Galway Energy Advisors LLC

Delivering Global Energy Transactions

LNG and Natural Gas Import and Delivery Options Evaluation for PREPA's Northern Power Plants – Feasibility Study & Fatal Flaw Evaluation

Submitted

to

Puerto Rico Public-Private Partnership Authority

And

Puerto Rico Electric Power Authority

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1 – STUDY BACKGROUND, REQUIREMENTS, AND METHODOLOGY

STUDY BACKGROUND

The Puerto Rico Electric Power Authority ("PREPA") owns and operates two power plants in the vicinity of San Juan – the San Juan Power Plant and the Palo Seco Power Plant.

Map 1 – San Juan Area with San Juan and Palo Seco Power Plants

In order to i) comply with upcoming Mercury and Air Toxics Standards ("MATS") administered by the US Environmental Protection Agency ("EPA") and ii) to reduce the cost of fuel for the production of electricity and the overcall cost of electricity in Puerto Rico, PREPA has elected to convert a number of the power generation units at its San Juan and Palo Seco Power Plants to burn natural gas as the primary fuel instead of No. 6 and No. 2 fuel oil. PREPA has partnered with the Puerto Rico Public-Private Authority ("P3A") to identify and assess the feasibility of various options to deliver natural gas to its two power plants in the San Juan metropolitan area without relying on a cross-island natural gas transmission pipeline. The consequence of this requirement is that PREPA and the P3A have elected to focus on options to deliver natural gas into the San Juan area in the form of Liquefied Natural Gas ("LNG") or Compressed Natural Gas ("CNG) using specialized ships.

Galway Energy Advisors LLC ("Galway") has been retained by the P3A to identify and evaluate

such potential options. Galway is a commercial advisory firm that provides clients in the energy industry services that include commercial structuring and negotiation, strategy development, project development advice and support, economic analysis, risk management, market analysis, and high level technical and operational evaluation and due diligence. Galway has been advising and supporting PREPA since late 2007 on defining and implementing its LNG initiatives. At PREPA's request, Galway started to interface with the Government Development Bank of Puerto Rico ("GDB") in mid-2010 regarding PREPA's LNG initiatives and since June 2011 has been advising both PREPA and the GDB on PREPA's LNG plans, negotiations for LNG and natural gas supplies, the development of the floating LNG terminal offshore the Aguirre Complex, and miscellaneous issues related to the importation and distribution of LNG and natural gas in Puerto Rico.

In order to properly identify and assess options to deliver natural gas to PREPA's power plants, Galway complimented its LNG techno-commercial capabilities by retaining the services of an engineering firm (CH-IV International – "CH-IV"), an environmental firm (TRC Environmental Corporation – "TRC"), and a regulatory law firm (WilmerHale – "WH"). CH-IV is a well-known engineering firm with significant LNG specific experience such as feasibility studies, FEED studies, technical studies and filings to support permitting applications with the Federal Energy Regulatory Commission ("FERC") and project management. The scope of their experience includes LNG import terminals (both onshore and floating), LNG peak shaving plants, and LNG liquefaction and export plants. As the owner's engineer for the EcoElectrica facility in Peñuelas, CH-IV offers a unique set of experience related to LNG projects in Puerto Rico. TRC is a nationally recognized leader in facility siting; environmental impact assessment; permitting; and licensing of natural gas pipelines, storage facilities, and LNG terminals. TRC has significant experience with LNG import and export projects in North America and has supported FERC filings for LNG projects as environmental consultant to both applicants and the FERC. WH is a well-known law firm with significant experience in natural gas and LNG regulatory matters. WH is currently advising the GDB on LNG, natural gas and EPA matters related to PREPA's initiatives. This multi-disciplinary team ("Team") collaborated closely to identify and assess potential options to deliver LNG or CNG and prepare this draft report that documents the Team's findings and recommendations. TRC and CH-IV prepared detailed environmental and technical reports that are included in this draft report as Appendices I and II respectively.

PREPA'S NATURAL GAS REQUIREMENTS

During a kick-off meeting held at PREPA's main offices in San Juan on August 12, 2014 with the Galway multi-disciplinary team, representatives from the P3A and representatives from PREPA, PREPA's natural requirements were discussed in detail.

NATURAL GAS VOLUMES REQUIREMENTS

PREPA informed the Team about both its average and peak volumetric natural requirements for both the Palo Seco and San Juan Power Plants as follows:

- Average Daily Requirement is equivalent to 115,000 million british thermal units ("MMBtu) per day
- Peak Daily Requirement is equivalent to 125,000 MMBtu per day

Consequently, for the purpose of this study, the Team focused on a facility that would be sized to handle approximately 125,000 MMBtu per day which is equivalent to approximately 1 million tons per annum ("MTPA") of LNG.

INFRASTRUCTURE SCOPE

The scope of the infrastructure options to be identified and evaluated was also discussed during the kick-off meeting:

1) Infrastructure must allow and support the safe and reliable berthing and unloading of specialized ships carrying and delivering either LNG or CNG.

2) Infrastructure must allow the storage of sufficient volumes of LNG or CNG to efficiently and rapidly unload the product from the specialized ships. LNG tanks can be located on land or in floating configuration such as a Floating Storage Unit ("FSU") or Floating Storage and Regasification Unit ("FSRU"). Any CNG storage system would likely consist of a floating solution.

   LNG or CNG storage capacity must be sufficient to provide a reliable supply of natural gas to PREPA's power plants with sufficient volumes of "buffer" inventory to address potential shipping schedule deviations due to inclement weather, loading port conditions, unloading port conditions, etc.

   The US Coast Guard ("USGC") imposes safety zones around LNG ships transiting through US ports and navigable waterways. These safety zones can result in limiting the traffic and operations of other vessels while an LNG ship is transiting. Activity in the port of San Juan is quite dynamic (as shown in Figure 8.1 in CH-IV's technical evaluation report in Appendix I) and, therefore, PREPA expressed a desire to minimize the number of monthly deliveries of LNG or CNG in order to mitigate the potential impact from the transiting of LNG or CNG ships on the other users of the port of San Juan. The goal is to mitigate potential concerns and opposition to LNG or CNG shipping activity from other port users. Therefore, PREPA would prefer that fewer larger

deliveries of LNG or CNG be planned for, preferably no more than one or two deliveries per month. Given PREPA's daily requirements, this would require the use of standard scale LNG ships with storage capacity in the range of 90,000 to 160,000 m3 (equivalent to 2 to 3.6 million MMBtu). The LNG storage capacity would have to be consistent with these size ships to ensure efficient and rapid unloading. As of today, there are no CNG projects in the US and no such projects have been presented to the FERC or USCG. Consequently, there are no explicit rules with regards to safety zones for CNG ships transiting through US ports or navigable waterways. However, the Team expects that similar activity restrictions that apply to LNG ships would also apply to CNG ships. Proposed CNG ship designs provide for significantly smaller storage capacity because of the lower volumetric density of CNG versus LNG and, therefore, significantly higher transiting activity would be required to satisfy PREPA's daily natural gas requirements. Consequently, the Team fears that frequent potential traffic restriction associated with CNG deliveries would likely increase the likelihood of opposition from other port users to the delivery of CNG in the port of San Juan.

3) The infrastructure must allow for the vaporization of LNG back to a gaseous state, or for the safe pressure reduction and reheating of CNG to the appropriate pressure and temperature for natural gas to be used in PREPA's power plants. The LNG vaporizers can be located either on land (in association with on land storage tanks or FSU), or as part of an FSRU. It is assumed that the CNG pressure reduction system would be included with the floating CNG storage system.

4) The infrastructure must ensure that natural gas is delivered to both PREPA's Palo Seco and San Juan Power Plants.

5) The infrastructure must allow PREPA to implement competitive LNG or CNG procurement processes and therefore must be compatible with sourcing LNG or CNG from multiple sources of LNG.

   LNG can be sourced from the global markets and imported to Puerto Rico from such countries as Trinidad and Tobago, Nigeria, Equatorial Guinea, Algeria, Angola, Norway, and the Middle East (other sources such as Australia, Peru, Malaysia, Indonesia, Russia and Papua New Guinea are much less likely because of the much larger distances from Puerto Rico). Another future source could be the Continental United States where liquefaction and export projects are under construction in Louisiana (Sabine Pass LNG and Cameron LNG) and Texas (Freeport LNG). However, the volumes from these projects are already committed and sold to companies such as BG, Gas Natural Fenosa, BP, Chubu Electric, Osaka Gas, Toshiba, SK Energy, KOGAS, Gail, Total, Mitsubishi, and Mitsui. Other LNG liquefaction and export projects are in various stages of

development. However, the volumes associated with the projects that are most advanced and likely to be sanctioned in 2015 have also already been committed to buyers. Consequently, PREPA requires the flexibility to be able to source LNG from both the global market and potentially from the Continental US.

There are currently no CNG production facilities of the scale required to satisfy PREPA's volume requirements. There are some projects under development in both the US (containerized CNG) and Trinidad (bulk CNG) but the timeframe for the sanction of either project is highly uncertain, and PREPA would require the flexibility to source CNG from either domestic or foreign sources.

STUDY METHODOLOGY

The Team conducted a multi-dimensional assessment that is primarily based on environmental and technical assessments of a series of options for LNG or CNG infrastructure solutions.

POTENTIONAL OPTIONS LIST

The Team identified a total of three potential locations for the LNG or CNG infrastructure based on discussions with PREPA and P3A about potentially available land or land owned by other government agencies and the Team's experience with siting LNG projects.

- Two locations inside San Juan Bay: Pier 15/16 and Army Dock (also referred to Liquids Dock in appendices) are shown as red pins on Map 2 below. Subsequently to the evaluation of these first two location, PREPA requested that a third location adjacent to the San Juan Power Plant on its western boundary (Warehouses Site). This site is also shown as a red pin on Map 2 below.
- One locations outside San Juan Bay: North Offshore is shown as red pins on Map 3 below

Prior to launching this feasibility study, PREPA had identified another potential location outside San Juan Bay in Ensenada Boca Vieja. However, PREPA determined that this location should not be evaluated as part of this feasibility study because it was determined that it would not be suitable for a floating or onshore LNG terminal because of the very shallow water depth, environmental issues (presence of protected corral and manatees habitat) and presence of a grandfathered sewage disposal line that runs through the potential site. For the purpose of illustration, this potential location is shown is a green pin on Map 3 below.

Map 2 – Potential LNG or CNG Infrastructure Locations Inside San Juan Bay

Map 3 – Potential LNG or CNG Infrastructure Locations Outside San Juan Bay

The Team then developed a list of potential infrastructure solutions for each of the locations based on the Team's experience and PREPA's requirements. The list of options is summarized in Table 1 below

Table 1 – List of Potential LNG or CNG Infrastructure Solutions

Option #	Location	Product	Infrastructure Description	Delivery Logistics
1	Pier 15/16	LNG	Regasification barge (floating storage and regasification) moored at Pier 15 or 16	Smaller scale shuttle tanker being loaded from LNG ship via ship-to-ship transfer in the area of Guayanilla Canyon on the protected south shore of Puerto Rico
2	Pier 15/16	LNG	Regasification barge (floating storage and regasification) moored at Pier 15 or 16	Standard scale LNG carrier delivering directly to regasification barge
3	Pier 15/16	LNG	FSRU moored at Pier 15 or 16	Standard scale LNG carrier delivering directly to FSRU
4	Pier 15/16	LNG	FSU and on land vaporization	Smaller scale shuttle tanker being loaded from LNG ship via ship-to-ship transfer in the area of Guayanilla Canyon on protected south side of Puerto Rico
5	Pier 15/16	LNG	On land storage and vaporization	Standard scale LNG carrier delivering directly to on land tanks
6	Army Dock	LNG	Regasification barge (floating storage and regasification) moored at Army Terminal	Smaller scale shuttle tanker being loaded from LNG ship via ship-to-ship transfer in the area of Guayanilla Canyon on protected south side of Puerto Rico
7	Army Dock	LNG	Regasification barge (floating storage and regasification) moored at Army Terminal	Standard scale LNG carrier delivering directly to regasification barge
8	Army Dock	LNG	FSRU moored at Army Terminal	Standard scale LNG carrier delivering directly to FSRU
9	Army Dock	LNG	FSU and on land vaporization	Smaller scale shuttle tanker being loaded from LNG ship via ship-to-ship transfer in the area of Guayanilla Canyon on

				protected south side of Puerto Rico
10	Army Dock	LNG	On land storage and vaporization	Standard scale LNG carrier delivering directly to on land tanks
11	North Offshore	LNG	FSRU moored at offshore buoy	Standard scale LNG carrier delivering directly to FSRU
12	Pier 15/16	CNG	Non-self-propelled vessel with onboard CNG storage and pressure reduction systems	Non-self-propelled vessel with onboard CNG storage and pressure reduction systems to replace berthed vessel when empty
13	Army Dock	CNG	Non-self-propelled vessel with onboard CNG storage and pressure reduction systems	Non-self-propelled vessel with onboard CNG storage and pressure reduction systems to replace berthed vessel when empty
14	Warehouse	LNG	On land storage and vaporization	Standard scale LNG carrier delivering directly to on land tanks

The first draft of this feasibility report evaluated options 1 through 13 in table 1 above. In this report, the conclusion stated that Option 5 above (on land storage and vaporization at Pier 15/16) was the most feasible of the alternatives that were evaluated. After consulting with government authorities, PREPA determined that siting the on land storage and vaporization equipment at the Pier 15/16 would not be feasible because of the presence of artifacts of historical and archeological significance, the presence of which was not made known to the Team until after the issuance of the 1st Draft Report. Consequently, PREPA identified a third potential site inside San Juan Bay (Warehouse Site) and requested that the Team add this fourteenth option of an LNG terminal located at the Warehouse Site consisting of on land storage and vaporization being serviced by standard scale LNG carriers. Options consisting of FSU or FSRU configurations were not included in the evaluation of the Warehouse Site because of the conclusions drawn that these types of options were non-preferential because of the uncertainty about the permitting process and uncertainty about the ability to successfully manage the regulatory siting challenges resulting from the large exclusion zones.

