Sabine Pass is proposing to add liquefaction capability to the existing SPLNG Terminal in Cameron Parish, Louisiana. Figure 1.1-1 depicts an artist's rendering of the existing SPLNG Terminal and the proposed Liquefaction Project facilities layout. Sabine Pass currently leases approximately 853 acres of private land for the existing SPLNG Terminal site. All proposed Project facilities will be constructed and operated within the existing 853-acre terminal site. Land requirements are discussed further in Section 1.4.

All Project components will be sited, constructed, operated, and maintained in accordance with applicable federal and state regulations. The Project will include the following components and will be constructed in two stages: Stage 1 beginning in 2012 and Stage 2 after sufficient commercial justification is achieved.

### **1.1.1 Liquefaction Train - Stage 1**

- Two ConocoPhillips Optimized Cascade<sup>SM</sup> LNG Process Trains (LNG Trains 1 and 2), each capable of a liquefaction capacity of approximately 4.0 mtpa;
- New and remodeled buildings to accommodate increased equipment, facilities, and operations and maintenance ("O&M") personnel required to operate the liquefaction trains; and
- Additional new utilities and support infrastructure, and modifications to the existing SPLNG Terminal to accommodate LNG Trains 1 and 2, as required.

### **1.1.2 Liquefaction Train - Stage 2**

- Two ConocoPhillips Optimized Cascade<sup>SM</sup> LNG Process Trains (LNG Trains 3 and 4), essentially identical to LNG Trains 1 and 2, that will increase the total processing capacity to approximately 16 mtpa of LNG;
- Additional power generation capacity; and.
- Modifications and additions to existing utilities and infrastructure as required.

### **1.1.3 LNG Liquefaction Trains (LNG Trains)**

Each ConocoPhillips Optimized Cascade<sup>SM</sup> LNG Train, contains the following equipment:

- Gas treatment facilities to remove condensate liquids, water, solids, CO<sub>2</sub>, sulfur, and mercury;
- Six LM2500+ G4 gas turbine-driven refrigerant compressors;
- Waste heat recovery systems for regenerating the gas driers and amine system;
- Induced draft air coolers;

- Associated fire and gas detection and safety systems;
- Associated control systems and electrical infrastructure;
- Utility connections and distribution systems as required;
- Piping, pipe racks, foundations, and structures within the LNG train battery limits; and
- Interconnections to existing facilities.

#### **1.1.4 Additional Power Generation**

New LM2500+ gas turbine generator (“GTG”), transformers, and other electrical accessories to supplement existing onsite power generation. Potentially up to two (2) GTGs will be installed as part of Stage 2 of the Liquefaction Project.

#### **1.1.5 Other Infrastructure and Modifications**

Additional utilities and support infrastructure, as well as modifications to the existing SPLNG Terminal will be required, and include:

- Storage tanks for propane and ethylene refrigerants;
- Storage tank for amine make up;
- Replacement of in-tank LNG pumps and piping modifications on the LNG tanks and jetty piping to increase flow capacity and facilitate loading of LNG carriers;
- Impoundments for the liquefaction trains, and modifications to existing LNG impoundments (if necessary) to accommodate LNG loading at 14,000 cubic meters (“m<sup>3</sup>)/hour;
- Flares for the liquefaction facilities;
- Marine loading flare;
- Recycle boil-off gas (“BOG”) compressors;
- Instrument air compressor packages;
- Improvements to heavy haul road from Lighthouse Road to the liquefaction trains, and plant roads to service the new facilities;
- Expansion to security and perimeter access control systems;
- Expansion to telecom, IT, CCTV, and other systems;
- Storage tanks for condensate, liquid nitrogen, diesel, and gasoline (if required);

- Potable water, service water, and demineralized water systems;
- Upgrades and expansion of potable water and sewage treatment facilities; and
- Soil improvement, piling, and paving for all facilities, including Stage 2 LNG Trains, LNG Tank S-106, and laydown areas if required.

#### **1.1.6 New and Remodeled Buildings**

New and remodeled buildings will be required to accommodate increased equipment, facilities, and O&M personnel required to operate the liquefaction trains, including:

- Modifications to the Control Building to add systems for the liquefaction trains and other new facilities;
- Modifications to the existing Maintenance/Warehouse Building to convert it to maintenance functions only;
- Warehouse to store spare parts and consumables for both the liquefaction and regasification facilities;
- Waste and materials storage building for chemicals, lubricants, and other hazardous substances;
- Building for lockers, canteen, offices, etc.; and
- Remote I/O buildings and substations as required.

#### **1.1.7 Marine Terminal and LNG Transfer Lines**

No additional marine facilities are required for the proposed Liquefaction Project. The check valve currently installed in the LNG unloading lines will be to simplify loading and unloading operations. The unloading and loading rate is proposed to be increased to 14,000 m<sup>3</sup>/hour. The rate will be increased by replacement of the in-tank pumps in the LNG storage tanks and by additional modifications to LNG transfer lines located on shore. No other modifications will be required for the marine terminal.

#### **1.1.8 LNG Storage**

The Liquefaction Project will utilize the existing LNG storage tanks that have been constructed as part of the SPLNG Terminal. Although six LNG storage tanks have been authorized at the SPLNG Terminal (three in Docket CP04-47-000 and three in Docket CP05-396-000), only five have been constructed. The sixth LNG storage tank (S-106) will be constructed to handle the additional storage requirements related to development of Stage 2 of the proposed Project. The sixth LNG storage tank as described in previous dockets is a single containment, top entry tank with a nominal working volume of approximately 160,000 m<sup>3</sup>. Because the sixth LNG storage tank has been previously authorized, it is not addressed further in these resource reports.

### **1.1.9 LNG Vaporization/Natural Gas Sendout**

Except for the required tie-ins to the existing SPLNG Terminal facilities, no impacts or modifications will occur to the existing LNG vaporization facilities. However, some minor facility modifications or changes to operational procedures related to vaporization and sendout may be necessary for the proposed Project.

### **1.1.10 LNG Impoundments**

LNG Tank S-106, previously authorized under FERC Docket CP05-396-000, will be surrounded by an individual impoundment consisting of an earthen dike, sized to contain 110 percent of the gross capacity of the LNG tank. This is described in more detail in Docket No. CP05-396-000. The liquefaction area will also have an impoundment sized to accommodate a 10 minute spill from the largest LNG lines in the area.

## **1.2 PURPOSE AND NEED**

Sabine Pass' Liquefaction Project has been proposed due to the improved outlook for domestic natural gas production, owing to drilling productivity gains that have enabled rapid growth in supplies from unconventional, and particularly shale, gas-bearing formations in the United States ("U.S."). Improvements in drilling and extraction technologies have coincided with rapid diffusion in the natural gas industry's understanding of the unconventional resource base and best practices in drilling and resource development. These changes have rendered obsolete once prominent fears of declining future domestic natural gas production. The export of natural gas as LNG would provide a market solution to allow the further deliberate development of these emerging sources of domestic natural gas and would result in the following benefits, all of which are consistent with the public interest:

- Stimulate the Louisiana state, regional and national economies through job creation, increased economic activity and tax revenues, including the direct creation of approximately 3,000 engineering and construction jobs during the course of the project and, indirectly, 30,000-50,000 permanent jobs in the exploration and production sector;
- Promote domestic production of petroleum and reduced reliance on foreign sources of oil;
- Further the President's National Export Initiative,<sup>2</sup> by improving U.S. balance of payments through the exportation of approximately 2 Bcf/d of natural gas valued at approximately \$5 billion and the displacement of \$1.7 billion in NGL imports;
- Raise domestic natural gas productive capacity and promote stability in domestic natural gas pricing;

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<sup>2</sup> See Executive Order No. 13,534, 75 Federal Register 12,433 (March 16, 2010), *available at* <http://www.whitehouse.gov/the-press-office/executive-order-national-export-initiative> ("A critical component of stimulating economic growth in the U.S. is ensuring that U.S. businesses can actively participate in international markets by increasing their exports of goods, services, and agricultural products. Improved export performance will, in turn, create good high-paying jobs.").

- Promote liberalization of global natural gas trade through fostering of a global, liquid, natural gas market;
- Advance national security and the security of U.S. allies through diversification of global natural gas supplies; and
- Increase economic trade and ties with foreign nations including neighboring countries in the Americas and displacing environmentally damaging fuels in those countries.

### **1.2.1 Analysis of Domestic Need for Gas to be Exported**

In support of its proposal to export domestic natural gas supplies as LNG, Sabine Pass commissioned reports by Advanced Resources International, Inc. (“ARI”) and Navigant Consulting, Inc. (“NCI”)<sup>3</sup> to assess domestic need for the natural gas to be exported from the Liquefaction Project. The ARI report, *U.S. Natural Gas Resources and Productive Capacity* (“ARI Report”), was commissioned to evaluate the scope of natural gas resources in the U.S. and their potential for future recovery. The NCI report, *Market Analysis for Sabine Pass LNG Export Project* (“NCI Report”), was commissioned to evaluate the market price impact of LNG exports from the SPLNG Terminal under several future U.S. demand scenarios.<sup>4</sup> Both the ARI Report and the NCI Report, as well as publicly available information, indicate that the U.S. has significant natural gas resources available at prices that are sufficient to meet projected domestic needs here in the U.S.

#### **1.2.1.1 Supply of Natural Gas in the U.S.**

Domestic gas production has been on an upward trend in recent years as rapid growth in supply from unconventional basins has more than outweighed declines in conventional onshore and offshore formations. Since 2005, when horizontal drilling began in earnest in the Barnett Shale formation in north-central Texas, U.S. dry gas production has grown 16.1%, to 20.96 trillion cubic feet (“Tcf”) (57.4 Bcf/d) in 2009, representing the highest U.S. production levels since 1973.<sup>5</sup>

Preliminary data point to continued growth in domestic production in 2010 despite a significant drop in U.S. natural gas drilling activity from peak levels in 2008.<sup>6</sup> The U.S. Energy Information Administration

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<sup>3</sup> To be provided in next version of Resource Report 1.

<sup>4</sup> ARI is a geological and engineering consulting firm which specializes in unconventional hydrocarbon geology, and has played an instrumental role over the last three decades in advancing the industry’s understanding of the domestic unconventional resource base. NCI is an international consultant to the energy and utility industry.

<sup>5</sup> See EIA, *Natural Gas Gross Withdrawals and Production* (July 29, 2010), [http://www.eia.gov/dnav/ng/ng\\_prod\\_sum\\_dc\\_u\\_nus\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_sum_dc_u_nus_a.htm).

<sup>6</sup> There were 992 rigs drilling for natural gas in the U.S. as of the week ended August 13, 2010, 28% below peak drilling levels of 1,606 rigs for the week ended September 12, 2008. Baker Hughes, *North America Rotary Rig Count* (Aug. 13, 2010), [http://files.shareholder.com/downloads/BHI/913806705x0x395656/B435AB0E-C2DF-48FA-9982-912C127B7AA5/U.S.\\_Rig\\_Report\\_081310revised.xls](http://files.shareholder.com/downloads/BHI/913806705x0x395656/B435AB0E-C2DF-48FA-9982-912C127B7AA5/U.S._Rig_Report_081310revised.xls)). Baker Hughes, *North America Rotary Rig Count* (Sept. 12, 2010).