One or more pipelines will be required to deliver vaporized LNG or depressurized CNG to both the San Juan and Palo Seco Power Plants from either of the four locations.

- Pier 15/16: a subsea pipeline crossing San Jan Bay (most likely horizontally directionally drilled instead of trenched) from Pier 15/16 to the San Juan Power Plant, AND onshore pipeline from San Juan Power Plant to Palo Seco Power Plant following the routing

originally contemplated for Via Verde. An alternative could include a buried underwater pipeline from the San Juan Power Plant to Palo Seco Power Plant (refer to Appendix 1 Attachment 5 in the TRC report for a conceptual route for this underwater pipeline).

- Army Dock or Warehouse Site: an onshore pipeline from San Juan Power Plant to Palo Seco Power Plant following the routing originally contemplated for Via Verde. An alternative could include a buried underwater pipeline from the San Juan Power Plant to Palo Seco Power Plant (refer to Appendix 1 Attachment 5 in the TRC report for a conceptual route for this underwater pipeline).
- North Offshore: a subsea pipeline from FSRU to western tip of Ensenada de Boca Vieja, AND a subsea pipeline horizontally drilled to Palo Seco, AND an onshore pipeline from Palo Seco Power Plant to the San Juan Power Plant following the routing originally contemplated for Via Verde.

ENVIRONMENTAL ASSESSMENT

TRC prepared a map of the environmentally sensitive zones in the study area that identified coral reefs, mangroves, sea grass beds, wetlands, critical wildlife areas, river and streams, karst areas, and aquifers. TRC determined that the environmental issues that are most likely to result in a high consequence impacts are those impacting coral reefs and mangroves. The regulatory requirements of dredge spoil management also represent a critical issue that could affect schedule. Impacts on the other environmentally sensitive areas can presumably be mitigated.

TRC then developed a classification scheme to quantify the severity of potential impacts from the infrastructure solutions identified above. This classification scheme includes the following a:

- High: impacts that are most assuredly going to result in significant project delays (more than 1 year) and/or cost a material amount of money to mitigate.
- Potentially High: impacts that could result in significant project delays (more than 1 year) and/or cost a material amount of money to mitigate.
- Moderate: impacts that have to be addressed, however, according to TRC experts, are impacts that can be mitigate with moderate project delays (less than 1 year) and/or mitigated at reasonable costs.
- Minor: impacts that are easily mitigated.
- Potential Issue – Need More Information: impacts where, based on TRC's experiences, could be considered "Moderate" to "High" but where further technical definition is required to properly assess the impact (e.g. choice of vaporization technology).
- None: no impacts are anticipated.

TRC's performed its assessment by leveraging its experts' experience and knowledge about siting and permitting LNG facilities in the US, and incorporated feedback from Galway about specific issues such as pipeline routing. TRC's report should be considered an initial screen of potential fatal flaws that is based on a desktop study. Further and more detailed and targeted assessments would be required to confirm the anticipated environmental impacts. The TRC report is included as Appendix I.

TECHNICAL ASSESSMENT

CH-IV completed a Feasibility and Options Study that focused on a) identifying and examining a full range of LNG and CNG delivery options, b) considering potential sites, c) quantifying various terminal configurations, site attributes and key differentiators within the context of each option's specific engineering challenges, solutions, and, very importantly, regulatory environment. CH-IV leveraged its extensive experience with LNG projects developed and built in the US as well as input from WH on regulatory matters and Galway on techno-commercial and commercial considerations.

One of the key components' of CH-IV assessment focused on the regulatory requirements that would impact the siting, design and operations of the potential options. Specifically, because of the requirement to be able to source LNG from the global market as well as potential from the continental US, the facility would need to be permitted as an Import LNG Terminal and therefore would be under the jurisdiction of the FERC. The Team viewed this requirement as a net positive because the FERC permitting process has a long history, is well established and predictable and is attended by relatively little uncertainty. Any permitting strategy that would require a new or one-off process would, in the Team's opinion, introduce significant permitting process, schedule and outcome uncertainty, which could be viewed as a fatal flaw in light of PREPA's obligations to meet MATS requirements.

There are a couple of important considerations with regards to the permitting approach that would impact this type of jurisdictional facility.

1) CFR 49 Part 193 applicability and considerations on the determination of the facility's impact on public safety and required mitigation measures.

   According to Part 193, the safety standards and mitigation measures defined in the rules would not apply to LNG facilities that are used by the ultimate consumer of LNG or natural gas. Therefore, it is possible that any LNG or natural gas facilities serving PREPA would qualify for a different set of safety standards and mitigation measures that may be less stringent than those imposed under Part 193. However, one of the FERC's duties is to ensure public safety from the potential impact of jurisdictional facilities. Consequently, based on the Team's experience with FERC staff on other projects, it is anticipated that FERC staff would, as they are empowered to do, require that any facilities build to serve PREPA demonstrate that it meets the siting requirements of Part 193 irrespective of any exemptions that may be offered by regulations. Consequently, CH-IV has analyzed siting related issues according to the standards required under Part 193.

2) Application of public impact and siting requirements for floating LNG terminal infrastructure.

There is significant uncertainty about the applicable methodology to determine impacts on the public of vapor dispersion and thermal radiation for LNG terminal that include floating LNG infrastructure. The "traditional[1]" method used (which is being used by Excelerate Energy in the permitting process for the Aguirre Offshore GasPort in Puerto Rico) is based on the USGC regulations that define Zones of Concern that delineate particular areas of specific risks and have been advisory in nature and have not constituted a proscriptive siting constraint. However, there have been recent developments that suggest that the application of proscriptive project-specific Zones of Concern may be required for LNG terminals that include any floating infrastructure (such as FSU or FSRU). Consequently, the Team feels that going forward, it is very likely that projects that include floating LNG infrastructure will be required to calculate and describe Zones of Concern for the floating infrastructure. The Team believes that FERC will then use those Zones of Concern to determine the potential impacts to the public in a similar manner as FERC currently applies for onshore LNG infrastructure. It is possible that alternatives to the "traditional" method to evaluate the impact of those Zones of Concern could be developed with FERC. However, the Team felt that this approach would introduce significant uncertainty about the permitting process, schedule and outcomes and should therefore be considered a fatal flaw in light of PREPA's MATS obligations. Therefore, CH-IV applied the "traditional" methodology to analyze siting related issues for floating LNG infrastructure.

For CNG, there are currently no CNG projects within the US. Therefore, no CNG project has been presented to FERC or USGC as part of a formal permitting process. Therefore, no specific rules, guidelines or precedent have been developed to provide a basis for the calculation of hazard zones for marine based CNG project within US jurisdiction. In the Team's opinion, this in itself presents significant uncertainty about the permitting process, schedule and outcomes for a CNG project and should therefore be considered a fatal flaw in light of PREPA's MATS obligations. However, for demonstration purposes, CH-IV did calculate hazard zones for the two CNG options based on analytical concepts used for LNG scenarios.

CH-IV calculated Zones of Concern for vapor dispersion and thermal radiation. These Zones of Concerns are shown in appendices A through L in CH-IV's Feasibility and Options Study report and are numbered in the map legends. The regulatory requirements for describing these Zones of Control are described in section 6.2 of CH-IV's Feasibility and Options Study report. Specifically, these include:

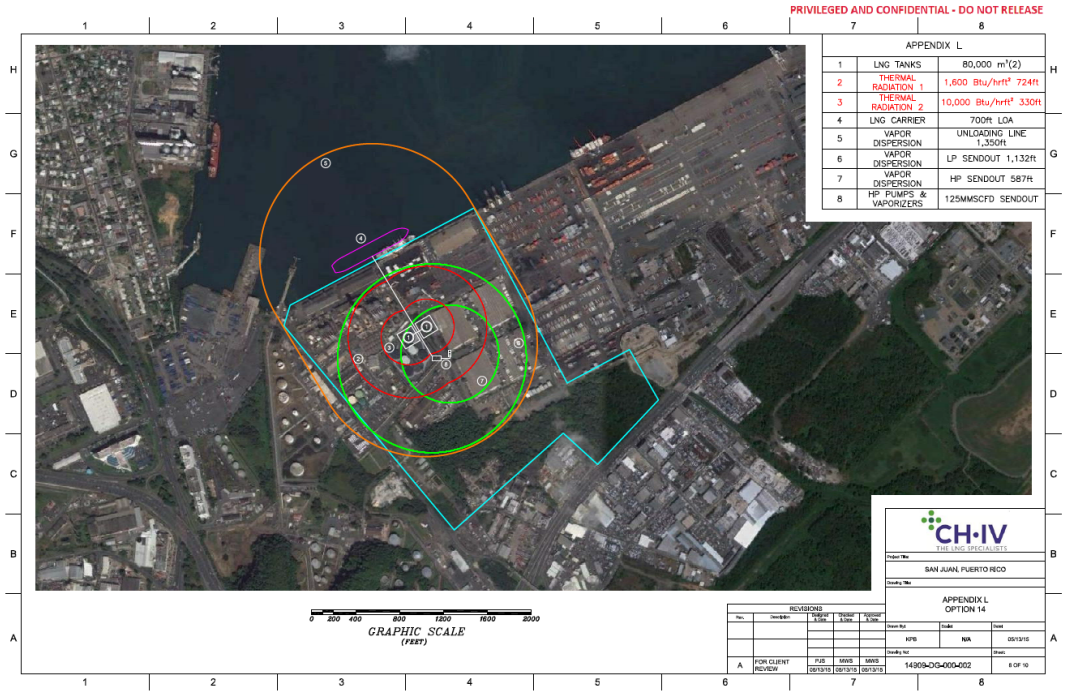
[1] Methods currently used to describe Zones of Concerns by FERC for jurisdictional onshore LNG facilities

- 49 CFR 193.2057 requires that "Each LNG container and LNG transfer system must have a thermal exclusion zone in accordance with section 2.2.3.2 of NFPA 59A (incorporated by reference)". This requires that provisions need to be made to minimize the possibility of damaging effects of fire reaching beyond a property line that can be built upon and that would result in a distinct hazard. These thermal radiation Zones of Concerns are defined in the report as Zone 1 (37.5 kW/m^2 equivalent to 10,000 BTU/ft^2-hr thermal flux) and Zone 2 (5 kW/m^2 equivalent to 1,600 BTU/ft^2-hr thermal flux).

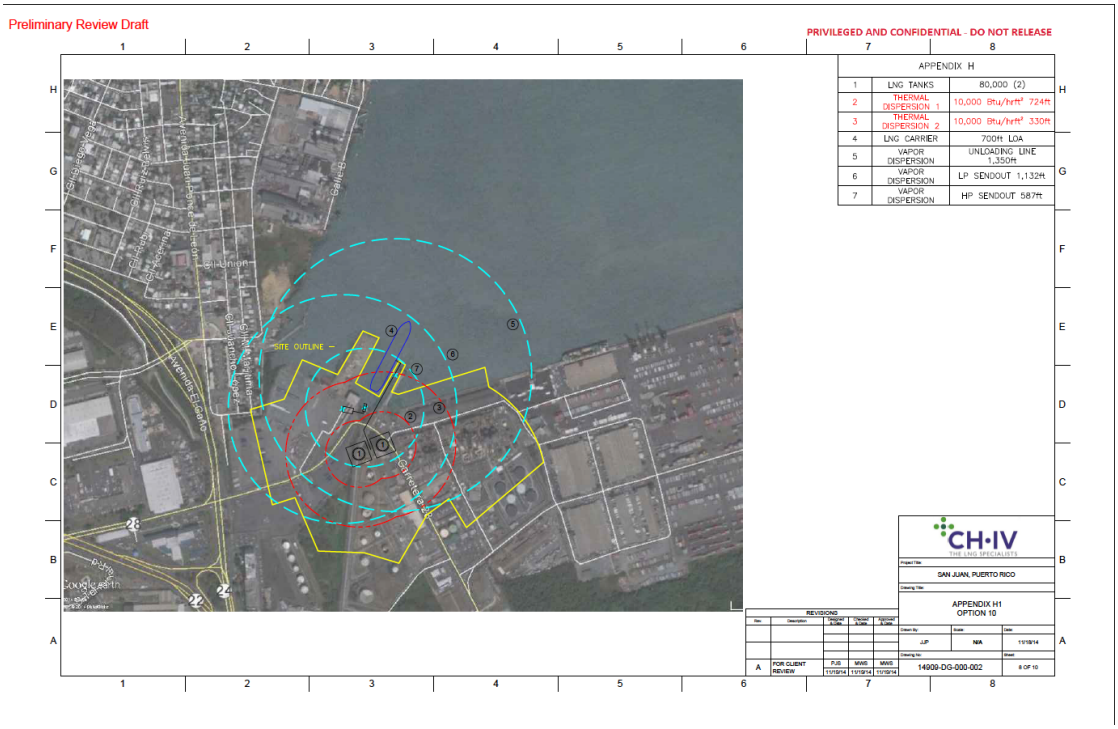
- 49 CFR 193.2059 requires that "Each LNG container and LNG transfer system must have a [vapor] dispersion exclusion zone in accordance with sections 2.2.3.3 and 2.2.3.4 of NFPA 59A (incorporated by reference)". This requires that provisions need to be made to minimize the possibility of a flammable mixture of vapors from a design LNG spill reaching a property line that can be built upon and that would result in a distinct hazard. These vapor dispersion Zones of Concerns are defined in the report as Zone 3 and are calculated and shown for various spill scenarios (therefore for some of the cases, multiple Zone 3's have been calculated and shown to reflect these different required spill scenarios).

Siting an LNG or CNG facility requires compliance with the Zones of Concerns described above and therefore required that the terminal control all of the property on land that is included within the three Zones of Concern described above. This means that access to the property is restricted and controlled by the terminal and the activities that can take place within the property boundary are limited to the operations of the LNG terminal and, in the case of the Warehouse Site, the operations of PREPA's power plant. Any option that included Zones of Concern that extended materially beyond the proposed property site limits on land and/or would impact the public were deemed to be undesirable. In option 14 (on land LNG storage and vaporization option at Warehouse Site), although some of Zone 3 vapor dispersion zones extend beyond the site boundary limit, as shown in Map 4 below, it does not extend beyond the property limit in a material way and therefore CH-IV concludes that this condition can be managed and mitigated through design and engineering methods and is therefore not a cause for concern during this feasibility assessment stage. This contrasts sharply from all options that include floating elements (FSU or FSRU's) where the Zone 3 extend materially over public areas, or option 10 (on land LNG storage and vaporization option at Army Dock). The material extensions of the Zone 3's beyond the proposed site boundary limits for Option 10 are shown on Map 5 below.

Map 4 – Option 14 (On Land LNG Storage and Vaporization Option at Warehouse Site) Zones of Concerns



Map 5 – Option 10 (On Land LNG Storage and Vaporization Option at Army Dock) Zones of Concerns



The results of CH-IV's assessment are document in its Feasibility and Options Study report and included in Appendix II.

COMMERCIAL ASSESSMENT

The commercial assessment focuses on how well the infrastructure solution would support PREPA's goal of being to tap into multiple sources of LNG or CNG to assure security of supply and implement a competitive procurement process that would attract multiple potential suppliers to participate in the process. Consequently, any solution that requires custom logistical chain would be viewed as less attractive as a solution that can leverage existing shipping fleets. For example, a solution that requires more frequent deliveries of smaller ships because of lower terminal storage capacity or draught requirements would be less favorable from a commercial perspective than a solution that would support deliveries using standard scale vessels for the industry. The results of this assessment are included in Table 2 in Section 4 of this report.

2 – OPTIONS ASSESSMENT SUMMARY

The following table summarizes the assessment of the thirteen options identified by the team. Detailed environmental and technical assessments are included in Appendices I and II respectively. Table 2 summarizes the assessment of the LNG and CNG infrastructure Options and Table 3 summarizes the environmental assessment for the cross bay pipeline to connect Pier 15/16 to the San Juan Power Plant, the on land pipeline between the San Juan and Palo Seco Power Plants and the buried underwater pipeline between the San Juan and Palo Seco Power Plants.

Table 2 – LNG and CNG Options Assessment Summary

	Environmental Impact		Technical Assessment		Regulatory	Commercial
Option #	**Dredging & Disposal/Bentic Impact**	**Land Use/ Aesthetics/ Cultural**	**Zones of Concern Impact on Public**	**Shipping Frequency**	**Permitting Process Uncertainty**	**Logistical Conformity**
1	Moderate Some dredging required	Minor Additional vessels at pier	Very High Significant vapor dispersion zone encroachment over San Juan	Low 2 per month	High Issues with determination of impact of floating LNG elements	Low/Moderate Requires custom and dedicated shuttle tanker and extended LNG carrier unloading periods
2	Moderate Some dredging required	Minor Additional vessels at pier	Very High Significant vapor dispersion zone encroachment over San Juan	Low 2 per month	High Issues with determination of impact of floating LNG elements	Low/Moderate Requires custom LNG carrier as existing ships in this size range are too old or dedicated to other trades
3	Potentially High	Moderate	Very High	Low	High	High

	Significant dredging required	Visual impact of FSRU from Convention Center	Significant vapor dispersion zone encroachment over San Juan	1.4 per month	Issues with determination of impact of floating LNG elements	Compatible with many vessels existing LNG fleet
4	Moderate Some dredging required	Minor Additional vessels at pier	Very High Significant vapor dispersion zone encroachment over San Juan	Low 2 per month	High Issues with determination of impact of floating LNG elements	Low/Moderate Requires custom and dedicated shuttle tanker and extended LNG carrier unloading periods
5	Potentially High Significant dredging required for use of larger ships	Moderate Visual impact of on land LNG storage tanks	Low/None Zones of concerns are completely contained within site boundaries	Low 1.4 or 2 per month (depending on ship size)	Low "Standard" configuration for FERC process	Low or Low/Moderate Depending on type of ship used
6	Potentially High Significant dredging required for use of larger ships	Minor Additional vessels at pier	Very High Significant vapor dispersion zone encroachment over San Juan	Low 2 per month	High Issues with determination of impact of floating LNG elements	Low/Moderate Requires custom and dedicated shuttle tanker and extended LNG carrier

						unloading periods
7	Potentially High Significant dredging required for use of larger ships	Minor Additional vessels at pier	Very High Significant vapor dispersion zone encroachment over San Juan	Low 2 per month	High Issues with determination of impact of floating LNG elements	Low/Moderate Requires custom LNG carrier as existing ships in this size range are too old or dedicated to other trades
8	Potentially High Significant dredging required	Minor Additional vessels at pier	Very High Significant vapor dispersion zone encroachment over San Juan	Low 1.4 per month	High Issues with determination of impact of floating LNG elements	High Compatible with many vessels existing LNG fleet
9	Potentially High Significant dredging required	Minor Additional vessels at pier	Very High Significant vapor dispersion zone encroachment over San Juan	Low 2 per month	High Issues with determination of impact of floating LNG elements	Low/Moderate Requires custom and dedicated shuttle tanker and extended LNG carrier unloading

						periods
10	Potentially High Significant dredging required for use of larger ships	Moderate Visual impact of on land LNG storage tanks	High Zones of concerns Vapor dispersion zone encroaches on facilities owned by Puma, existing Port tenants adjacent to San Juan Power Plant and some public areas	Low 1.4 or 2 per month (depending on ship size)	Low "Standard" configuration for FERC process	Low or Low/Moderate Depending on type of ship used
11	Potentially High Pipeline would have to cross potential corral reef areas	High Likely visible from registered historic structures within pristine view shed	Very High Significant vapor dispersion zone encroachment over San Juan	None in San Juan Bay Concerns about severe metocean conditions impeding unloading into FSRU	High Issues with determination of impact of floating LNG elements because of proximity to San Juan	Low/Moderate Concerns about severe metocean conditions impeding unloading into FSRU & concerns of associate natural gas supply disruptions

12[2]	Moderate Some dredging required	Minor Additional vessels at pier	Medium Potential Zones of concerns are mostly contained contained within site boundaries	High 10 per month	High Lack of guidelines/permitting process or experience for CNG	Low No marine CNG projects have been implemented. Would require custom dedicated ships. Concerns about security of supply since no CNG production capacity or CNG ships exist at the moment and none are in advanced stages of development
13[3]	Potentially High Significant dredging required for use of larger	Minor Additional vessels at pier	High Potential Zones of concerns for most release scenarios	High 10 per month	High Lack of guidelines/permitting process or	Low No marine CNG projects have been

[2] The environmental assessment for option 12 is the same as option 1 since it is site specific

[3] The environmental assessment for option 13 is the same as option 6 since it is site specific

	ships		encroaches on facilities owned by Puma, existing Port tenants adjacent to San Juan Power Plant and some public areas		experience for CNG	implemented. Would require custom dedicated ships. Concerns about security of supply since no CNG production capacity or CNG ships exist at the moment and none are in advanced stages of development
14[4]	Potentially High Significant dredging required for use of larger ships	Moderate Visual impact of on land LNG storage tanks	Low/None Zones of concerns 1 & 2 are completely contained within site boundaries, Zones of concerns do not extend materially site boundaries and are manageable/mitigable	Low 1.4 or 2 per month (depending on ship size)	Low "Standard" configuration for FERC process	Low or Low/Moderate Depending on type of ship used

[4] The environmental assessment for option 14 is the same as option 10 since the two locations are very near each other

Table 3 – Environmental Assessment Summary for Pipelines

Pipeline	Dredging & Disposal/Benthic Impact	Land Use/Aesthetics/Cultural
Cross Bay from Pier 15/16 to San Juan Power Plant	Minor It is assumed that the pipeline would be constructed with Horizontal Directional Drilling ("HDD") which will have minor impact on the bentos of the bay during construction and none during operations	None
Onshore Pipeline From San Juan to Palo Seco Plant (or vice versa) Route 1 – Along highway 165	None	High This pipeline will be very difficult to permit because of the proximity to roads, residences, and the potential impact to environmentally sensitive areas
Onshore Pipeline From San Juan to Palo Seco Plant (or vice versa) Route 2 – Routing proposed for Via Verde	None	Potentially High This pipeline will be difficult to permit because of the proximity to roads and industrial sources
Buried Underwater Pipeline From San Juan to Palo Seco Plants (or vise versa)	Minor – if HDD installation technically feasible Moderate/High – if trenching method is required	Moderate Construction and pullback spaces in harbor highly visible during construction (temporary)

Offshore Pipeline from Offshore FSRU to Palo Seco Power Plant	Potential High This pipeline will be difficult to permit because of the proximity to roads and industrial sources	None

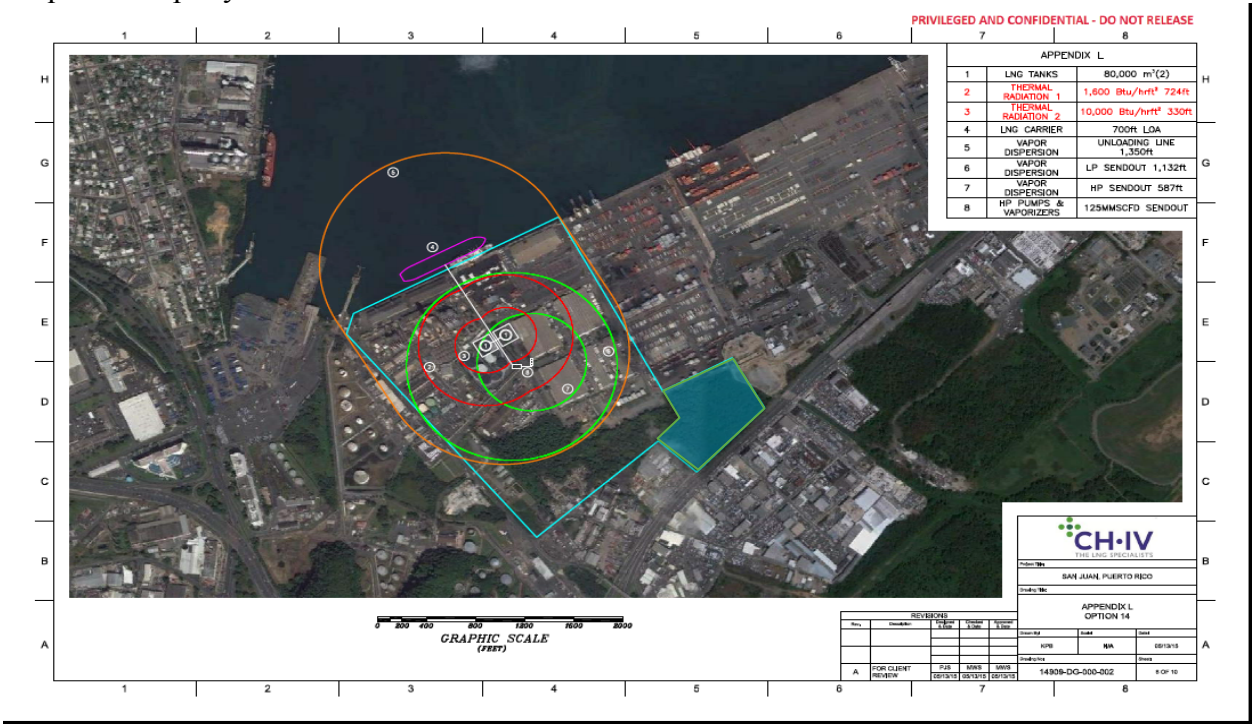
It is worthwhile pointing out that several of the options evaluated will required significant dredging. TRC categorized the environmental impact for those options from dredging has Potentially High because the dredging and the disposal of the dredge spoil will have to be permitted by the US Corps of Engineers ("USACE"). This permitting effort will likely take 1.5 to 4 years. However, based on its experience, TRC expects that the permitting timeline for any dredging projects would be on the lower end of this range and it is TRC's judgement that obtaining a dredging permit from the USACE will not be the critical path permitting issue. However, the dredging requirements could become a Fatal Flaw if the dredge material management exceeds the USACE's existing offshore spoil disposal site capacity and a new Ocean Dredged Material Site ("ODMDS") is required. TRC expects that it would take years to obtain a Marine Protection, Research and Sanctuaries Act ("MPRSA") § 102 approval from the EPA for a new ODMDS. However, initial informal feedback obtained during discussion between PREPA and USACE indicate that USACE does not have any concerns about capacity its existing offshore spoil disposal site.