(“EIA”) estimates U.S. dry gas production totaled 59.3 Bcf/d in May 2010, a 1.69 Bcf/d increase compared to May 2009 dry production of 57.4 Bcf/d.<sup>7</sup> Increased drilling productivity in certain prolific shale formations, particularly the Marcellus and Haynesville shales, have enabled domestic production to continue expanding despite a reduction in industry upstream development.

The robust potential for future U.S. natural gas supply has been reflected in other recent industry evaluations. The Potential Gas Committee of the Colorado School of Mines (“Potential Gas Committee”) in June 2009 raised its estimates of the U.S. technically recoverable gas resource base by 515 Tcf (+39%) to 1,836 Tcf at year-end 2008.<sup>8</sup> Including 238 Tcf of established proved domestic natural gas reserves, the Potential Gas Committee determined that the U.S. possesses future available gas supply of 2,074 Tcf,<sup>9</sup> the highest resource evaluation in the group’s 44-year history and over 90 years of domestic market needs, based on 2009 consumption levels.<sup>10</sup>

In its recently published study, *The Future of Natural Gas*, the Massachusetts Institute of Technology (“MIT”) (“MIT Study”) estimates that the U.S. has a mean recoverable resource base of approximately 2,100 Tcf.<sup>11</sup> This estimate includes 650 Tcf of recoverable shale resources, “approximately 400 Tcf [of which] could be economically developed with a gas price at or below \$6/million British thermal units (“MMBtu”) at the well-head.”<sup>12</sup> According to the MIT Study’s mean resource estimate, U.S. gas production will rise by 40% between 2005 and 2050.

In addition, the ARI Report provides an independent analysis of the unconventional natural gas resource base in the U.S. to supplement publicly available information on conventional onshore and offshore gas resources. ARI estimates that the U.S. possesses technically recoverable natural gas resources totaling 2,585 Tcf, including 2,286 Tcf in the Lower 48 state region and 299 Tcf in Alaska.<sup>13</sup> Of this total, 246 Tcf represent proved natural gas reserves and 2,238 Tcf comprise undiscovered or inferred resources.<sup>14</sup> Unconventional gas-bearing formations account for 53% (or 1,373 Tcf) of technically recoverable

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<sup>7</sup> See EIA, *U.S. Dry Natural Gas Production* (July 29, 2010), <http://www.eia.gov/dnav/ng/hist/n9070us2m.htm>.

<sup>8</sup> See Press Release, Potential Gas Committee, Potential Gas Committee Reports Unprecedented Increase In Magnitude of U.S. Natural Gas Resource Base (June 18, 2009), <http://www.aga.org/NR/rdonlyres/65B2FD7E-A208-4687-9B4B-6EC079DA673D/0/0906PGCPRESS.PDF>.

<sup>9</sup> *Id.* at 2.

<sup>10</sup> U.S. natural gas demand totaled 22.8 Tcf in 2009. EIA, *Natural Gas Consumption by End Use* (July 29, 2010), [http://www.eia.gov/dnav/ng/ng\\_cons\\_sum\\_dcu\\_nus\\_a.htm](http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm).

<sup>11</sup> MIT Energy Initiative, MIT, *The Future of Natural Gas*, at 9 (2010) [hereinafter “MIT Report”], <http://web.mit.edu/mitei/research/studies/naturalgas.html>.

<sup>12</sup> *Id.* at xii.

<sup>13</sup> ARI Report at 8.

<sup>14</sup> *Id.*

domestic gas resources and include 700 Tcf of recoverable reserves from shale formations (567 Tcf from tight sandstones and 106 Tcf from coalbed formations).<sup>15</sup>

The ARI Report notes that assessments of the domestic natural gas resource base are not static and have expanded over time due to improvements in oilfield service technologies such as horizontal drilling, multi-well pad drilling, and improved fracturing and stimulation of tight gas formations.<sup>16</sup> ARI projects that technology gains will continue to drive down production costs and augment recoverable natural gas reserves in the future. Remaining recoverable domestic shale gas resources, for example, are projected to increase 18.9% by 2035 to 853 Tcf from their assessment of 711 Tcf at the start of 2009.<sup>17</sup>

The ARI Report also examines the market impact of its unconventional gas forecast in the context of the EIA's latest Reference Case in its Annual Energy Outlook 2010 ("AEO 2010") for the U.S. natural gas market through 2035.<sup>18</sup> Using the AEO 2010 reference natural gas case outputs and, holding all other variables constant, ARI used its Technology Model for Unconventional Gas Supply to re-assess the outlook for domestic unconventional gas productive capacity given EIA's projected track for future U.S. natural gas prices.<sup>19</sup> This substitution is appropriate given that EIA historically has underestimated the future contributions of unconventional gas, and particularly shale gas, to domestic markets.<sup>20</sup> These underestimation issues remain a concern in EIA's AEO 2010 forecast, which appears 4.5 Bcf/d too conservative in its estimate of current U.S. shale gas production.<sup>21</sup>

Assuming the same natural gas price outlook as generated by AEO 2010, ARI estimates U.S. unconventional gas productive capacity would grow to 69.0 Bcf/d in 2035 from 36.3 Bcf/d in 2010.<sup>22</sup> Natural gas produced from shales would account for 26.9 Bcf/d, or 82.3% of the 32.7 Bcf/d in projected growth in domestic productive capacity from unconventional geologic formations over the 25-year timeframe.<sup>23</sup> ARI subsequently merged its findings with the AEO 2010's projections for conventional domestic dry production, including the estimated start of a 4.5 Bcf/d pipeline from Alaska's North Slope

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<sup>15</sup> *Id.*

<sup>16</sup> *See id.* at 9.

<sup>17</sup> *Id.* at 9, 35-38.

<sup>18</sup> *See* EIA, DOE, *Annual Energy Outlook 2010*, Table 117 (May 11, 2010) [hereinafter "AEO 2010"], [http://www.eia.doe.gov/oiaf/aeo/supplement/suptab\\_117.xls](http://www.eia.doe.gov/oiaf/aeo/supplement/suptab_117.xls).

<sup>19</sup> AEO 2010 estimates U.S. natural gas prices will rise from \$4.50/MMBtu to \$6.64/MMBtu through 2020, while long-term prices are projected to increase from \$6.74/MMBtu to \$8.88/MMBtu between 2021 and 2035. *See id.* at Table 13, [http://www.eia.doe.gov/oiaf/aeo/excel/aeotab\\_13.xls](http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_13.xls).

<sup>20</sup> Navigant Consulting Inc., *North American Natural Gas Supply Assessment*, at 5-6 (July 4, 2008), <http://www.cleanskies.org/pdf/navigant-natural-gas-supply-0708.pdf>.

<sup>21</sup> AEO 2010 projects U.S. shale gas production of 2.75 Tcf (7.5 Bcf/d) in 2010. *See* AEO 2010, at Table 14, [http://www.eia.doe.gov/oiaf/aeo/excel/aeotab\\_14.xls](http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_14.xls). However, ARI notes that preliminary U.S. shale gas production totals 12.2 Bcf/d in 2010. ARI Report at 6.

<sup>22</sup> ARI Report at 23.

<sup>23</sup> *Id.* at 27.

to the Lower 48 states in 2024, and concluded that U.S. dry natural gas productive capacity would grow to 92.7 Bcf/d in 2035 from 58.6 Bcf/d in 2010, given the future market price track presented in the AEO 2010 report.<sup>24</sup> This growth in domestic productive capacity would well exceed expectations for future U.S. demand, projected by EIA in AEO 2010 to grow to 68.1 Bcf/d in 2035 from 64.7 Bcf/d in 2010.<sup>25</sup> Under the modified supply case presented by ARI, domestic natural gas productive capacity would exceed projected U.S. demand by 11.0 Bcf/d in 2015, 19.9 Bcf/d in 2025, and 28.7 Bcf/d in 2035.<sup>26</sup>

The ARI Report and the publicly available information demonstrate that the U.S. has sufficient natural gas resources available at modest prices to meet projected domestic demand over the next 20 or more years. Further, the ARI Report establishes that the availability of new natural gas reserves is likely to continue expanding into the future as new unconventional formations are discovered and the oil and gas industry continues to improve drilling and extraction techniques.

### ***1.2.1.2 Natural Gas Demand***

The outlook for natural gas demand in the U.S. has dimmed considerably over the last decade as a consequence of persistent market price volatility, as well as structural changes afoot in the domestic economy. In its 1999 study on the U.S.'s natural gas market, the National Petroleum Council estimated that domestic consumption of natural gas would grow to 29.0 Tcf (79.5 Bcf/d) in 2010, a 31.8% increase from 22.0 Tcf (60.2 Bcf/d) of domestic demand in 1998.<sup>27</sup> Instead, the EIA, in its most recent short-term market assessment, predicts U.S. natural gas consumption of 23.68 Tcf (64.9 Bcf/d) in 2010, or growth of only 7.6% from the 1998 benchmark.<sup>28</sup> U.S. demand in 2009 of 22.81 Tcf in fact was 2.2% lower than the 23.33 Tcf consumed at the start of the decade, according to EIA data.<sup>29</sup> Moreover, the 29 Tcf domestic natural gas market once envisioned by the National Petroleum Council has been indefinitely postponed based on evolving market conditions. The AEO 2010 predicts long-term annual gas demand growth of only 0.2%, with the domestic market expected to reach 24.86 Tcf (68.1 Bcf/d) in 2035.<sup>30</sup> Structural factors have contributed to these more conservative estimates of future demand growth. The composition of U.S. economic activity in time has gravitated toward less energy-dependent activities such as services and health care at the expense of manufacturing-based activity. Furthermore, improved technology and efficiency standards have lead to sharp reductions in energy usage in consumer products that directly, or through reduced electricity usage, indirectly impact U.S. natural gas consumption.

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<sup>24</sup> *Id.* at 23-24.

<sup>25</sup> *Id.* at 24.

<sup>26</sup> *Id.*

<sup>27</sup> National Petroleum Council, *Meeting the Challenges of the Nation's Growing Natural Gas Demand*, Vol. 1. Summary Report, at 33 (Dec. 1999), <http://www.npc.org/>.

<sup>28</sup> See EIA, *Short Term Energy Outlook*, at 4 (Aug. 10, 2010), [http://www.eia.doe.gov/emeu/steo/pub/steo\\_full.pdf](http://www.eia.doe.gov/emeu/steo/pub/steo_full.pdf).

<sup>29</sup> EIA, *Natural Gas Consumption by End Use*, [http://www.eia.gov/dnav/ng/ng\\_cons\\_sum\\_dcunusa.htm](http://www.eia.gov/dnav/ng/ng_cons_sum_dcunusa.htm).