3 – CONCLUSIONS AND RECOMMENDATIONS

The Team's conclusions and recommendations from the multi-disciplinary assessment of potential options to deliver natural gas to the San Juan and Palo Seco Power Plants Technical and Commercial assessments are:

- Despite the dredging requirements, Option 14, which consists of a more traditional on land LNG Import terminal configuration at the Warehouse Site, appears to be the most feasible of the options considered because the preliminary analysis suggests that meeting regulatory siting challenges is manageable (including the non-material slight extension of the vapor dispersion zones beyond the site limits) as long as whole property contained within the blue boundary shown in Map 5 below is used for the exclusive use of the LNG terminal and PREPA's power plant. A relatively small section in the southeastern corner of the proposed site (highlighted in blue) may potentially not be required, but this will have to be verified as part of the second phase of technical evaluation. Therefore, the Team concludes and recommends that Option 14 is the most preferential of the fourteen options considered. Equipment layouts and other siting considerations will need to be optimized in the second phase of the technical evaluation, which scope may need to be expanded to address vapor dispersion mitigation and management.

Map 6 – Option 14 (On Land LNG Storage and Vaporization Option at Warehouse Site) Required Property Boundaries and Zones of Concerns



- Option 5, which consists of a more traditional on land LNG Import terminal configuration at Pier 15/16, initially appeared to be the most feasible of the initial thirteen options considered because the preliminary analysis suggested that meeting regulatory siting challenges were manageable. PREPA learned, after consulting with government authorities, of the presence of artifacts of historical and archeological significance (which was not made known to the Team until after the issuance of the 1st Draft Report). Therefore, the Team concludes that this option is now non-preferential because of the siting challenges caused by the presence of artifacts of historical and archeological significance.

- The other options at Pier 15/16 that incorporate floating infrastructure for the terminal (either FSU or FSRU) have been determined to be non-preferential because of the uncertainty about the permitting process and uncertainty about the ability to successfully manage the regulatory siting challenges.

- Similarly, the options evaluated for the Army Dock site that include floating infrastructure have been determined to be non-preferential because of the uncertainty about the permitting process and uncertainty about the ability to successfully manage the regulatory siting challenges.

- The option to site an onshore facility at/near the Army Dock and PREPA's San Juan Power Plant has also been determined to be non-preferential because of PREPA's expectations that securing all the land identified as the site boundaries will be very challenging. But even if the land could be assembled, the site is not sufficiently large nor situated properly for the Team to have confidence that it will be manageable to meet regulatory siting challenges imposed by proximity to the public and third party installations.

- Option 11, Offshore FSRU option, has been determined to be non-preferential for several reasons including:
    - The uncertainty about the permitting process and uncertainty about the ability to successfully manage the regulatory siting challenges;
    - The High Impact environmental assessment associated with the visibility of a FSRU from the registered historic structures in Isla de Cabras National Park and San Felipe del Morro Fort, which currently have a "pristine viewshed". It is the Team's opinion that it is very unlikely the viewshed impact would be approved by the regulatory agency reviewing the EIS;
    - The requirement for the pipeline connecting the FSRU to the Palo Seco Power Plant to cross a corral reef area. Crossing a corral reef area has a Potentially High impact because of the increased turbidity, noise vibration, and possibility of corral/equipment collisions associated with construction of the pipeline could impact the corral reef.
    - The expectation that challenging metocean condition along Puerto Rico's norther coast will significantly hinder the ability to reload the FSRU reliably which would result in poor availability of natural gas to PREPA's power plants.

- The 2 CNG options have been determined to be non-preferential because of the uncertainty about the permitting process and uncertainty about the ability to successfully manage the regulatory siting challenges. It is also uncertain how the frequent monthly deliveries of CNG would impact other port users and, therefore, it is uncertain how much opposition from other port users a CNG solution would face. In addition, since there are no marine CNG project in operations anywhere around the world, relying on such a solution would expose PREPA so significant security of supply risks and minimal bargaining leverage during the procurement process.

- Regardless of which LNG site is chosen, there will have to be a natural gas pipeline that connects the San Juan Power Plant and the Palo Seco Power Plant. TRC has evaluated the environmental and socioeconomic impacts of this pipeline based on the two routes supplied by PREPA. Route 1 follows an onshore route generally along highway 165 (Avenida El Cano) within 50 feet of this major thoroughfare and within 200 feet of residential areas. The new natural gas pipeline will have to be a buried pipeline, as the United States Department of Transportation ("DOT") Pipelines and Hazardous Materials Safety Administration ("PHMSA") requires all new natural gas pipelines to be buried with at least 3 feet of cover. TRC believes there are two issues associated with Route 1: 1) the pipeline will have to cross both populated areas (i.e., PHMSA Class ¾ locations) and potentially sensitive environmental areas (e.g., mangrove swamps), and 2) there will likely be substantial public opposition (this is based on the experience from the Via Verde pipeline permitting effort). TRC considerers this pipeline route to be a high impact issue. Constructability in this tight corridor may also present a moderate impact issue. There is a second route (Route 2) that will be specifically routed to minimize encroachment on highways, roads, and residential areas. This route will be closer to the industrial areas and still has the potential for impacts on wetlands and/or other environmentally sensitive areas.

- Dredging will also be required for all options but the Offshore FSRU Option. Obtaining a dredging and spoil disposal permit will likely take 1.5 to 4 years. However, based on its experience, TRC expects that the permitting timeline for any dredging projects would be on the lower end of this range and it is TRC's judgement that obtaining a dredging permit from the USACE will not be the critical path permitting issue.

- No environmental or social impact issues that have been identified at this stage as Fatal Flaws.

- This evaluation did not focus on the level of public opposition or support that such a project would face. The location in (or very close to) San Juan and the Port of San Juan (which drives a significant level of economic activity for the island) will very likely make any project to deliver natural gas to PREPA's power plants very high visibility and will be subject to significant focus and scrutiny from the public, authorities and stakeholders that could be impacted economically by such projects. Although the Team's assessment is that meeting the siting and permitting requirement for the the recommended solution of

an onshore LNG terminal at the Warehouse Site are manageable, this project is a high footprint endeavor that will in all likelihood garner additional scrutiny because of its localized impact (dredging, large tanks, large vessels delivery LNG). Therefore is the Team's recommendation that P3A and PREPA carefully assess the potential execution risks associated with overcoming likely public opposition.

4 – APPENDICES: TRC & CH-IV Reports

San Juan LNG Phase I

Fatal Flaw

May 2015

Prepared For
Galway Group

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Executive Summary

Our primary objective for this project has been to help Galway Group quickly determine if there are fatal flaws in locating an LNG import terminal in San Juan Bay, Puerto Rico. We have conducted an evaluation that considers:

- Biological Resources,
- Water Quality,
- Air Quality, and
- Social Impacts.

TRC evaluated the environmental and social impacts for the LNG facility "cases" developed by CH IV. The cases are shown in Appendix 1 Attachment 1. An additional terminal site (adjacent to the San Juan power plant site and sharing the same berthing cases) and an additional offshore pipeline route from San Juan power plant to Palo Seco power plant were added to these cases. TRC engaged a team of LNG environmental experts to evaluate the environmental/socioeconomic issues for each case to determine 1) if there are any fatal flaws with any case, and 2) identify significant issues.

The final results of the TRC team analysis is presented in Appendix 1 Attachment 2. The conclusions are:

- There are no environmental or social impact issues that will be a fatal flaw.
- Regardless of which LNG site is chosen, there will have to be a natural gas (NG) pipeline that runs between the San Juan power plant and the Palo Seco power plant. TRC has evaluated the environmental and socioeconomic impacts of this pipeline based on the two onshore routes supplied by Puerto Rico electric Power Authority (PREPA) (route was posted to the Sharepoint site on 10/7/2014) and a preliminary offshore route.
    - Route 1 follows an onshore route generally along highway 165 (Avenida El Cano) within 50 feet of this major thoroughfare and within 200 feet of residential areas. The new NG pipeline will have to be a buried pipeline, as the United States Department of Transportation (DOT) Pipelines and Hazardous Materials Safety Administration (PHMSA) requires all new NG pipelines to be buried with at least 3 feet of cover. TRC believes there are two issues associated with Route 1; 1) the pipeline will have to cross both populated areas (i.e., PHMSA Class 3/4 locations) and potentially sensitive environmental areas (e.g., mangrove swamps), and 2) there will likely be substantial public opposition (this is based

on the experience from the Via Verde pipeline permitting effort). TRC considerers this pipeline route to be a high impact issue. Constructability in this tight corridor may also present a moderate impact issue.

- There is a second route (Route 2) that will be specifically routed to minimize encroachment on highways, roads and residential areas. This route will be closer to the industrial areas and still has the potential for impacts on wetlands and/or other environmentally sensitive areas.
- An offshore option through San Juan Bay would avoid most of these onshore issues but would present constructability issues required to minimize impacts to shipping channels and aquatic resources (vegetation, corals). Assuming that constructability challenges could be overcome, the shoreline crossing at Palo Seco and the channel crossings (Army Terminal Channel and Turning Basin) would require horizontal directional drill (HDD) installation to avoid sensitive shoreline resources and traffic disruptions, respectively. The remainder of the line would also likely require HDD installation to avoid direct and indirect (turbidity) impacts to vegetation and corals. Visual and traffic impacts during the extended time on station required for drilling operations, pullback, welding, burial, tie-ins, etc. and the workspace required for HDD pullback would present high impact issues.

- There is only one (1) LNG import terminal case that has a high impact. This is the case with the "North Offshore" send out location (Case 11). In this case the visibility of a Floating Storage and Regasification Unit (FSRU) from the registered historic structures in Isia de Cabras National Park and San Felipe del Morro Fort, which currently have a "pristine view shed", would represent a high level impact and it is very unlikely the view shed impact would be approved by the regulatory agency reviewing the Environmental Impact Statement (EIS).
- TRC has identified six (6) cases which would have a moderate impact because of impacts from dredging. These are all cases associated with Pier 15/16. Whenever dredging will be required, TRC has identified a moderate impact. The main issues are that 1) dredging will increase the turbidity of the immediate area and could impact nearby environmentally sensitive areas such as sea grass beds and coral reefs, and 2) the dredging will have to be permitted with the US Army Corp of Engineers (USACE). This process could take form 2 – 4 years. During the project kickoff meeting in San Juan, Sonia Miranda Vega stated that she talked with the USACE Jackson District and they said it would likely take 4 four years to permit any significant dredging. However, we believe the timeline will be on the lower end of the 2 – 4 year range. It is our judgment that obtaining a dredging permit from the USACE will not be the critical path permitting issue.
- There is one (1) case (Case 11) which would likely require a pipeline to cross a coral reef area. Crossing a coral reef has a potentially high impact because the increased turbidity,

noise/vibration, and possibility of coral/equipment collisions associated with construction of the pipeline could impact the coral reef.

- All other issues are considered either moderate or low impact.

Section 1

1.1 Study Areas

For this study TRC was asked to identify any environmental or social impacts, resulting from the construction and/or operation of a Liquefied Natural Gas (LNG) receiving facility which could result fatal flaws. Based on conversations at project kickoff meeting (in San Juan on July 12-13, 2014) and subsequent team conference calls, CH IV prepared a "case list" that is used as the basis of TRC's LNG import terminal options. This "case list" is presented as Appendix 1 Attachment 1.