<sup>30</sup> See AEO 2010, at Table 13, [http://www.eia.doe.gov/oiaf/aeo/excel/aeotab\\_13.xls](http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_13.xls).



According to Department of Energy Secretary Stephen Chu, "... the improvement in the efficiency of refrigerators alone since the 1970s is responsible for energy savings today greater than all non-hydro renewable power generation. During that time, the inflation adjusted cost of refrigerators dropped by about half while energy consumption was simultaneously reduced by more than 75 percent."<sup>31</sup> Dr. Chu further noted that appliance standards issued in the last 16 months alone will further reduce energy use and save American consumers more than \$250 billion over the next 20 years.<sup>32</sup> This same trend of increased efficiency through technology gains is evident in industrial applications of natural gas. The new generation of combined-cycle natural gas power plants, for example, consume much less natural gas per unit of electricity output than their older steam-based counterparts. The result of these trends is that meeting the future economic needs of the U.S. economy will require relatively less natural gas, and energy in general, than in the past.

### ***1.2.1.3 Supply-Demand Balance Demonstrates the Lack of Regional/National Need***

It is evident from the current supply/demand balance of natural gas in the U.S. that the request for authorization to site, construct, and operate the Liquefaction Project is in the public interest. U.S. natural gas production has been steadily increasing in recent years while domestic demand since 2008 has experienced a significant retrenchment owing to the global recession. Robust supply and a dimmed outlook for market growth have led to historically low prices, prompting domestic producers to slow drilling, defer completions of recently drilled wells and reduce plans for future investments in natural gas producing basins.<sup>33</sup> Market price volatility during this period also has forced the periodic shut-in of actively producing wells in marginal gas-producing fields, suggesting that domestic natural gas productive capacity has exceeded the ability of the U.S. market to absorb incremental supplies.<sup>34</sup> It stands to reason that the ability to export domestic gas as LNG would greatly expand the market scope and access for domestic natural gas producers and thus serve to encourage domestic production at times when U.S. market prices might not otherwise do so. Such production would be available to supply domestic markets and thereby serve to moderate U.S. gas price volatility and keep prices to U.S. natural consumers at reasonable levels.

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<sup>31</sup> Hearing on National Energy Policies Before the Subcomm. on Energy and Water Development of the S. Comm. on Appropriations, 111<sup>th</sup> Cong. 2-3 (2010) (testimony of Hon. Steven Chu, Secretary, Dep't of Energy).

<sup>32</sup> *Id.* at 3.

<sup>33</sup> Three of the four articles on the cover of the August 4, 2010 edition of *Gas Daily* concern the impact on producers and production of the current over supply situation: "Chesapeake lays it down until prices pass \$6"; "Prices prompt Petrohawk to trim shale spending" and "Analysts ponder long-term impact of low prices." Platts, *Gas Daily*, Aug. 4, 2010, at 1.

<sup>34</sup> "A third of wells on Wyoming state land shut due to low prices", Platts *Gas Daily*, October 27, 2009 page 1. Also, "Encana Shuts in Gas Wells on Low Prices" *Natural Gas Intelligence*, Jun. 22, 2009.

## **1.2.2 Other Public Interest Considerations**

### ***1.2.2.1 Benefits to U.S., Regional and Local Economies***

The Liquefaction Project will stimulate the national, regional and local economies through job creation, increased economic activity and tax revenues both directly and indirectly. Most of the technology, equipment and material needed to construct the Liquefaction Project can be obtained from U.S. sources. The manufacturing and supply of the required materials would result in an investment of over \$400 million per LNG train, which equates to over \$1.6 billion for the Liquefaction Project as a whole. Moreover, the national economy would benefit indirectly from the Project's role in supporting the exploration and production chain for natural gas extraction. This indirect stimulus will have a profound multiplier effect due to the wages, taxes and lease payments involved in the natural gas supply chain. Additionally, the Liquefaction Project will further the President's National Export Initiative. The National Export Initiative is designed to reduce barriers to trade and promote U.S. exports. The goal is to double U.S. exports over the next five years to create jobs and boost the economy. In this regard, the Liquefaction Project would help to reduce barriers to trade and promote U.S. businesses with the goal of increasing exports, thereby creating jobs and boosting the economy.

The Louisiana state and local economies would benefit from an immediate boost during the construction and operation of the Liquefaction Project. Given the magnitude of the economic benefits associated with the construction and operation of the Sabine Pass Liquefaction Project, the Project has received significant support from a board spectrum of local, state and federal office-holders in the state of Louisiana, including the entire congressional delegation from the state. In this regard, the need for LNG export facilities in the U.S., and in Louisiana in particular, has been recognized by U.S. Senator Mary Landrieu:

*The United States is currently experiencing a natural gas revolution that will open up new markets here at home and abroad.... In northwest Louisiana alone, the Haynesville Shale reserve has 251 trillion cubic feet of recoverable natural gas, almost 11 times the amount consumed by Americans last year. Accessing this growing supply of natural gas and building the means to deliver it to consumers will stabilize prices and allow the U.S. to become a major exporter of natural gas. This project by Cheniere Energy at Sabine Pass is a key piece of that puzzle. The result will be more jobs for Louisianians, a stronger economy and more secure energy future of America.*<sup>35</sup>

### ***1.2.2.2 Direct Benefits***

The Liquefaction Project would provide a stable source of income and employment to the Louisiana and Gulf Coast communities. Approximately 3,000 jobs would be created directly through the design, engineering and construction of the Liquefaction Project, which translates into approximately \$1 billion in

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<sup>35</sup> Press Release, U.S. Senator Mary Landrieu, Landrieu Welcomes Changes to Sabine Pass to Allow Exportation of Natural Gas (June 4, 2010), <http://landrieu.senate.gov/mediacenter/pressreleases/06-04-2010-2.cfm>.

wages to U.S. workers over a six year period.<sup>36</sup> A rough estimate of the craft labor to be paid over the Project duration is \$350 million, with a peak of about 2,750 craft workers on site. In addition, Sabine Pass Project staff and contractor management staff will peak at about 250 people, with staff wages in the range of \$170 million for Phase 1 of the Project.

A rough estimate of the craft labor wages to be paid over the Project duration for Phase 2 is \$300 million. Sabine Pass Project staff and contractor management staff payroll will be in the range of \$150 million. Sabine Pass estimates that approximately 150 to 250 full-time positions will be required to maintain and operate the Liquefaction Project.

Southeast Louisiana and southwest Texas in particular will benefit from added jobs, as the bulk of the construction workforce will come from those areas. The Sabine Pass Liquefaction Project would provide a lifeline to the southwest Louisiana area, particularly Cameron Parish, which was decimated by Hurricanes Ike and Rita and has yet to fully recover. Once constructed and operational, the state and local economies would derive significant tax revenues from the Liquefaction Project, including tax revenues on natural gas liquids, increased gas production, labor, pipeline and other infrastructure construction.

#### **1.2.2.3 Indirect Benefits**

The Liquefaction Project potentially will play a significant role in contributing to the growth of natural gas production in the U.S. The natural gas supply chain has very significant multiplier effects on the U.S. economy due to the large number of industry jobs paid at high wage rates, and to frequently robust lease payments made to landowners in association with natural gas production. The expenditures associated with the Liquefaction Project and increased gas production resulting from the ability to export domestic supplies would ripple through the U.S. economy and generate even more economic activity as businesses and workers spend money. In this regard, there will be significant employment and income impacts on local businesses such as restaurants, service companies, retailers and hotels, while the additional U.S. natural gas productive capacity which LNG exports would create would ripple through multiple gas producing states. The Liquefaction Project also may spur the creation of new value-added businesses associated with the liquefaction and export processes.

#### **1.2.3 Reduction in the U.S. Trade Deficit**

Allowing for the exportation of LNG from the U.S. also will have a beneficial impact for the U.S. on the balance of payments between the U.S. and the rest of the world by reducing the overall U.S. trade deficit. According to the U.S. Department of Commerce, Bureau of Economic Analysis, in 2009 the total U.S. trade deficit was \$380.7 billion (comprised of approximately \$1.5 trillion in exports minus approximately \$1.9 trillion in imports).<sup>37</sup> Significantly, of that \$380.7 billion deficit, more than half (over \$204 billion)

<sup>36</sup> Estimated construction work force numbers and payroll have been provided by Sabine Pass's engineering, procurement and construction contractor, Bechtel Corporation, and include current staff working on the Liquefaction Project for front end engineering and design.

<sup>37</sup> See BEA, U.S. Dep't of Commerce, *U.S. Int'l Trade in Goods and Services*, Feb. 10, 2010, at 11, <http://www.bea.gov/newsreleases/international/trade/2010/pdf/trad1209.pdf>.

was the direct result of a negative balance of trade in petroleum products (including crude oil, natural gas, fuel oil and other petroleum-based distillates such as kerosene).<sup>38</sup> Given the substantial impact the U.S.'s negative trade balance in petroleum products has on its overall trade deficit and balance of payments, granting Sabine Pass's request to construct the Liquefaction Project for the export LNG would have a significant positive impact on reducing that deficit.

#### **1.2.4 Geopolitical Benefits**

The export of domestically-produced LNG would promote liberalization of the global gas trade through fostering of a global, liquid, natural gas market; and will advance national security interests as well as the security interests of U.S. allies through the diversification of global natural gas supplies. The current natural gas trade has developed regionally with three primary markets: North America, Europe and Asia. There is substantial trade within these markets, but little trade between the markets. The pricing structure within each market is significantly different. In North America, natural gas is traded in a highly liquid and competitive market and the price is very transparent. The European and Asian markets are dominated by natural gas prices linked to the price of crude oil. LNG contracts also are indexed to crude oil. By introducing market-based price structures, Sabine Pass increases the potential for global decoupling of oil parity pricing. This would provide significant benefits worldwide because, as stated in the MIT Study, "[a]n interconnected delivery system combined with price competition are essential feature of a "liquid" market."<sup>39</sup> The Sabine Pass Liquefaction Project can serve as a catalyst for this interconnection.

Natural gas is poised to grow as an energy source globally. Energy and security have historically been linked and this relationship is likely to tighten. On April 8, 2010, in addressing the North Atlantic Treaty Organization ("NATO"), the President said lack of international energy security was a 21st century asymmetric threat for all to address.<sup>40</sup> He suggested that the European Union ("EU") make an effort collectively within the EU and reiterated that diversity in sources of energy supply was a good thing for everyone. He also pledged cooperation and support with regard to that issue. Energy security is not a new issue for NATO. Its economic committee has, for years, had regular briefings on the topic as well as on industrial planning and energy security. The U.S. government and NATO have stressed that planning in response to terrorism is an area where energy security is an integral part. The U.S. government has expressed concerns over structural difficulties that inhibit an EU common position on energy security cooperation. Exports of U.S. natural gas could provide the catalyst that helps assure energy security within NATO. Exports of U.S. natural gas would play a significant role in reducing the stranglehold of Eurasian/MidEastern price cartels on the U.S. NATO allies, and also on the majority of U.S. trading partners worldwide.

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<sup>38</sup> *See Id.*

<sup>39</sup> *MIT Report, supra* note [13], at 70.

<sup>40</sup> Press Release, The White House, Press Gaggle by Nat'l Security Advisor General Jim Jones and NSC Chief of Staff Denis McDonough Aboard Air Force One (Apr. 9, 2010), <http://www.whitehouse.gov/the-press-office/press-gaggle-national-security-advisor-general-jim-jones-and-nsc-chief-staff-denis->.

As a related matter, a global, liquid natural gas market is beneficial to U.S. and global economic interests and, at the same time, advances security interests through diversity of supply and resilience to disruptions.<sup>41</sup> To this end, the importance of the Sabine Pass Liquefaction Project has been recognized by multiple European utilities that are interested in this Project because of the pricing structure of U.S. natural gas markets and the security and diversity of supply offered by those markets. The gas supply in Europe is restricted to a small group of countries. The entrance of the U.S. into the global LNG market as a supplier would help to diversify the global gas market. Further, the U.S. provides a stable trading partner for the European utilities. This has important security implications because “[t]he U.S., with its unique international security responsibilities, can be constrained in pursuing collective action if its allies are limited by energy security vulnerabilities.”<sup>42</sup>

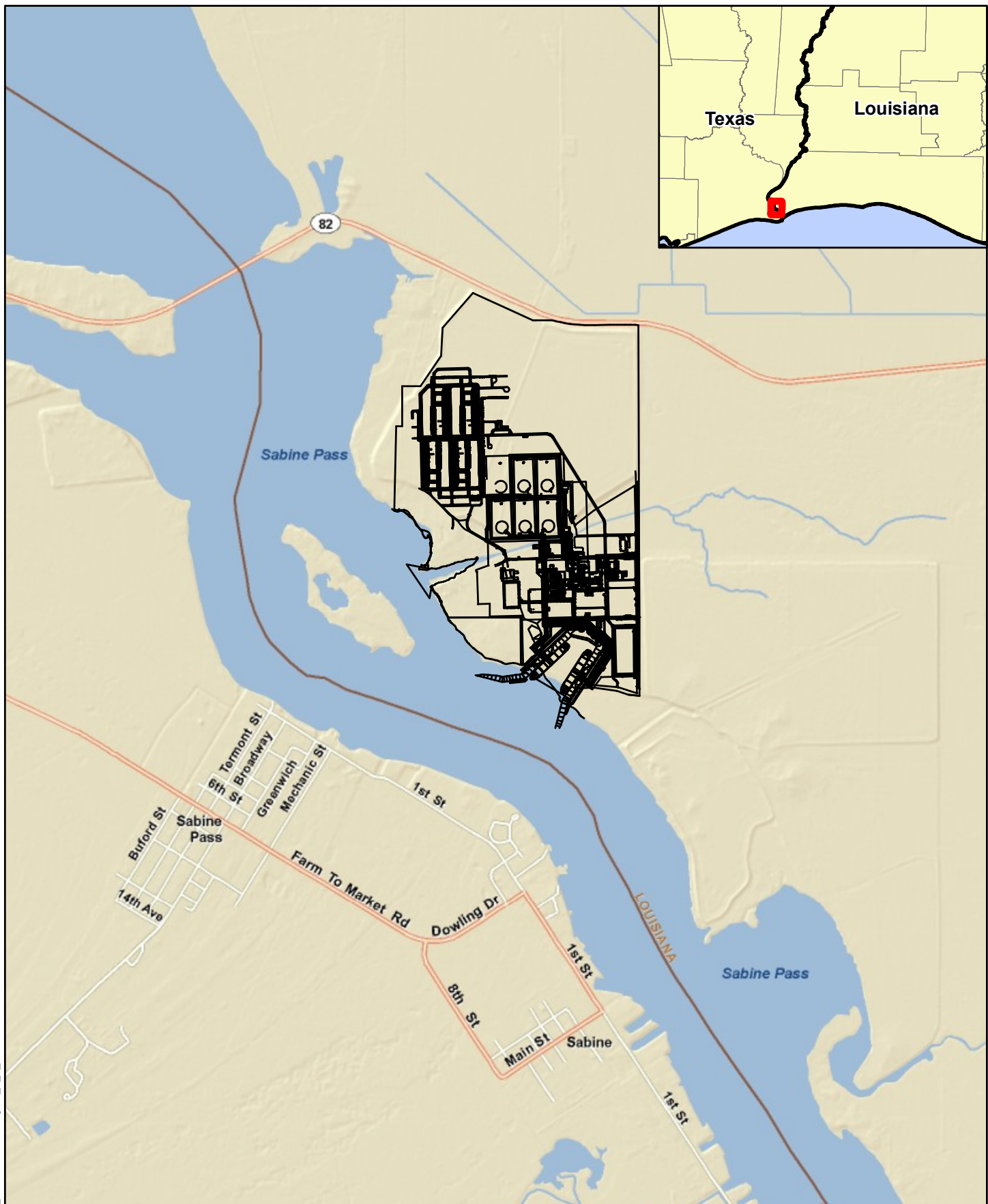
### **1.3 LOCATION AND DESCRIPTION OF PROJECT FACILITIES**

All proposed Project facilities will be located entirely within the 853-acre site previously leased in conjunction with the development of the existing SPLNG Terminal. The locations of the proposed facilities are depicted in Figure 1.3-1. A topographic map and aerial photography of the Project are included in Appendix A.2.

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<sup>41</sup> *MIT Report, supra* note [13], at xv (“Greater international market liquidity would be beneficial to U.S. interests. U.S. prices for natural gas would be lower than under current regional markets, leading to more gas use in the U.S. Greater market liquidity would also contribute to security by enhancing diversity of global supply and resilience to supply disruptions for the U.S. and its allies. These factors moderate security concerns about import dependence”). *See also id.* at xvii (“For reasons of both economy and global security, the U.S. should pursue policies that encourage an efficient integrated global gas market with transparency and diversity of supply, and governed by economic considerations”).

<sup>42</sup> *MIT Report, supra* note [13], at 71.



0 0.25 0.5 1 Miles

Base Map: ESRI World Street Map

Sabine Pass Liquefaction Project

Figure 1.3-1  
General Location Map

### 1.3.1 Liquefaction Facilities (LNG Train)

The LNG Trains, the major component of the proposed Project, will be located west and northwest of the existing LNG Tanks, in an area impacted previously by placement of dredged material. The LNG Trains will consist of the individual components listed in Section 1.1.3

### 1.3.2 Additional Facilities

All buildings, building modifications, and infrastructure will be constructed within the existing SPLNG Terminal facility boundary.

## 1.4 LAND REQUIREMENTS

Approximately 243.15 acres of the 853-acre of the SPLNG Terminal site will be affected by construction of the Liquefaction Project, of which 203.47 acres will be utilized for operation of the Project. Table 1.4-1 lists the land requirements for the Liquefaction Project.

<b>TABLE 1.4-1 Land Requirements for the Liquefaction Project</b>		
<b>Facility</b>	<b>Land Impacted by Construction<sup>1</sup> (acres)</b>	<b>Land Impacted During Operation<sup>2</sup> (acres)</b>
Liquefaction Project <sup>3</sup>	191.21	191.21
Staging Areas <sup>4</sup>		
Construction dock laydown	8.80	0.00
Craft parking area	8.96	0.00
Laydown area <sup>5</sup>	34.18	12.26 <sup>6</sup>
<b>Total</b>	<b>243.15</b>	<b>203.47</b>
<sup>1</sup> Construction area includes the entire construction footprint, including all temporary and permanent construction areas. <sup>2</sup> Operational area includes only permanent Project facility. <sup>3</sup> Includes all areas of the site which will undergo soil improvement, including 12.84 acres for Tank S-106, approved in Docket CP05-396-000 et al. <sup>4</sup> Existing staging areas that were approved in Docket CP04-47 and CP05-396 and have been converted to industrial land use as part of operation of the SPLNG Terminal. <sup>5</sup> Laydown area was permitted and utilized during construction of Phase II of the SPLNG Terminal. <sup>6</sup> Warehouse and parking will be constructed to accommodate both the SPLNG Terminal and Liquefaction Project.		

## **1.5 CONSTRUCTION SCHEDULE AND PROCEDURES**

### **1.5.1 Project Schedule**

Sabine Pass is seeking FERC authorization to site, construct, and operate the Liquefaction Project no later than December 2011, and anticipates requesting authorization to commence construction in January 2012. Assuming limited delays, the optimum overall Project duration from starting engineering design, permitting, and commercial activities to start up of the Phase 1 LNG Train is approximately 55 months. Construction and start up of the Stage 2 LNG Train will be completed about 6 to 9 months later in order to take advantage of the transition of craft and other resources between the two phases. Sabine Pass expects the Stage 1 LNG Train to be complete and ready for export in January 2015; and the Stage 2 LNG Train in July 2015.

### **1.5.2 Construction Procedures**

All Project components will be sited, constructed, operated, and maintained in accordance with all applicable federal and state regulations. Sabine Pass will implement and adhere to the FERC's *Upland Erosion Control, Revegetation, and Maintenance Plan* (Plan) and the *Wetland and Waterbody Construction and Mitigation Procedures* (Procedures) included in Appendix A.3. Wetland areas that will be temporarily or permanently impacted during construction and operation of the Project will be mitigated as agreed upon with the state and federal resource and regulatory agencies. Most affected wetlands are previously disturbed and within a dredge material placement area. Wetland impacts and mitigation will be addressed in a Project wetland mitigation plan, which will be developed in consultation with appropriate federal and state agencies.

Sabine Pass will employ a tracking system to ensure that relevant clearances and permits are received prior to requesting approval to begin construction from the FERC. For purposes of quality assurance and compliance with mitigation measures, other applicable regulatory requirements, and Project specifications, Sabine Pass will be represented on site by a Chief Inspector (CI). One or more craft inspectors and one or more Environmental Inspectors (EIs) will assist the CI. All Sabine Pass inspectors will have access to the relevant compliance specifications and other documents contained in the construction contracts. The EI's duties will be fully consistent with those contained in paragraph III.B (Responsibilities of the Environmental Inspector) of the Plan to ensure that the environmental conditions associated with other permits or authorizations are satisfied. The EI(s) will have authority to stop work or require other corrective action(s) to achieve environmental compliance. In addition to monitoring compliance, the EI's duties will include training Project personnel about environmental requirements and reporting compliance status to the contractors, Sabine Pass, the FERC, and other agencies, as required.