1.2 Environmentally Sensitive Areas

TRC prepared a map of the environmentally sensitive zones in the study area. This map is presented in Appendix 1 Attachment 3. TRC identified coral reefs, mangroves, sea grass beds, wetlands, critical wildlife areas, river and streams, karst areas, and aquifers. The cases that are most likely to result in a high consequence impacts are the cases that include actions that would impact coral reefs and mangroves. Impacts on the other environmentally sensitive areas can presumably be mitigated.

1.3 Identification of Impacts

1.3.1 Methodology

TRC developed a classification scheme for quantify the severity of impacts. Table 1 below shows the ranking scheme. The most severe impacts were identified as "high" impacts. High impacts were defined as those impacts that are most assuredly going to result in in significant project delays (more than 1 year) and/or cost a material amount of money to mitigate. "Potentially high" impacts are defined as those impacts that could result significant project delays and/or cost a material amount of money to mitigate, however the probability of this being an issue is uncertain at this time. "Moderate" impacts are impacts that have to be addressed, however according to TRC experts are impacts that can be mitigated with moderate delays (less than 1 year) and/or mitigated at a reasonable cost. "Minor" impacts are easily mitigated. The classification of "Potential issue need more information" identifies an impact where, based on TRC experience, could be "moderate" to "high" but there are LNG gasification technology issues that have to be more defined before an impact category can be assigned.

Table 1 - Impact Classification

Color	Impact
	High
	Potentially High
	Moderate
	Minor
	None
	Potential Issue, need more information.

1.3.2 Resources Evaluated

An Environmental Impact Statement (EIS) for an LNG import terminal has to address impacts on marine wildlife, essential fish habitat (EFH), and benthic species; impacts on threatened or endangered species; impacts on land use and recreation; and air and noise. The TRC evaluation considered all of these resources. Each category and the actions that will adversely impact the resource are discussed below.

Offshore and In-Harbor Impacts

Benthic Resources - the benthic resources are the biogeographic resources at the bottom of the bay and/or sea. This includes, coral reefs, sea grass, and other macroalgae. The main activity from this proposed project that could impact the benthic resources are dredging and pipeline construction in the marine environment.

Fisheries – This includes fish and their spawning areas. The activities that could adversely impact the fisheries include construction of a subsurface pipeline and significant water withdraw from the bay.

Transportation – As it relates to this project, this includes disruption of marine transportation in the busy San Juan Harbor.

On-shore Impacts

Water Use/Water Quality – Significant water demand for the LNG regasification process could have an impact on the water supply for the San Juan area, especially it the water is withdrawn from the aquifers in the area. The water quality could be impacted if the water used to regasify the LNG is directly released into the shallow San Juan Bay.

Wetlands/Wildlife - Any onshore construction or change of land use has the potential to destroy existing wetlands or disrupt wildlife.

Visual Impacts – Significant structures (such as LNG storage tanks or large stationary Floating Storage and Regasification Units - FSRU) could result in degradation of the view shed at historical structures or pristine environments.

Air Quality – There will be emissions to the atmosphere of nitrogen oxides (NO_x) and carbon monoxide (CO) from any fuel combustion facilities associated with the regasification facilities. These emissions have the potential to adversely impact the existing air quality resources. These impacts cannot be quantified until there is more information on the magnitude of the emissions and the specific locations of the emission sources.

1.3.3 Impacts

A detailed matrix of the proposed impacts are shown in Appendix 1 Attachment 4. A discussion of the activities that result in impacts classified is presented below.

Impacts From Dredging – CH IV has identified 11 cases for the LNG import terminal. In CH IV's case definition (see Appendix 1 Attachment 1) they documented the "controlling draft" for the marine vessels associated with this case. TRC also had available the depths of the various channels and turning basins in San Juan Harbor (see Appendix 1 Attachment 3) as defined by the US Army Corp of Engineers (USACE). If the controlling depth was deeper than the existing channel depths, then TRC took the position that dredging will be required. Further, the existing channel is narrower than typical approach channels at domestic LNG terminals, and widening of the channel would also require dredging. In TRC's review it was identified that all of the cases associated with Pier 15/16 will have to accommodate dredging to some extent. Cases associated with the Liquids Dock (including cases using Site No. 3) would not require dredging. All dredging was considered a "moderate" impact because the dredging and the disposal of the dredging spoils will have to be permitted by the USACE. The permitting effort will take 1.5 – 4 years. TRC's experience is that dredging to improve an existing channel is likely manageable in a 2 year time frame, especially if the USACE can incorporate dredge material management into their existing capacity. It becomes a Fatal Flaw only in the unlikely event it exceeds existing capacity and requires a new Ocean Dredged Material Disposal Site (ODMDS), which would take years to receive a Marine Protection, Research and Sanctuaries Act (MPRSA) §102 approval from EPA.

Pipeline Between Pier 15/16 and San Juan Power Plant – It is assumed that the a subsurface pipeline could be constructed with Horizontal Directional Drilling (HDD) across San Juan Bay.

HDD is a technology that will minimize impacts to the benthic environment and the fisheries. However, impacts will not be completely eliminated.

Pipeline Between San Juan Power Plant and Palo Seco Power Plant – There are two potential onshore pipeline routes plus a preliminary offshore pipeline route.

Route 1 (see Appendix 1 Attachment 5) is along an existing right of way that parallels highway 165. This pipeline follows an onshore route generally along highway 165 (Avenida El Cano) and is within 50 feet of this major thoroughfare and within 200 feet of residential areas. The new NG pipeline will have to be a buried pipeline, as the United States Department of Transportation (DOT) Pipelines and Hazardous Materials Safety Administration (PHMSA) requires all new NG pipelines to be buried with at least 3 feet of cover. TRC believes there are two issues associated with this pipeline; 1) the pipeline will have to cross both populated areas (i.e., PHMSA Class 3/4 locations) and potentially sensitive environmental areas (e.g., mangrove swamps), and 2) there will likely be substantial public opposition (this is based on the experience from the Via Verde pipeline permitting effort). TRC considerers this pipeline route to be a high impact issues. Constructability in this tight corridor may also present a moderate impact issue.

Route 2 is a route that will be specifically routed to minimize encroachment on highways, roads and residential areas. The new NG pipeline will have to be a buried pipeline, as the DOT PHMSA requires all new NG pipelines to be buried with at least 3 feet of cover. This route will be closer to the industrial areas and still has the potential for impacts on wetlands and/or other environmentally sensitive areas.

An offshore pipeline route (see Appendix 1 Attachment 5) would present significant constructability challenges and may not be feasible from an engineering perspective; however, engineering analysis is beyond the scope of the environmental analysis. Assuming that constructability challenges could be overcome, the shoreline crossing at Palo Seco and the channel crossings (Army Terminal Channel and Turning Basin) would require horizontal directional drill (HDD) installation to avoid sensitive shoreline resources and traffic disruptions, respectively. Open-cut construction techniques, such as trenching, plowing, or jetting the pipeline in would have significant direct and indirect (water quality/sedimentation) impacts on the benthic community, and HDD installation may be required for the entirety of the route. Workspace required for HDD pullback (estimated at one mile) and the extended time on station for drilling operations,

pullback, welding, burial, tie-ins, etc. would present high impact visual and traffic (commercial and recreational) issues, temporarily during construction.

Transportation – TRC believes all cases could result in a "moderate" impact to marine traffic in San Juan bay. Just the fact there will be more barges or ships coming into the already busy harbor will result in some disruption of the existing harbor traffic. Traffic disruption will be compounded by the fact the barges and/or ships will be carrying and unloading LNG. The US Coast Guard has regulations that prevents other ships from getting near the LNG laden vessels while in transit or docked at a terminal. Marine traffic could also be disrupted during the construction of "across bay" subsurface pipelines (i.e., Pier 15/16 to San Juan Power Plant and San Juan power plant to Palo Seco power plant).

Visual Impacts - – Significant structures (such as LNG storage tanks or large stationary Floating Storage and Regasification Units - FSRU) could result in degradation of the view shed at historical structures or pristine environments. The Offshore (North) case would have a FSRU which could impact the visibility from the registered historic structures in Isia de Cabras National Park and San Felipe del Morro Fort, which currently have a "pristine view shed". TRC believes this is a "High" impact classification because it is unlikely the view shed impact would be approved by the regulatory agency reviewing the EIS. TRC believes the structures at Pier 15/16 will be able to be seen from the convention center. However we believe these are "moderate" impacts in that the view shed does not impact historical landmarks or pristine views. Similarly, the structures at the liquids dock will be able to be visible to the general public and are classified as "moderate" impacts in that the view shed does not impact historical landmarks or pristine views.

1.4 Conclusions

TRC's review concludes that there will be environmental and/or social impacts from the construction and operation of an LNG import terminal. A summary of the impacts are shown in Appendix 1 Attachment 1. TRC has not identified any fatal flaws resulting from environmental or socioeconomic impacts.

Appendix 1

Attachment 1

CH IV LNG Cases

Days Elasticity 3
Sendout Rate: 125

Option Number	Description	Location	Sendout Rate (mmscfd)	Storage Volume (m^3)	Days at Design Sendout	Days Elasticity	Net Days at Capacity	Available Loading Volume at Maximum Elasticity Level (m^3)	Remaining Tank Volume (m^3)	Loading Rate (m^3/hr)	Supply Vessel Capacity	Offload Duration (hrs)	Sandia Zone 3 (ft)	59A LFL/2	Controlling Draft (ft)	Volume of Dredging Required (yd^3)
1	Regas Barge with onboard storage, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon. Note this is not a designated lightering zone.	Pier 15/16														
			125	125,000	19.26	3	16.26	107,477	17,523	8,000	85,000	13			36.9	
			125	80,000	12.33	3	9.33	62,477	17,523	6,000	50,000	10			32.0	
			125	60,000	9.24	3	6.24	42,477	17,523	5,000	30,000	8			28.7	
2	Regas Barge with LNG Carrier landing direct import.	Pier 15/16														
			125	125,000	19.26	3	16.26	107,477	17,523	8,000	145,000	20			40.2	
			125	80,000	12.33	3	9.33	62,477	17,523	6,000	85,000	16			36.9	
3	FSRU moored at pier LNG Carrier landing direct import.	Pier 15/16														
			125	165,000	25.42	3	22.42	147,477	17,523	10,000	145,000	16			40.2	
			125	125,000	19.26	3	16.26	107,477	17,523	8,000	85,000	13			36.9	
4	FSU with vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pier 15/16														
			125	125,000	19.26	3	16.26	107,477	17,523	8,000	85,000	13			36.9	
			125	80,000	12.33	3	9.33	62,477	17,523	6,000	50,000	10			32.0	
			125	60,000	9.24	3	6.24	42,477	17,523	5,000	30,000	8			28.7	
5	Storage and vaporization ashore, LNG provided by LNG Carrier	Pier 15/16														
	1 x 160,000 tank		125	160,000	24.65	3	21.65	142,477	17,523	8,000	85,000	13			36.9	
	2 x 80,000 tanks															
	1 x 120,000 tank		125	120,000	18.49	3	15.49	102,477	17,523	6,000	50,000	10			32.0	
	2 x 60,000 tank															
	1 x 80,000 tank		125	80,000	12.33	3	9.33	62,477	17,523	5,000	30,000	8			28.7	
	1 x 60,000 tank		125	60,000	9.24	3	6.24	42,477	17,523	5,000	30,000	8			28.7	
5	Storage and vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pier 15/16														
	1 x 160,000 tank		125	160,000	24.65	3	21.65	142,477	17,523	8,000	85,000	13			36.9	
	2 x 80,000 tanks		125	160,000	24.65	3	21.65	142,477	17,523	8,000	85,000	13			36.9	
	1 x 120,000 tank		125	120,000	18.49	3	15.49	102,477	17,523	6,000	50,000	10			32.0	
	2 x 60,000 tank		125	120,000	18.49	3	15.49	102,477	17,523	6,000	50,000	10			32.0	
	1 x 80,000 tank		125	80,000	12.33	3	9.33	62,477	17,523	5,000	30,000	8			28.7	
	1 x 60,000 tank		125	60,000	9.24	3	6.24	42,477	17,523	5,000	30,000	8			28.7	
	3 x 40,000 tank		125	120,000	18.49	3	15.49	102,477	17,523	5,000	30,000	8			28.7	
6	Regas Barge with onboard storage, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon. Note this is not a designated lightering zone.	Liquids Dock														
			125	125,000	19.26	3	16.26	107,477	17,523	8,000	85,000	13			36.9	
			125	80,000	12.33	3	9.33	62,477	17,523	6,000	50,000	10			32.0	
			125	60,000	9.24	3	6.24	42,477	17,523	5,000	30,000	8			28.7	
7	Regas Barge with LNG Carrier landing direct import.	Liquids Dock														
			125	125,000	19.26	3	16.26	107,477	17,523	8,000	145,000	20			40.2	
			125	80,000	12.33	3	9.33	62,477	17,523	6,000	85,000	16			36.9	
8	FSRU moored at pier LNG Carrier landing direct import.	Liquids Dock														
			125	165,000	25.42	3	22.42	147,477	17,523	10,000	145,000	16			40.2	
			125	125,000	19.26	3	16.26	107,477	17,523	8,000	85,000	13			36.9	
9	FSU with vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Liquids Dock														
			125	125,000	19.26	3	16.26	107,477	17,523	8,000	85,000	13			36.9	
			125	80,000	12.33	3	9.33	62,477	17,523	6,000	50,000	10			32.0	
			125	60,000	9.24	3	6.24	42,477	17,523	5,000	30,000	8			28.7	
10	Storage and vaporization ashore, LNG provided by LNG Carrier	Liquids Dock														
	1 x 160,000 tank		125	160,000	24.65	3	21.65	142,477	17,523	8,000	85,000	13			36.9	
	2 x 80,000 tanks															
	1 x 120,000 tank		125	120,000	18.49	3	15.49	102,477	17,523	6,000	50,000	10			32.0	
	2 x 60,000 tank															
	1 x 80,000 tank		125	80,000	12.33	3	9.33	62,477	17,523	5,000	30,000	8			28.7	
	1 x 60,000 tank		125	60,000	9.24	3	6.24	42,477	17,523	5,000	30,000	8			28.7	
11	FSRU on weathervaning buoy approximately 3 miles offshore with gas feed line landing in vicinity of west tip of Ensanada de Boca Vieja, HDD approximately 3 miles to Palo Seco	Liquids Dock														
			125	165,000	25.42	3	22.42	147,477	17,523	8,000	85,000	13			36.9	