Sabine Pass will develop an environmental training program tailored to the construction of the Liquefaction Project. The program will be designed to ensure that:



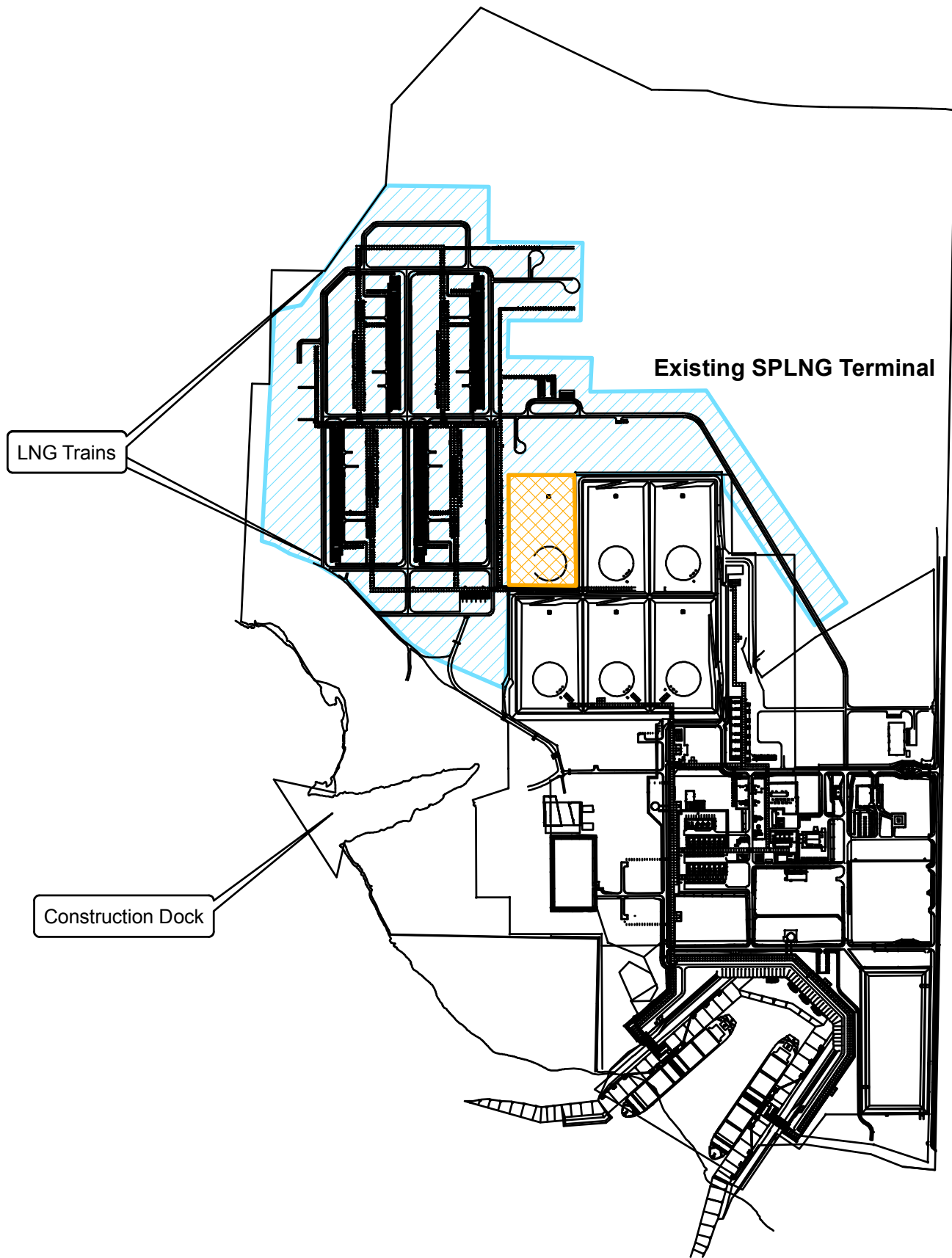
- Qualified environmental training personnel provide thorough and well-focused training sessions regarding the environmental requirements applicable to the trainees' activities;
- All individuals receive environmental training before they begin work;
- Adequate training records are kept; and
- Refresher training is provided as needed to maintain high awareness of environmental requirements.



### **1.5.3 Temporary Construction Facilities**

The Liquefaction Project will involve modifications to the existing SPLNG Terminal facilities, and the construction of new process units. The main construction offices will be located in areas previously improved and utilized during construction of the SPLNG Terminal in order to maximize the use of existing infrastructure and developed access. To maintain control of the site, this area will be used to provide common office areas for all contractors and parking areas outside the boundaries of the process and construction areas. All contractor personnel will be required to access the Project through a turnstile area and swipe an electronic card key. The main construction offices and temporary facilities in this area can be mobilized without significant preparation work. Support / satellite offices, warehousing, lunchrooms, temporary access roads, parking lots, and material laydown storage will be erected as necessary to support craft labor.

Additional temporary facilities, primarily laydown areas and support / satellite areas, will be located around the new process units. The entire area making up the Phase 1 and Phase 2 process units and adjacent laydown areas will require significant site improvements including clearing and grubbing, soil stabilization, backfill and grading activities that must be performed prior to mobilization of permanent plant construction. The permanent site grading for drainage will be directed to an outfall on the western perimeter of the site and will be completed to assure proper drainage during construction and operation. A water run-off plan to control sediment and silt will be implemented during construction. Site preparation will involve an area of approximately 191.21 acres, and will include the installation of required construction power, communications and water. The extent of the site disturbance and the general layout of the proposed facilities are shown on Figure 1.5-1.

Because major equipment will be delivered primarily by barge, improvements to the existing construction dock will be implemented to allow heavy roll-on / roll-off. Upgrading and extending the existing SPLNG Terminal access roads will be performed to support heavy haul to the new construction areas.



-  Previously Authorized LNG Tank Location
-  Areas to be Disturbed by Construction



0 250 500 1,000  
Feet

### Sabine Pass Liquefaction Project

**Figure 1.5-1**  
**Areas to be Disturbed by Construction**

#### **1.5.4 Site Fill Material Requirements**

The process facilities for the Liquefaction Project will be west and northwest of the LNG storage tanks. Part of the Process Area is in relatively good soil which will require clearing, grubbing, and rough grading. The remaining portion of the Process Area will be located in an existing dredged material placement area where soils will require considerable improvement and stabilization to provide a load bearing surface for construction. The techniques to be used to improve the soils will be similar to those used in Phase 1 and Phase 2 of the SPLNG Terminal facilities. Various stabilizers used include Portland cement, fly ash, and other admixtures. Appropriate geogrids, geotextiles, and aggregates, where needed (imported gravel and crushed stone), will be used to level and finish the Liquefaction Project areas. Materials for site improvement, such as gravel and stone surfacing, will be imported via barge or trucks.

The LNG liquefaction area will be filled approximately 3 feet above existing ground surface. It is expected that the total settlement as a result of placing fill of this thickness in the Project area will be approximately 17 inches, with about 25% of the predicted total settlement occurring during fill placement. The balance of the settlement will occur at a decreasing rate over a period of about 30 to 50 years. Numerous settlement observation points will be identified prior to fill placement. The settlement of these points will be monitored at various times during and following fill placement to verify the predicted amount of settlement.

The clay fill and sand are readily available from nearby suppliers in the general area. The gravel and stone surfacing is routinely imported into the Lake Charles and Sabine Pass Channel areas via barge. These existing sources will be used to obtain material for the Project.

#### **1.5.5 Liquefaction Facilities (LNG Trains)**

Prior to commencing construction of the Project components, it will be necessary to construct access roads to the process areas, and complete cut and fill to rough grade in the required areas in order to prepare the site for construction. Additional activities during the site-works phase of construction will include: (1) cutting necessary drainage ditches to allow proper surface water run off, (2) cutting and backfilling for placement of any temporary construction facilities such as parking lots, office areas, and lay-down areas, (3) installation of perimeter fencing and temporary construction fencing, and (4) cut and fill for any roads within the Project site boundaries.

The site-works portion of the Project, as discussed above, need not be completed prior to commencement of subsequent activities. The primary critical path activity is the erection of the Phillips Optimized Cascade<sup>SM</sup> LNG Trains. Therefore, the execution strategy will be structured to prevent slowing construction in this area.

The foundations for equipment, buildings, and pipe racks will be installed on precast piles that will be delivered to the site by barge to the construction dock. Piles will be installed in a manner to efficiently complete piling operations on a schedule that will best support the subsequent construction operations.

After pile driving is complete, pile caps will be installed at the top of each pile. These will consist of formwork, rebar installation, and pouring of concrete. Horizontal pipe support racks will be installed after the pile caps. Pipe installation on the pipe racks will be implemented from multiple directions after installation of the pipe racks. Pipe spool fabrication will be done in a covered area on or off-site. Structural steel membranes will be prefabricated off-site and erected upon arrival.

The majority of the straight run pipe will be field fabricated prior to placement on the pipe racks. Pipe expansion loops will be pre-fabricated in a shop, transported to position, and then erected with the straight run piping. Pipe will also be painted to the maximum extent at the shops, after shop welds have been tested in accordance with the applicable codes. Pipe spool size will be as large as can be practically trucked to site to minimize site work and the number of deliveries.

Wherever practical, large equipment will arrive at site in preassembled packages that will facilitate final hook-up and testing. All equipment will be designed, fabricated, and tested by highly qualified specialist suppliers at their respective facilities, and shipped to site only after the necessary inspections have taken place and the equipment is released. The larger equipment, such as the cold boxes, acid gas absorber and stripper columns, and the refrigerant compressors, will be offloaded at the construction dock on multi-wheel transport crawlers, and transported to their foundations. Other material and equipment will be shipped to site by truck.

Installation of the equipment will proceed at the same time as the installation of the pipe on the pipe rack. The target is to have all equipment installed prior to the erection progress of the pipe rack arriving at the main process areas. This will allow a seamless tie in at this location. The shop, warehouse, and control building erection will progress as the pipe-rack installation is occurring.

When construction is approximately 70% complete, the focus will shift from construction by area to completion by systems. The civil and structural work will be substantially complete, the equipment set, and most of the large bore piping installed. The Project schedule will be driven by the mechanical completion and pre-commissioning requirements. The system completion and turnover packages will be defined and scoped by engineering, and assembled by the construction team. A turnover coordinator will prepare the systems completion and turnover packages which will include the following documentation:

- Marked-up drawings to show the limit of the system and the location of blinds;
- Line list by system with pressure testing documentation;
- List of equipment including motors with data sheets and inspection reports;
- Marked-up Single Line Diagrams with inspection/test reports for electrical equipment;
- Cable reports;
- Instrument Index with data sheets and calibration sheets;

- Loop Diagrams;
- Any applicable vendor documentation/drawings;
- Turnover Exception Lists; and
- Detailed Punchlist.

As the piping installation, hydrotesting, pneumatic testing, and equipment erection work is completed and the density of craft personnel and construction equipment is reduced within each of the areas, the balance of the painting and insulation work will be completed. The pipe racks will be completed first followed by the process and utility areas. After the installation of the equipment and piping has been completed, the final road paving, site grading, landscaping and cleanup will be done. The temporary construction facilities will be demobilized on a progressive basis when they are no longer needed.

Construction of other necessary facilities and other buildings, as well as foundations and major utility equipment will commence once construction of the LNG Trains has begun. Emphasis will be placed on coordinating the arrival of the major equipment with the completion and curing of the respective foundation so that the equipment can be placed on its foundation when it arrives. This will avoid double handling and intermediate storage on site.

The buildings are independent sites and will be constructed simultaneously with the liquefaction facilities, so that electrical and instrument contractors can install their equipment according to their respective schedules.

#### **1.5.6 Site Access and Traffic**

Construction traffic will access the site via Louisiana State Highway (“SH”) 82. Once at the site, construction traffic will utilize Duck Blind Road, which parallels the western boundary of the SPLNG Terminal property, or Lighthouse Road, the SPLNG Terminal main entrance road, which parallels the eastern boundary of the property.

Material deliveries to the site will generate, on average, 10 to 12 deliveries via truck per day during construction, with a peak of 15 to 20 trips per day during the peak construction. A similar number of small, two-axle truck trips will also be expected. Material delivery vehicles will not exceed the load capacity of either the public roads or the SH 82 bridge. Heavy material delivery will occur via barge to the on-site construction dock, or alternately via SH 27 to SH 82 from Holly Beach, Louisiana. Peak construction traffic will generate more than 1,750 trips during the morning as well as the evening commuting hours.

#### **1.5.7 Dredging Requirements**

Maintenance dredging of the construction dock, if required, will be performed to provide the necessary 17 feet of draft for the barges delivering heavy equipment, piles, and other materials.

### **1.5.8 Drainage of the Finished Site**

Stormwater runoff will be directed north to three 30-inch drain pipes to be installed at the northwestern edge of the LNG Train construction area. These drain pipes will be buried and run westerly under Duck Blind Road and over the existing pipelines into the Sabine Pass Channel. Other areas will be graded to divert stormwater into existing drainages that also discharge to the Sabine Pass Channel. Undisturbed areas of the site will retain their natural drainage.

### **1.5.9 Sewer Collection and Disposal**

Sanitary sewage from each building containing toilets will be collected and treated in a central sanitary treatment unit which will need to be expanded to accommodate the additional personnel. Lift stations will be installed to carry the waste to the central treatment unit. The treated sewage will be discharged with the facility stormwater. The existing Louisiana Pollution Discharge Elimination System (LPDES) Permit to Discharge Water from Natural Gas Facilities (NGF-3) issued by the Louisiana Department of Environmental Quality will be updated to reflect the new facilities. The permit application will state the volume of the discharge, identify the receiving body of water (Sabine Pass Channel) and provide for analytical results as required by state law.

## **1.6 OPERATIONS AND MAINTENANCE**

All personnel at the SPLNG Terminal have been trained as part of the operations of the existing LNG terminal. It is anticipated that from 150 to 250 additional permanent personnel will be required for the Liquefaction Project. Personnel will be trained in LNG safety, cryogenic operations, and the proper operation of all equipment. Operators will meet all the training requirements of the U.S. Department of Transportation minimum federal safety standards specified in Title 49 of the Code of Federal Regulations (CFR), Parts 192 and 193. Safety procedures will be discussed further in Resource Report 11.

### **1.6.1 Operations**

Operating procedures will be developed for the new liquefaction facilities, and extensive training will be provided for operational personnel to ensure that they are familiar with and understand the importance of adherence to safe procedures. These procedures will provide functional requirement of the control and safeguarding systems, to include addressing safe start-up, normal shutdowns, emergency shutdowns, fire, gas and spills, etc., as well as routine operation and monitoring. Particular attention will be given to coordination with and involvement of appropriate local officials and other plant operators in the vicinity of the SPLNG Terminal.

### **1.6.2 Maintenance**

Facility maintenance will be conducted in accordance with 49 CFR 193, Subpart G. Full-time terminal maintenance staff will conduct routine maintenance and minor overhauls. Major overhauls and other major maintenance will be handled by soliciting the services of trained contract personnel to perform the maintenance. All scheduled and unscheduled maintenance will be entered into a computerized

maintenance management system (“CMMS”). All personnel, operations, maintenance, and others, will be trained on the use of CMMS. The CMMS will print out work orders every morning. These work orders will be distributed to the maintenance personnel during the morning meetings.

Scheduled maintenance, such as preventive and predictive maintenance of equipment, will be input into the system to automatically print out work orders either on a time basis or on hours of operation, depending on the requirement. Scheduled maintenance will be performed on safety and environmental equipment, instrumentation, and any other equipment that will require maintenance on a routine basis. When a problem is detected that requires unscheduled maintenance attention, the person that detects the problem will enter it into the CMMS. If a problem requires immediate attention, the appropriate person will be notified.

## **1.7 FUTURE PLANS AND ABANDONMENT**

### **1.7.1 Future Plans**

Sabine Pass has no plans for further expansion. To the extent that expansion of the facilities is warranted in response to additional demand for liquefaction services, any new facilities would be designed to be compatible with the proposed facilities and Sabine Pass will obtain all necessary permits and approvals for those facilities.

### **1.7.2 Abandonment of Facilities**

No facilities are proposed for abandonment or removal at this time.

## **1.8 PERMITS AND APPROVALS**

Sabine Pass will obtain all necessary permits, clearances, and licenses relating to the construction and operation of the Liquefaction Project. Table 1.8-1 provides a list of permits that Sabine Pass will obtain or amend for the Liquefaction Project. Copies of approvals and correspondence with regulatory agencies and others are included in Appendix A.4. Sabine Pass will file any additional correspondence and approvals with the FERC upon receipt.

Sabine Pass will include copies of all relevant environmental permits and approvals in the construction bid packages and contracts. Construction contractor(s) employed by Sabine Pass will be required to be familiar with all permits and licenses obtained by Sabine Pass and comply with all federal, state, and local laws, ordinances, and regulations that apply to construction of the facility and to restoration of any areas temporarily disturbed during construction. Should other safety, design, and construction codes and regulations be enacted or adopted by governmental agencies having jurisdiction over the locations where the work is to be performed, the contractor(s) will be required to observe and abide by all provisions that are applicable.

<b>TABLE 1.8-1</b> <b>Permits and Consultations for the Liquefaction Project</b>			
<b>Agency</b>	<b>Permit/Consultation</b>	<b>Date Submitted/ Anticipated Submittal</b>	<b>Date Received/ Anticipated Receipt</b>
<b><u>FEDERAL</u></b>			
Federal Energy Regulatory Commission	Section 3 Application - Natural Gas Act	<i>February 2011</i>	<i>December 2011</i>
U.S. Army Corps of Engineers	Section 404 - Clean Water Act Permit	<i>February 2011</i>	<i>December 2011</i>
U.S. Fish and Wildlife Service (USFWS)	Section 7 Consultation - Endangered Species Act	<i>February 2011</i>	<i>December 2011</i>
U.S. Coast Guard	Letter of Intent and Waterway Suitability Assessment	June 17, 2010	June 24, 2010
EPA Region VI	Clean Water Act Consultation	<i>February 2011</i>	<i>December 2011</i>
	Clean Air Act Consultation	<i>February 2011</i>	<i>December 2011</i>
Federal Emergency Management, Region VI (FEMA)	Construction within a floodplain	<i>February 2011</i>	<i>December 2011</i>
<b><u>STATE</u></b>			
Louisiana Department of Environmental Quality (LDEQ)	Section 401 - Clean Water Act, Water Quality Certification	<i>February 2011</i>	<i>December 2011</i>
	Louisiana Pollutant Discharge Elimination System (LPDES) Construction Stormwater Permit	<i>December 2011</i>	<i>January 2012</i>
	Air Permit	<i>February 2011</i>	<i>December 2011</i>
Louisiana Department of Natural Resources, Coastal Management Division (LDNR)	Coastal Management Plan Consistency Determination	<i>February 2011</i>	<i>December 2011</i>
Louisiana Department of Wildlife and Fisheries (LDWF)	Sensitive Species/Habitats Consultation	June 17, 2010	July 15, 2010
Louisiana State Historic Preservation Office (SHPO)	Section 106 - National Historic Preservation Act	June 17, 2010	July 2, 2010
<b><u>LOCAL</u></b>			
Cameron Parish	Building Permits	<i>February 2011</i>	<i>December 2011</i>
Cameron Parish Floodplain Administrator	Permit for Construction in a Zone "VE" or Variance as: functionally dependent use"	<i>February 2011</i>	<i>December 2011</i>
<b><u>NATIVE AMERICAN GROUPS</u></b>			
Caddo Indian Nation of Oklahoma	Consultation	<i>February 2011</i>	<i>December 2011</i>



<b>TABLE 1.8-1 Permits and Consultations for the Liquefaction Project</b>			
<b>Agency</b>	<b>Permit/Consultation</b>	<b>Date Submitted/ <i>Anticipated Submittal</i></b>	<b>Date Received/ <i>Anticipated Receipt</i></b>
Alabama-Coushatta Nation of Texas	Consultation	<i>February 2011</i>	<i>December 2011</i>
Coushatta Tribe of Louisiana	Consultation	<i>February 2011</i>	<i>December 2011</i>
Chitimacha Tribe	Consultation	<i>February 2011</i>	<i>December 2011</i>
Jena Band of Choctaw	Consultation	<i>February 2011</i>	<i>December 2011</i>
Tunica-Biloxi Tribe	Consultation	<i>February 2011</i>	<i>December 2011</i>

## **1.9 AFFECTED LANDOWNERS**

The names and addresses of all landowners whose land is adjacent to the Liquefaction Project facilities are provided in Appendix A.5, as required in 18 CFR. §157.6(d) of the FERC's regulations. Further, in accordance with 18 CFR 157.21(f)(3) and 18 CFR §157.6(d)(2), Sabine Pass has sent letters to each of these entities and individuals regarding the Project. There are no landowners with residences within a 0.5 mile of the SPLNG Terminal site.

## **1.10 NON-JURISDICTIONAL FACILITIES**

The liquefaction facilities will require an additional source of fresh water. This water will be utilized in the following processes:

- Feed source to the demineralized water system for injection into the gas turbines for NO<sub>x</sub> control, and for make up of the amine unit;
- Humidification equipment at the inlet to the gas turbine drivers;
- Potable water for the additional operation and maintenance personnel.