Appendix 1

Attachment 2

Critical Issue Summary Matrix

Appendix 1 Attachement 2 Critical Issue Summary Matrix

Case No.	Sendout Location	Description		Fatal Flaws	Critical Issues	
		LNG and Regasification	Pipeline(s)		Dredging & Disposal / Benthic Impacts	Land Use / Aesthetics / Cultural
1	Pier 15/16	Regas Barge with onboard storage, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon. Note this is not a designated lightering zone.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Minor - additional vessels at piers
2	Pier 15/16	Regas Barge with LNG Carrier landing direct import.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Minor - additional vessels at piers
3	Pier 15/16	FSRU moored at pier LNG Carrier landing direct import.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Moderate - FSRU will be viaible from the Convention Center
4	Pier 15/16	FSU with vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Minor - additional vessels at piers
5a	Pier 15/16	Storage and vaporization ashore, LNG provided by LNG Carrier	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Moderate - onshore LNG storage tanks
5b	Pier 15/16	Storage and vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Moderate - onshore LNG storage tanks
6	Liquids Dock	Regas Barge with onboard storage, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon. Note this is not a designated lightering zone.	Pipeline from San Juan Power Plant to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Minor - additional vessels
7	Liquids Dock	Regas Barge with LNG Carrier landing direct import.	Pipeline from San Juan Power Plant to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Minor - additional vessels
8	Liquids Dock	FSRU moored at pier LNG Carrier landing direct import.	Pipeline from San Juan Power Plant to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Minor - additional vessels
9	Liquids Dock	FSU with vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline from San Juan Power Plant to Palo Seco[1]	None	Minor - no significant dredging	Minor - additional vessels

Appendix 1 Attachement 2 Critical Issue Summary Matrix

Case No.	Sendout Location	Description		Fatal Flaws	Critical Issues	
		LNG and Regasification	Pipeline(s)		Dredging & Disposal / Benthic Impacts	Land Use / Aesthetics / Cultural
10	Liquids Dock	Storage and vaporization ashore, LNG provided by LNG Carrier	Pipeline from San Juan Power Plant to Palo Seco[1]	None	Moderate - There will be significant dredging but the permitting effort will not be the critical path issue.	Moderate - onshore LNG storage tanks
11	Offshore (North)	FSRU on weathervaning buoy approximately 3 miles offshore with gas feed line landing in vicinity of west tip of Ensanada de Boca Vieja, HDD approximately 3 miles to Palo Seco	Pipeline 1 - subsea from FSRU to western tip of Ensanada de Boca Vieja; Pipeline 2 - landing point to Palo Seco; Pipeline 3 - Palo Seco to San Juan[1]	None	Potential - pipeline in potential coral reef area	High:[2] Visible from registered historic structures Within "pristine" viewshed
Cross Bay Pipeline	Pier 15/16		Pipeline from Pier 15/16 to San Juan Power Plant	None	It is assumed that the pipeline could be constructed with Horizontal Directional Drilling (HDD) which will have a minore impact on the benthos of the bay during construction.	None
On Shore Pipeline Route 1	San Juan Power Plant		Pipeline from San Juan Power Plant to Palo Seco along route proposled in Val Verde EIS.	None	None	Potentially High - This pipeline will be difficult to permit because of the proximity to roads and industrial sources.
Onshore Pipeline Route 2	San Juan Power Plant		Pipeline from San Juan Power Plant to Palo Seco along highway 165.	None	None	High - This pipeline will be very difficult to permit because of the proximity to roads, residences, and the potential impact to environmentally sensitive areas.
Under Water Pipeline from FSRU	San Juan Power Plant		Under Water Pipeline from FSRU	None	Potential - pipeline in potential coral reef area	None
Offshore Pipeline from San Juan power plant to Palo Seco power plant	San Juan Power Plant		Pipeline from San Juan power plant to Palo Seco power plant offshore through San Juan Bay.	None	It is assumed that the pipeline could be constructed with Horizontal Directional Drilling (HDD) which will have a minor impact on the benthos of the bay during construction.	Moderate – construction and pullback workspace in harbor highly visible during construction (temporary)

[1] The impacts from the pipelines (Pier 15/16 to San Juan Power Plant and San Juan to Palo Seco) are addressed as Cases 12 and 13.

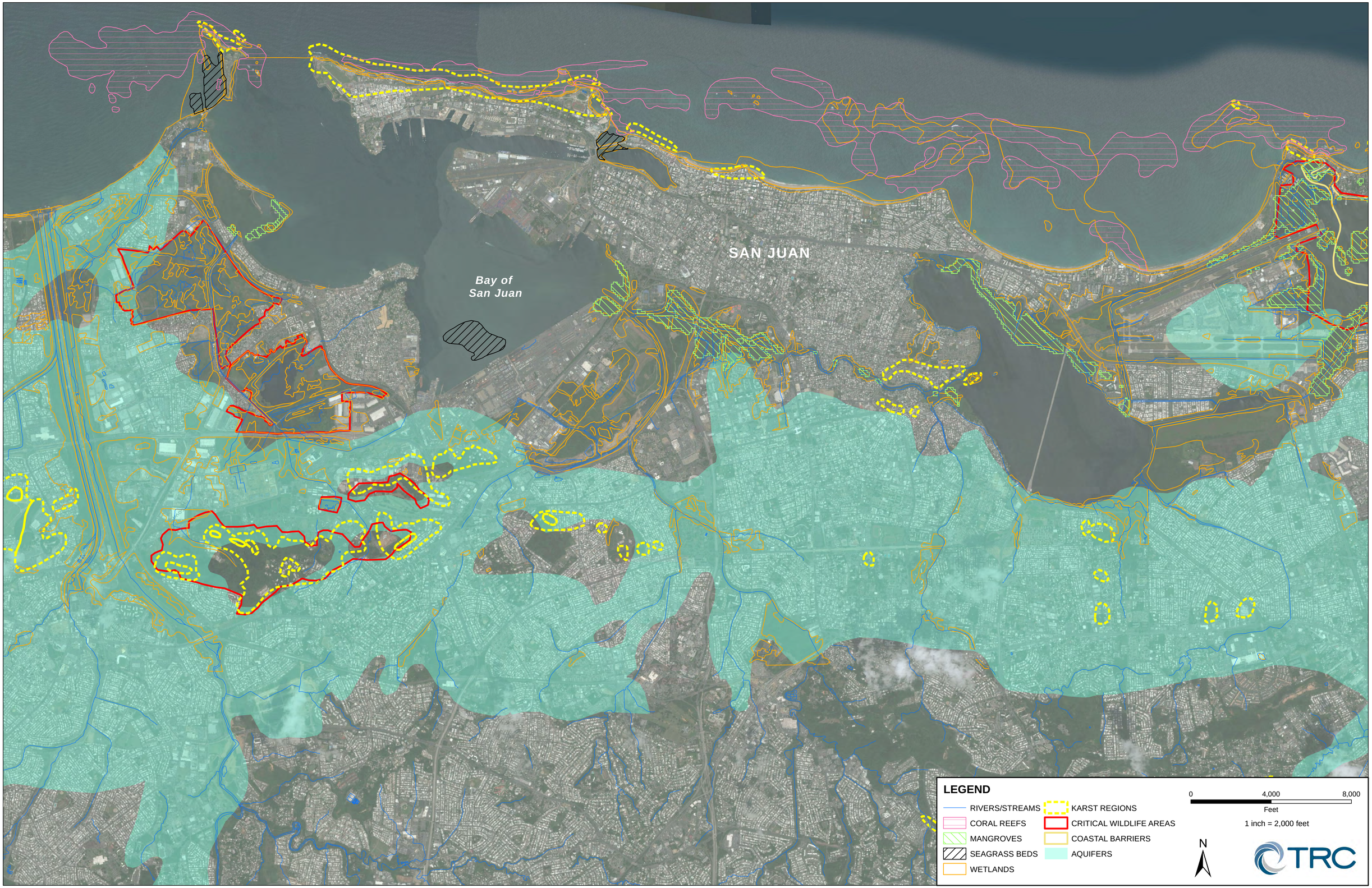
[2] Mitigation is to move the facility. Is there a location it can it be moved to a location that would not be a concern?

Color	Impact
	High
	Potentially High
	Moderate
	Minor
	None
	Potential Issue, need more information.

Appendix 1

Attachment 3

Map of Environmentally Sensitive Zones


SAN JUAN
Bay of
San Juan
LEGEND
RIVERS/STREAMS
CORAL REEFS
MANGROVES
SEAGRASS BEDS
WETLANDS
KARST REGIONS
CRITICAL WILDLIFE AREAS
COASTAL BARRIERS
AQUIFERS
0
4,000
8,000
Feet
1 inch = 2,000 feet
N
TRC

Appendix 1

Attachment 4

Detailed Matrix of Proposed Impacts

Appendix 1 Attachment 4

Case No.	Sendout Location	Description		Fatal Flaws	Offshore Impacts	In-Harbor Impacts		
		LNG and Regasification	Pipeline(s)		Benthic	Benthic	Fisheries	Transportation
1	Pier 15/16	Regas Barge with onboard storage, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon. Note this is not a designated lightering zone.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	None	Moderate - There will be significant dredging. Channel dredging for LNG carriers would increase turbidity and has the potential to impact benthic communities. The permitting effort will not be the critical path issue.	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic
2	Pier 15/16	Regas Barge with LNG Carrier landing direct import.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	None	Moderate - There will be significant dredging. Channel dredging for LNG carriers would increase turbidity and has the potential to impact benthic communities. The permitting effort will not be the critical path issue.	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic
3	Pier 15/16	FSRU moored at pier LNG Carrier landing direct import.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	None	Moderate - There will be significant dredging. Channel dredging for LNG carriers would increase turbidity and has the potential to impact benthic communities. The permitting effort will not be the critical path issue.	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic
4	Pier 15/16	FSU with vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	None	Moderate - There will be significant dredging. Channel dredging for LNG carriers would increase turbidity and has the potential to impact benthic communities. The permitting effort will not be the critical path issue.	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic
5a	Pier 15/16	Storage and vaporization ashore, LNG provided by LNG Carrier	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	None	Moderate - There will be significant dredging. Channel dredging for LNG carriers would increase turbidity and has the potential to impact benthic communities. The permitting effort will not be the critical path issue.	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic
5b	Pier 15/16	Storage and vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	None	None	Moderate - There will be significant dredging. Channel dredging for LNG carriers would increase turbidity and has the potential to impact benthic communities. The permitting effort will not be the critical path issue.	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic
6	Liquids Dock	Regas Barge with onboard storage, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon. Note this is not a designated lightering zone.	Pipeline from San Juan Power Plant to Palo Seco[1]	None	None	None	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic. Marine vessels at the liquids terminal location will have the largest impact on existing in-harbour traffic.
7	Liquids Dock	Regas Barge with LNG Carrier landing direct import.	Pipeline from San Juan Power Plant to Palo Seco[1]	None	None	None	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic. Marine vessels at the liquids terminal location will have the largest impact on existing in-harbour traffic.