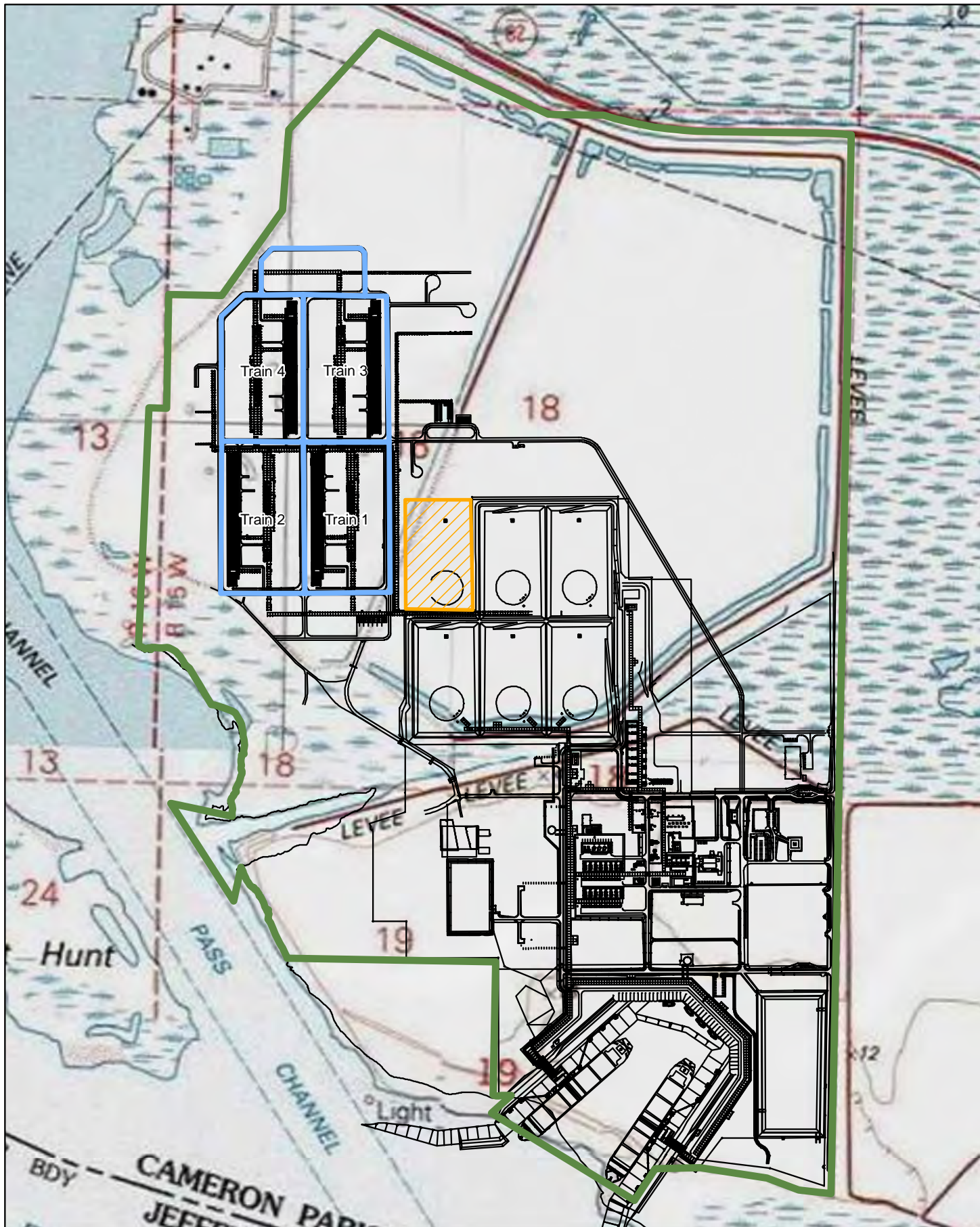
A new water line will be run from an existing supply on the Texas side of the new Causeway Bridge. Appendix A.6 will provide details of the non-jurisdictional water line at a later date.

## Appendix A.1

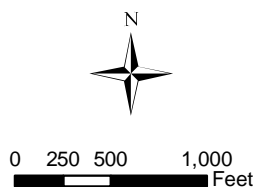
### Market Analysis Reports – Pending

## Appendix A.2

### Topographic and Aerial Maps



- Property Boundary
- LNG Trains
- Previously Authorized LNG Tank Location






Sabine Pass Liquefaction Project

Figure A.2-1  
Location of Liquefaction Facilities





Base Map: ESRI World Street Map

-  Property Boundary
-  LNG Trains
-  Previously Authorized LNG Tank Location



0 250 500 1,000  
Feet

Sabine Pass Liquefaction Project

Figure A.2-2  
Location of Liquefaction Facilities

Appendix A.3  
FERC's Plan and Procedures

Available on FERC's website at:

<http://www.ferc.gov/industries/gas/enviro/guidelines.asp>

Appendix A.4  
Agency Correspondence

Available on FERC's website at:

[http://elibrary.FERC.gov/idmws/file\\_list.asp?accession\\_num=20100903-5093](http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20100903-5093)

Appendix A.5  
Affected Landowners

Submitted to FERC on August 17, 2010  
(Privileged and Confidential)



Appendix A.6  
Non-Jurisdictional Facilities – Pending



*Sabine Pass Liquefaction, LLC*

*Initial Draft Resource Report 10 – Alternatives*

*Docket No. PF10-24-000*

*September 3, 2010*

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## ACRONYMS AND ABBREVIATIONS

Btu	British thermal unit
Bcf	billion cubic feet per day
CNG	compressed natural gas
F	Fahrenheit
GTL	gas to liquids
Iroquois	Iroquois Gas Transmission System L.P.
LNG	liquefied natural gas
mtpa	million metric tonnes of LNG per annum
NGH	natural gas hydrates
NO <sub>x</sub>	nitrogen oxides
Project	Liquefaction Project
Sabine Pass	Sabine Pass Liquefaction, LLC and Sabine Pass LNG, L.P.
SPLNG Terminal	Sabine Pass LNG Import Terminal
U.S.	United States

## **10.0 ALTERNATIVES**

### **10.1 INTRODUCTION**

This draft resource report describes the alternatives considered by Sabine Pass Liquefaction, LLC and Sabine Pass LNG, L.P. (collectively referred to as “Sabine Pass”) for the proposed liquefaction and export plant (“Liquefaction Project” or “Project”) in identifying the best method of accomplishing the Project objective, starting with examination of the broadest feasible range of alternatives and narrowing those alternatives to the Project as currently proposed. Selection of the preferred Project site and overall design was the result of a comprehensive evaluation process that involved weighing the potential environmental, logistical, economic, safety, and engineering costs and benefits of each aspect of the Project. As a result, the preferred terminal site is considered the most environmentally acceptable, technologically feasible, and economically viable option for meeting the stated Project objective.

This resource report is organized into four major sections: Section 10.1 discusses the “no action” alternative; Section 10.2 discusses alternative energy sources; Section 10.3 provides a description of other potential system alternatives that could be implemented to meet the Project objectives; and Section 10.4 discusses alternative configurations for the Project facilities, including other layouts and liquefaction processes.

### **10.2 NO-ACTION ALTERNATIVE**

This section addresses the consequences of not constructing the proposed Project. Potential adverse impacts associated with the Project (i.e., impacts to surface and groundwater quality, fisheries, wildlife, vegetation, geologic resources, soils, air and noise quality, etc.) would be avoided under the no-action alternative. However, selection of the no-action alternative also would mean that the objectives of the Project would not be accomplished.

Sabine Pass LNG, L.P. currently operates the largest liquefied natural gas (“LNG”) import terminal (“SPLNG Terminal”) in the United States (“U.S.”). Sabine Pass proposes to add liquefaction services to the SPLNG Terminal, transforming it into a bi-directional facility capable of liquefying domestic natural gas for export, in addition to regasifying imported foreign-sourced LNG. Sabine Pass expects to take advantage of the existing infrastructure at the SPLNG Terminal to offer customers bi-directional services at attractive pricing. This added service would provide customers with an attractive option to source natural gas supply from the U.S. pipeline grid at prices indexed to Henry Hub.

The addition of liquefaction capability at the SPLNG Terminal will facilitate the development of unconventional, and particularly shale, gas-bearing formations in the U.S. Exporting natural gas as LNG will provide the U.S. with significant benefits, including:

- Stimulate the Louisiana state, regional and national economies through job creation, increased economic activity and tax revenues, including the direct creation of approximately 3,000 engineering and construction jobs during the course of the project and, indirectly, 30,000-50,000 permanent jobs in the exploration and production sector;
- Promote domestic production of petroleum and reduced reliance on foreign sources of oil;
- Further the President's National Export Initiative, by improving U.S. balance of payments through the exportation of approximately 2 Bcf/d of natural gas valued at today's prices of approximately \$5 billion and the displacement of \$1.7 billion in NGL imports;
- Raise domestic natural gas productive capacity and promote stability in domestic natural gas pricing;
- Promote liberalization of global natural gas trade through fostering of a global, liquid, natural gas market;
- Advance national security and the security of U.S. allies through diversification of global natural gas supplies; and
- Increase economic trade and ties with foreign nations including neighboring countries in the Americas and displacing environmentally damaging fuels in those countries.

### **10.3 ALTERNATE ENERGY SOURCES**

The purpose of the Liquefaction Project is to export clean-burning natural gas to other countries to meet growing market demands because of the lower cost of Henry Hub priced natural gas. In addition, the ability to export domestic gas as LNG will serve the purpose of greatly expanding the market scope and access for domestic natural gas producers and, thus, serve to encourage domestic production at times when U.S. market prices might not otherwise do so. Continued production, along with the added flexibility provided by the import capabilities of the SPLNG Terminal, will improve the availability of natural gas to supply domestic markets when conditions support it. Natural gas has been termed a bridge fuel between the dominant fossil fuels used today and renewable fuels because it is clean burning and can reliably serve as a backup fuel to intermittent renewable energy sources. In this regard, natural gas has become a major international commodity.

A two-year study by the Massachusetts Institute of Technology ("MIT") encourages U.S. policymakers to consider the nation's growing supply of natural gas as a substitute for aging power plants utilizing other fossil fuels. Under a scenario that envisions a federal policy aimed at cutting greenhouse gas emissions to 50 percent below 2005 levels by 2050, the MIT study found a substantial role for natural gas because when used to fire a power plant, gas emits about half of the carbon dioxide emissions as conventional plants utilizing other fossil fuels.

Similarly, there is a current growing demand in many developing countries for low-cost, environmentally friendly fuels. The standard of living for the general population and the advancement of commercial development in these developing countries is being significantly impacted due to their reliance on expensive and “dirty” foreign-sourced fuels.

Like the U.S., many countries are emphasizing renewable energy resources such as wind or solar power as a means to reduce greenhouse gas emissions and other pollutants. Although this is an effective solution, most renewable sources are intermittent and not sufficiently reliable. Also, many locations simply do not have sufficient real estate, sunlight, wind, or water to adequately serve the population’s needs, even if the necessary infrastructure were built. As a result, these countries must have an alternate energy source to supplement or back up the renewable energy. Natural gas is the most readily available, dependable, economically attractive, and environmentally acceptable fuel source for use in residential, commercial, and industrial markets.

### **10.3.1 Natural Gas**

Overall, natural gas provides the most readily available, dependable, economically attractive, and environmentally acceptable fuel for use in residential, commercial, and industrial markets. Compared to using other fuels, the use of natural gas clearly benefits the environment, complements the use of renewables and provides a cost-effective solution to energy demands. Specifically, compared to other fossil fuels, the use of natural gas:

- Results in significantly lower emissions of sulfur oxides (which are a primary cause of acid deposition);
- Generates lower emissions of total suspended particulates, hydrocarbons, carbon monoxide, and NO<sub>x</sub>;
- Eliminates residual wastes and the subsequent land requirements for the disposal of such wastes; and
- Provides a lower cost, reliable energy source which in turn contributes to social and commercial development.

In summary, natural gas was determined to be the most environmentally sound and cost-effective solution of the practical and available supplemental energy options. As a clean burning fuel, natural gas minimizes the emission of air pollutants that contribute to acid rain and cause concern over the greenhouse effect. Of the fossil fuels, natural gas combustion results in the lowest levels of carbon dioxide and sulfur dioxide emissions.

## **10.4 SYSTEM ALTERNATIVES**

System alternatives are those alternatives that could replace all or part of the Project by making use of other existing natural gas export facilities, or by reconfiguring the basic configuration of the Project.

### **10.4.1 Existing or Planned LNG Export Facilities**

The only LNG export facility currently operating in the U.S. is the Kenai LNG Plant, located in the Cook Inlet Basin area, Alaska, which began operation in 1967. The original export authorization has been amended and extended numerous times by the Department of Energy. The current amendment authorizes the export of approximately 98.1 Bcf of natural gas over two years<sup>1</sup>. The Kenai LNG Plant sends all available LNG to Pacific Rim countries (mostly, Japan), and cannot be economically or practically expanded to service other markets because of its remote location. Therefore, the objective of the Sabine Pass Liquefaction Project, to provide an outlet for domestically produced natural gas from the Marcellus and Haynesville shales in Texas and Louisiana, could not be accomplished by securing export capacity at the Kenai LNG Plant.

Kitimat LNG, Inc. is proposing to construct and operate an LNG export, liquefaction and LNG send-out terminal at Bish Cove near the Port of Kitimat, British Columbia, Canada. The Kitimat LNG Project, if constructed, would include new gas pipelines, marine berths, LNG storage, liquefaction, and LNG loading facilities. The terminal would take delivery of gas from the Western Canadian Sedimentary basin via the nearby Pacific Trail pipelines, which will be connected to Spectra Energy's existing Westcoast Pipeline system. The main market for the Kitimat LNG Project would be Japan and other countries in the Pacific Rim. The sendout capacity would be 3.5 to 5 million metric tones of LNG per annum ("mmtpa"). It would not be economically feasible to transport natural gas sourced from the Mid-Continent/Gulf Coast Corridor supply basins, which account for approximately half of the increase in unconventional gas productive capacity in the U.S., to the proposed Kitimat LNG facility. Furthermore, regular deliveries of LNG from Kitimat LNG to markets in Europe and other locations in the Atlantic basin would not be feasible due to the shipping distances involved. Therefore, the Kitimat LNG Project is not a reasonable alternative for the Sabine Pass Liquefaction Project.

### **10.4.2 Export via Pipeline**

Iroquois Gas Transmission System L.P. ("Iroquois") recently held a non-binding open season for its NYMarc Project that is being proposed to connect the rapidly expanding Marcellus shale gas supplies to New York, New England, and eastern Canadian gas markets. The project would provide producers in the Marcellus Shale access to Iroquois' existing marketplace and the opportunity to supply more than 1 Bcf per day of Northeast market demand. Several other pipelines already export natural gas from the U.S. to

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<sup>1</sup> ConocoPhillips Alaska Natural Gas Corporation and Marathon Oil Company, FE Docket No.: 07-02-LNG, DOE Opinion and Order No. 2500 (June 3, 2008).



Canada or Mexico. However, export to other countries in Europe, Central America, the Caribbean, or South America via pipeline would involve very long distances on land or across oceans. The technology for installing pipelines across oceans does not currently exist, and land routes, where feasible, would be prohibitively expensive. Therefore, export of natural gas via pipeline to countries other than Canada and Mexico cannot be considered an alternative to the Liquefaction Project.

#### **10.4.3 Other Methods of Transporting Natural Gas**

There are three technologies and processes that can convert natural gas into other products that, like LNG, can be sent overseas to be used as fuel. Sabine Pass reviewed these alternate technologies and determined they did not fully fit the purpose and need of the Project.

Gas to Liquids (GTL) is a process that converts natural gas into heavier liquid hydrocarbons such as naphtha or diesel. The process has been applied on a large scale where large stranded gas reserves exist, such as those in Qatar, Nigeria, and Malaysia. After evaluation, Sabine Pass does not consider a GTL facility to be a viable option for the following reasons:

- These facilities have high capital costs, high operation and maintenance costs, and are energy intensive;
- The low sulfur diesel created carries a premium price, and does not have the same environmental benefits of natural gas; and
- A very large amount of new infrastructure would need to be added at the SPLNG Terminal site for GTL storage and loading that is not needed for LNG.

Compressed Natural Gas (CNG) is made by compressing natural gas to high pressures (2,900 to 3,600 pounds per square inch) so that it occupies less than 1% of the volume it occupies at atmospheric pressure. The CNG can then be stored and transported in spheres or bullets. CNG is used mostly as a substitute for gasoline in buses, taxis, and other vehicles. Sabine Pass concluded that CNG is not a suitable option to meet the purpose of the Liquefaction Project for the following reasons:

- Because of the high pressures involved and the fact that the same amount of energy requires over 6 times the volume as LNG, larger scale transportation becomes very expensive. Therefore CNG would not be suitable for transportation to markets in Europe, South America, or many locations in the Caribbean.
- There are very few ships, if any, capable of transporting CNG; whereas a large fleet is available for LNG. Custom ships would probably need to be designed and built for exporting large quantities of CNG, and the marine facilities at the SPLNG Terminal may also need significant modification.

- The receiving facilities at the destination ports would also need to be designed and built since very few (if any) currently exist. LNG receiving terminals already exist or are planned in most of the markets Sabine Pass intends to target.

Natural Gas Hydrates (NGH) are formed under certain conditions when methane is trapped within a crystal structure of water, forming a solid similar to ice. Large deposits of NGH are located in deep ocean deposits around the world, but an economical method for mining this resource has not yet been developed. NGHs are chemically stable at about -4°Fahrenheit (“F”) compared with -260°F for LNG. Sabine Pass concluded the production and export of NGH is not a suitable option to meet the purpose of the Liquefaction Project for the following reasons:

- Generally, one cubic meter of NGH contains approximately 160 cubic meters of natural gas, while one cubic meter of LNG contains 600 cubic meters of natural gas, thus limiting the quantity of gas that can be transported with NGH technology;
- At this time no commercial facilities have been built to convert natural gas into NGH;
- Technology has not been developed to store, load, transport, unload, and process large amounts of NGH;
- Conversion of power plants to be fueled by NGHs has not yet been attempted; and
- A very large amount of new infrastructure would need to be added at the SPLNG Terminal for NGH storage and loading that is not needed for LNG.

## **10.5 OTHER CONFIGURATIONS**

Sabine Pass evaluated configuration alternatives for the Liquefaction Project layout to assess the potential for minimizing environmental impact and maximizing utilization. Several alternate configurations were compared and evaluated as summarized below:

### **10.5.1 Alternate Layouts for the Liquefaction Facilities**

The criteria for developing the plant layout of the Project (i.e., the location and configuration of the major project components), is governed by those considerations prescribed in Code of Federal Regulations 49 Part 193 Subpart B and National Fire Protection Association 59A. Compliance with these Rules and Codes reasonably assures the public safety in the vicinity of Project, provides design contingency, and provides adequate ingress and egress in case of a potential emergency situation. The biggest criteria are the position of the LNG tank impoundments and the other LNG impoundments which are designed to contain possible LNG spills. These impoundments were sized and located during construction of the SPLNG Terminal so that neither harmful fire radiation nor flammable vapor clouds go off the site limits during defined failure scenarios. As part of the Liquefaction Project, the LNG loading rate to the LNG carriers was increased, and some small modifications to impoundment size will be made if necessary.

Additional impoundments located near the LNG liquefaction trains will be sized and located appropriately.

Although other layouts were considered, the proposed layout minimized environmental impacts and ensured the code requirements for siting were met. The final layouts and the evaluation of the failure scenarios will be described in detail in Resource Report 13.

#### **10.5.2 Alternate Liquefaction Methods**

The selected liquefaction method is the ConocoPhillips Optimized Cascade<sup>SM</sup> process. Although several processes exist to liquefy natural gas, this process was chosen for the following reasons:

- The Optimized Cascade<sup>SM</sup> process uses a Template Design adaptable to a variety of conditions and compressor configurations. This simplifies the design process and reduces risk of systems underperforming.
- The process has been successfully used for over 40 years at the Kenai Alaska LNG facility.
- The process has also been used successfully at the following overseas facilities:
  - Atlantic LNG Trains 1, 2, 3 and 4, 2005
  - Egyptian LNG Trains 1 & 2, 2005
  - Darwin LNG, 2006
  - Equatorial Guinea LNG, 2007
  - Angola LNG, under construction

Once the liquefaction facilities are constructed, the SPLNG Terminal will be capable of both importing and vaporizing LNG and liquefying natural gas to produce LNG for export. This bi-directional capability requires a liquefaction process that is very flexible and reliable. The ConocoPhillips Optimized Cascade<sup>SM</sup> process meets these requirements for the following reasons:

- Reliability is high since the design is based on two 50% capacity compressors for each refrigeration cycle. If one compressor fails, LNG production can be maintained at 60% to 80% of nameplate production.
- Turndown capabilities are good since the two-in-one concept provides for maximum fuel efficiency even at 60-80% utilization.
- Start up is quick and operation is easy since the process uses pure refrigerants rather than mixed refrigerants whose composition must be carefully balanced.

- Cool down is quick since the equipment used in the cryogenic exchangers are simple, well proven brazed aluminum exchangers.
- Fuel efficiency is excellent since the compressor drivers chosen are aero derivative type gas turbines.

ConocoPhillips has had a collaboration agreement for over 40 years with Bechtel to design and build LNG facilities using the ConocoPhillips Optimized Cascade Process<sup>SM</sup>. Bechtel was the main contractor for construction of both phases of the SPLNG Terminal and is thus well qualified to incorporate the ConocoPhillips liquefaction process facilities into the existing SPLNG Terminal.

## **10.6 CONCLUSIONS**

For the above identified reasons, the proposed site is the most appropriate location for the Liquefaction Project. Further, because the proposed site was a previously disturbed site and the area has been previously reviewed for environmental impacts, the location of the liquefaction facility results in minimal new environmental impacts. Due to its proximity to the productive shale plays and existing interconnecting pipeline infrastructure, no new pipeline capacity is required and therefore, there would be no new environmental impacts from pipeline construction. The proposed location is the best site for a proposed liquefaction facility.