Appendix 1 Attachment 4

Case No.	Sendout Location	Description		Fatal Flaws	Offshore Impacts	In-Harbor Impacts		
		LNG and Regasification	Pipeline(s)		Benthic	Benthic	Fisheries	Transportation
8	Liquids Dock	FSRU moored at pier LNG Carrier landing direct import.	Pipeline from San Juan Power Plant to Palo Seco[1]	None	None	None	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic. Marine vessels at the liquids terminal location will have the largest impact on existing in-harbour traffic.
9	Liquids Dock	FSU with vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline from San Juan Power Plant to Palo Seco[1]	None	None	None	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic. Marine vessels at the liquids terminal location will have the largest impact on existing in-harbour traffic.
10	Liquids Dock	Storage and vaporization ashore, LNG provided by LNG Carrier	Pipeline from San Juan Power Plant to Palo Seco[1]	None	None	None	Potential entrainment/ impingement impacts on ichthyoplankton during regasification	New vessel traffic could impact existing in-harbor vessel traffic. Marine vessels at the liquids terminal location will have the largest impact on existing in-harbour traffic.
11	Offshore (North)	FSRU on weathervaning buoy approximately 3 miles offshore with gas feed line landing in vicinity of west tip of Ensanada de Boca Vieja, HDD approximately 3 miles to Palo Seco	Pipeline 1 - subsea from FSRU to western tip of Ensanada de Boca Vieja; Pipeline 2 - landing point to Palo Seco; Pipeline 3 - Palo Seco to San Juan[1]	None	Moorings and sendout pipeline (direct and secondary impacts - footprint, sedimentation, and turbidity)	None	None	None
12	Pier 15/16		Pipeline from Pier 15/16 to San Juan Power Plant		None	Minor - Horizontal Directional Drilling (HDD) will have a minor impact.	Minor - Horizontal Directional Drilling (HDD) will have a minor impact.	There could be minor disruptioons to marine traffic during construction
13	San Juan Power Plant		Pipeline from San Juan Power Plant to Palo Seco along route proposled in Val Verde EIS.			None	None	None
14	San Juan Power Plant		Pipeline from San Juan Power Plant to Palo Seco along highway 165.	None	None	None	None	None
15	San Juan Power Plant		Pipeline from San Juan power plant to Palo Seco power plant offshore through San Juan Bay.	None	None	Minor – if HDD installation feasible Moderate/major – if trenching methods proposed	Minor – if HDD installation feasible Moderate – if trenching methods proposed	Moderate disruptions to commercial and recreational marine traffic during construction.

[1] The impacts from the pipelines (Pier 15/16 to San Juan Power Plant and San Juan to Palo Seco) are addressed as Cases 12-15.
[2] Mitigation is to move the facility. Is there a location it can it be moved to a location that would not be a concern?

Color	Impact
	High
	Potentially High
	Moderate
	Minor
	None
	Potential Issue, need more information.

Case No.	Sendout Location	Description		On-Shore Impacts			
		LNG and Regasification	Pipeline(s)	Water Use / Quality	Wetlands / Wildlife	Land Use/Aesthetics/Cultural	Air Quality
1	Pier 15/16	Regas Barge with onboard storage, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon. Note this is not a designated lightering zone.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Minor - more marine vessels at Pier 15/16	Potential air impacts from combustion sources associated with regasification
2	Pier 15/16	Regas Barge with LNG Carrier landing direct import.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Minor - more vessels at Pier 15/16	Potential air impacts from combustion sources associated with regasification
3	Pier 15/16	FSRU moored at pier LNG Carrier landing direct import.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Moderate - more vessels at Pier 15/16 and permanent FSRU	Potential air impacts from combustion sources associated with regasification
4	Pier 15/16	FSU with vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Minor - more vessels at Pier 15/16	Potential air impacts from combustion sources associated with regasification
5a	Pier 15/16	Storage and vaporization ashore, LNG provided by LNG Carrier	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Potentially significant - onshore storage tanks	Potential air impacts from combustion sources associated with regasification
5b	Pier 15/16	Storage and vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline 1 - Pier 15/16 to San Juan Power Plant; Pipeline 2 from San Juan to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Potentially significant - onshore storage tanks	Potential air impacts from combustion sources associated with regasification
6	Liquids Dock	Regas Barge with onboard storage, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon. Note this is not a designated lightering zone.	Pipeline from San Juan Power Plant to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Minor - more vessels at Liquids Dock	Potential air impacts from combustion sources associated with regasification. The negative impact will be largest at the liquids terminal because of the other soruces in the area.
7	Liquids Dock	Regas Barge with LNG Carrier landing direct import.	Pipeline from San Juan Power Plant to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Minor - more vessels at Liquids Dock	Potential air impacts from combustion sources associated with regasification. The negative impact will be largest at the liquids terminal because of the other soruces in the area.

Case No.	Sendout Location	Description		On-Shore Impacts			
		LNG and Regasification	Pipeline(s)	Water Use / Quality	Wetlands / Wildlife	Land Use/Aesthetics/Cultural	Air Quality
8	Liquids Dock	FSRU moored at pier LNG Carrier landing direct import.	Pipeline from San Juan Power Plant to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Moderate - more vessels at Liquids Dock and permanent FSRU	Potential air impacts from combustion sources associated with regasification. The negative impact will be largest at the liquids terminal because of the other soruces in the area.
9	Liquids Dock	FSU with vaporization ashore, LNG provided by Shuttle Tanker using STS in area of Guayanilla Canyon.	Pipeline from San Juan Power Plant to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Moderate - more vessels at Liquids Dock and permanent FSU	Potential air impacts from combustion sources associated with regasification. The negative impact will be largest at the liquids terminal because of the other soruces in the area.
10	Liquids Dock	Storage and vaporization ashore, LNG provided by LNG Carrier	Pipeline from San Juan Power Plant to Palo Seco[1]	Potential aquifer impacts from groundwater withdrawal	None	Moderate - onshore storage tanks	Potential air impacts from combustion sources associated with regasification. The negative impact will be largest at the liquids terminal because of the other sources in the area.
11	Offshore (North)	FSRU on weathervaning buoy approximately 3 miles offshore with gas feed line landing in vicinity of west tip of Ensanada de Boca Vieja, HDD approximately 3 miles to Palo Seco	Pipeline 1 - subsea from FSRU to western tip of Ensanada de Boca Vieja; Pipeline 2 - landing point to Palo Seco; Pipeline 3 - Palo Seco to San Juan[1]	None	None	High - FSRU visible from Ensanada de Boca Vieja beaches.	Potential air impacts from combustion sources associated with regasification
12	Pier 15/16		Pipeline from Pier 15/16 to San Juan Power Plant	None	None	None	None
13	San Juan Power Plant		Pipeline from San Juan Power Plant to Palo Seco along route proposled in Val Verde EIS.		Potential impacts to wetlands and wildlife from San Juan to Palo Seco pipeline	Potentially High - This pipeline will be difficult to permit because of the proximity to roads and industrial sources.	
14	San Juan Power Plant		Pipeline from San Juan Power Plant to Palo Seco along highway 165.	None	Potential impacts to wetlands and wildlife from San Juan to Palo Seco pipeline	High - This pipeline will be very difficult to permit because of the proximity to roads, residences, and the potential impact to environmentally sensitive areas.	None
15	San Juan Power Plant		Pipeline from San Juan power plant to Palo Seco power plant offshore through San Juan Bay.	Minor – if HDD installation feasible Moderate – if trenching methods proposed Temporary	None	Moderate – construction and pullback workspace in harbor highly visible during construction (temporary)	None

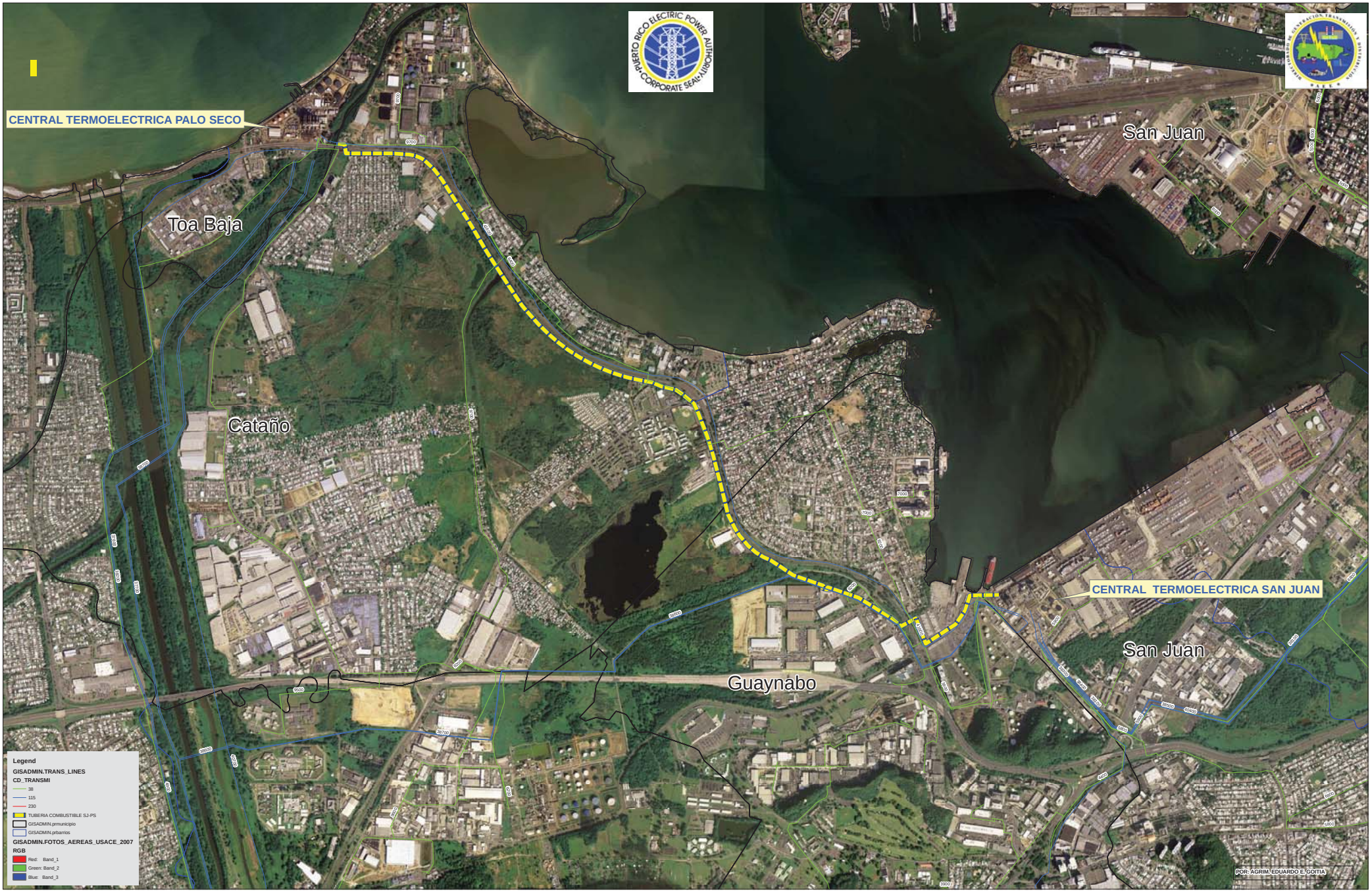
[1] The impacts from the pipelines (Pier 15/16 to San Juan Power Plant and San Juan to Palo Seco) are addressed as Cases 12-15.
[2] Mitigation is to move the facility. Is there a location it can it be moved to a location that would not be a concern?

Color	Impact
	High
	Potentially High
	Moderate
	Minor
	None
	Potential Issue, need more information.

Appendix 1

Attachment 5

Map of the Proposed Pipeline Routes Between San Juan Power Plant and Palo Seco Power Plant


CENTRAL TERMOELECTRICA PALO SECO
Toa Baja
Cataño
Guaynabo
San Juan
San Juan
CENTRAL TERMOELECTRICA SAN JUAN
PUERTO RICO ELECTRIC POWER AUTHORITY
CORPORATE SEAL AUTHORITY
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CD_TRANSMI
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115
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TUBERIA COMBUSTIBLE SJ-PS
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GISADMIN.prbarrios
GISADMIN.FOTOS_AEREAS_USACE_2007
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
POR: AGRIM. EDUARDO E. GOITIA


Offshore Route
N
0
1,000
2,000
Feet
Coordinate System: NAD 1983 StatePlane Puerto Rico Virgin Islands FIPS 5200 Feet

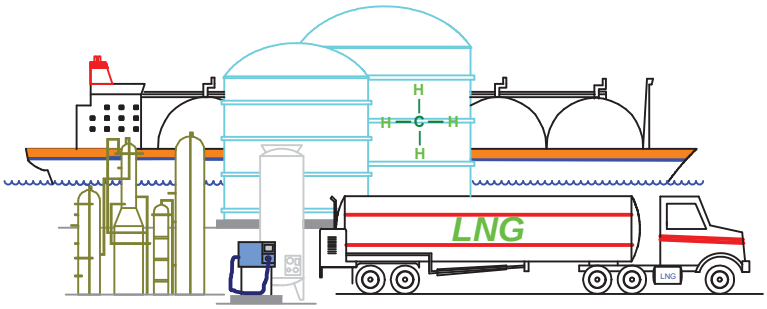
SAN JUAN LNG IMPORT TERMINAL

FEASIBILITY AND OPTION STUDY

Prepared for ~

Galway Group, LLC

Prepared by ~



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CH·IV International Document: 14909-TR-000-01

May 21, 2015

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1 INTRODUCTION

The Puerto Rico Electric Power Authority (PREPA) is exploring the feasibility of various options to provide alternate fuel delivery to its power generation equipment at its San Juan Power Plant and its Palo Seco Power Plant. PREPA seeks to introduce alternative fuel equivalent to approximately 5,841 m^3/day of LNG. Accordingly, PREPA wishes to examine options in landing LNG at a receiving terminal for regasification and transmission to the two existing power plants.

2 SCOPE OF STUDY

This Feasibility and Option Study is targeted to (a) develop and examine a full range of LNG and CNG delivery options, (b) consider available sites, (c) quantify various terminal configurations, site attributes and key differentiators within the context of each option's specific engineering challenges, solutions, associated commercial impacts, and regulatory environment. The Feasibility and Option Study shall provide PREPA with an options analysis leading to, and in support of, final conclusions and recommendations for a terminal configuration and site location.

CH·IV International (CH·IV) has identified several technology options for importing LNG and CNG and has also identified potential locations for each. CH·IV has studied each option and location to determine the technical feasibility of each. The purpose of this report is to:

- Describe the findings of the evaluation performed for each option,
- Identify potential fatal flaws for each option, and
- Describe those options for which no fatal flaws were evident and which should be considered further.

3 LNG TERMINAL DESIGN CONSIDERATIONS

3.1 LNG Receipt and Natural Gas Sendout Requirements

PREPA has estimated that the targeted annual LNG landing volume for the Project is approximately 1 million tonnes annually (1.0 MTPA) which is equivalent to approximately 125 MMSCFD of natural gas sendout. Baseload consumers of the natural gas send out are anticipated to include planned conversions at Palo Seco and the San Juan Power (Combined Cycle and Thermoelectric) facilities and expansion at the Palo Seco facility.

3.2 LNG Storage Considerations and Requirements

For the design of any LNG facility, the quantity of LNG to be stored either offshore or onshore is generally a function of:

- Terminal natural gas sendout rate and the desired minimum number of days storage at full sendout rate;
- Availability at Terminal berth; and
- LNG Carrier logistics and specifics, including source of LNG, transit time, Carrier availability and size (i.e. number and size of LNG Carriers available to supply the facility).

The business model base case assumption presented by the Project is an annual delivery of 1,000,000 tonnes of LNG. Assuming a baseload demand of 125 MMSCFD, this Feasibility and Option Study assumes the following capacities:

- FSRU storage capacity of 165,000 m^3 for near-shore solutions,
- FSU storage capacity of ≤125,000 m^3 for near-shore solutions,
- Aggregate LNG storage capacity of 160,000 m^3 for on-shore solutions, and
- LNG carrier capacity of ≤145,000 m^3.
- Other related considerations – for LNG Carrier transits, a minimum channel width requirement of 400 feet is assumed.

4 LOCATIONS CONSIDERED

Subsequent to performing site visits and desktop research, CH·IV identified several general areas for potentially siting offshore and/or onshore LNG infrastructure facilities. Each area is described below.

4.1 Option 1: Regasification Barge at Pier 15/16 with Shuttle Delivery

This option comprises a non-self-propelled vessel with onboard regasification capability and ≤125,000 m^3 storage capacity to be moored dockside in way of Pier 15/16. Cargo delivery would be provided by shuttle tanker through ship – to – ship (STS) transfer in the area of Guayanilla Canyon.

This option provides receipt and storage of LNG aboard the FSRU and vaporization of the LNG to natural gas via on board regasification. The natural gas from the on board regasification process would be sent to an onshore pipeline co-located at the facility and then to a subsea pipeline crossing San Juan Bay to the San Juan power plant.

From its San Juan power plant riser, the pipeline would bifurcate to provide feed gas for San Juan power plant prime movers and an additional pipeline to be run to provide feed gas for the Palo Seco facility.

Figure 4.1: Pier 15/16 Location

4.2 Option 2: Regasification Barge at Pier 15/16 with LNG Carrier Delivery

Similar to Option 1, this option comprises a non-self-propelled vessel with onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of Pier 15/16. In this option, cargo delivery would be provided by an LNG Carrier entering San Juan Bay to transfer cargo directly to Regasification Barge through either STS or through plant piping arrangement at marine jetty.

As before, this option provides receipt and storage of LNG aboard the regasification barge and vaporization of the LNG via on board regasification with pipeline as described in Option 1.

Figure 4.2: Guayanilla Canyon

4.3 Option 3: FSRU at Pier 15/16 with LNG Carrier Delivery

This option comprises a self-propelled Floating Storage and Regasification Unit (FSRU) with onboard regasification capability and ≤165,000 m³ storage capacity to be moored dockside in way of Pier 15/16. In this option, cargo delivery would be provided by an LNG Carrier entering San Juan Bay to transfer cargo directly to FSRU through either STS or through plant piping arrangement at marine jetty.

As before, this option provides receipt and storage of LNG aboard the FSRU and vaporization of the LNG to natural gas via on board regasification with pipeline as described in Option 1.

4.4 Option 4: FSU at Pier 15/16 with Shuttle Delivery

This option comprises a Floating Storage Unit (FSU), either self-propelled or non-self-propelled, with no onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of Pier 15/16. Cargo delivery would be provided by shuttle tanker through STS transfer in the area of Guayanilla Canyon.

This arrangement provides for the FSU to pump LNG to the co-located shoreside facility for vaporization and send – out through the pipeline arrangement described in the earlier options.

4.5 Option 5: Storage and Vaporization at Pier 15/16

This option comprises a "conventional" shoreside LNG receiving terminal with storage and vaporization to shore and cargo provided through LNG Carrier. LNG storage considered in this case is an aggregate of 160,000 m³ through the use of two 80,000 m³ full containment tanks.

Distribution of gas to the San Juan and Palo Seco power plants is as earlier described.

4.6 Option 6: Regasification Barge at Army Dock with Shuttle Delivery

This option comprises a non-self-propelled vessel with onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of the Army Dock on the west side of the San Juan Power Plant. Cargo delivery would be provided by shuttle tanker through STS transfer in the area of Guayanilla Canyon.

This option provides receipt and storage of LNG aboard the FSRU and vaporization of the LNG to natural gas via on board regasification. The natural gas from the on board regasification process would be sent to an onshore pipeline co-located at the facility and bifurcated to provide feed gas to the San Juan power plant into a pipeline providing feed gas to Palo Seco.

4.7 Option 7: Regasification Barge at Army Dock with LNG Carrier Delivery

Similar to Option 6, this option comprises a non-self-propelled vessel with onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of the Army Dock. In this option, cargo delivery would be provided by an LNG Carrier entering San Juan Bay to transfer cargo directly to Regasification Barge through either STS or through plant piping arrangement at marine jetty.

As before, this option provides receipt and storage of LNG aboard the Regasification Barge and vaporization of the LNG via on board regasification with pipeline as described in Option 6.

4.8 Option 8: FSRU at Army Dock with LNG Carrier Delivery

This option comprises a self-propelled FSRU with onboard regasification capability and ≤165,000 m³ storage capacity to be moored dockside in way of the Army Dock. In this option, cargo delivery would be provided by an LNG Carrier entering San Juan

Bay to transfer cargo directly to FSRU through either STS or through plant piping arrangement at marine jetty.

As before, this option provides receipt and storage of LNG aboard the FSRU and vaporization of the LNG to natural gas via on board regasification with pipeline as described in Option 6.

Figure 4.3: Army Dock

4.9 Option 9: FSU at the Army Dock with Shuttle Delivery

This option comprises an FSU, either self-propelled or non-self-propelled, with no onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of the Army Dock. Cargo delivery would be provided by shuttle tanker through STS transfer in the area of Guayanilla Canyon.

This arrangement provides for the FSU to pump LNG to the co-located shoreside facility for vaporization and sendout through the pipeline arrangement described in the earlier options for the Army Dock.

4.10 Option 10: Storage and Vaporization at the Army Dock

This option comprises "conventional" shoreside LNG receiving terminal with storage and vaporization to shore and cargo provided through LNG Carrier. LNG storage considered in this case is an aggregate of 160,000 m³ through the use of two 80,000 m³ full containment tanks.

Distribution of gas to the San Juan and Palo Seco power plants is as earlier described in the Army Dock options.

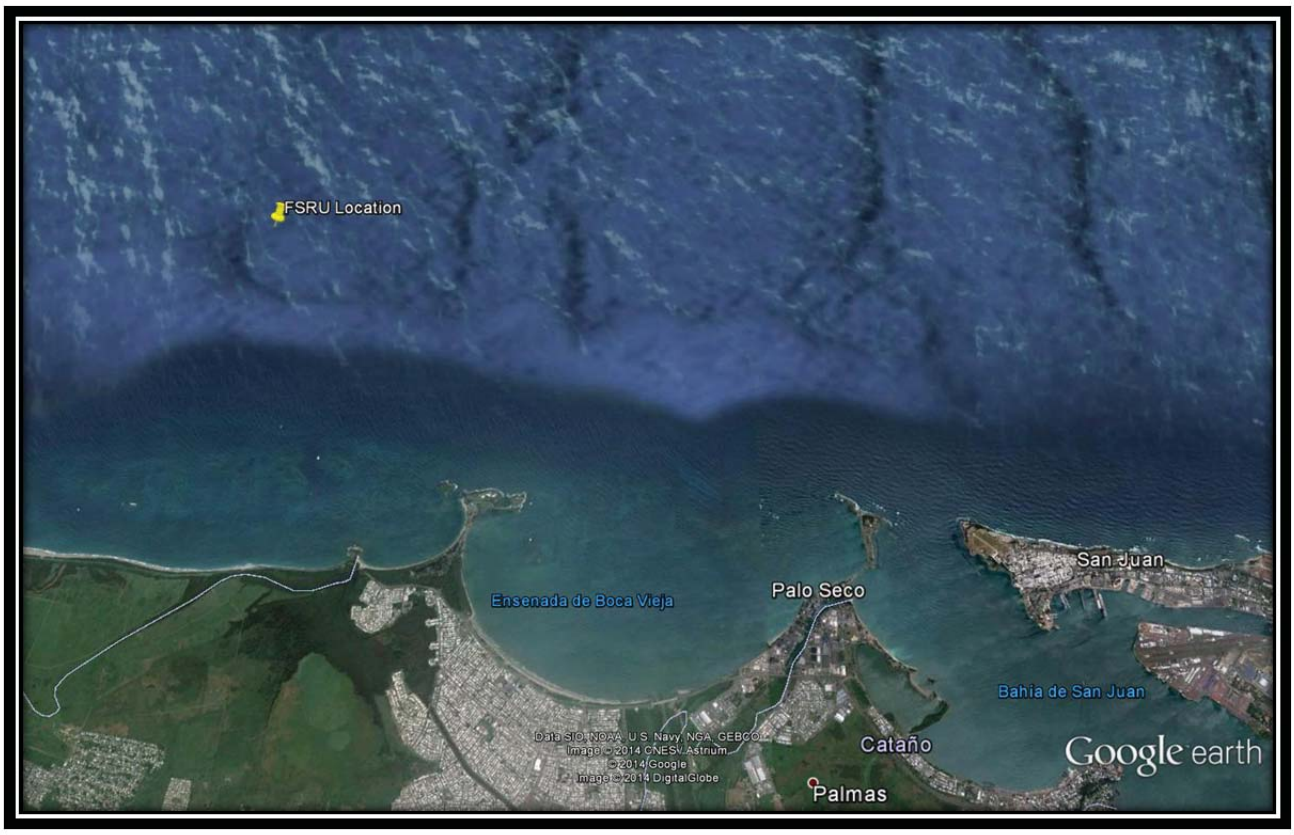

Figure 4.4: FSRU Location

4.11 Option 11: FSRU Moored Offshore

This option comprises an FSRU of ≤165,000 m³ storage capacity moored at approximately 3 miles offshore as depicted in the figure. The moored FSRU would send out natural gas through a riser/PLEM assembly to a sub-seabed pipeline landing in the vicinity of the West tip of Ensenada de Boca Vieja and from there the pipeline would be horizontally directionally drilled to a pipeline riser at the Palo Seco site. At

the Palo Seco site, the pipeline would bifurcate with one line providing feed gas to the Palo Seco prime movers and the other providing feed gas to a pipeline to run to the San Juan power plant.

4.12 Option 12: CNG Barge Moored at Pier 15/16

This option comprises a non-self-propelled vessel with onboard CNG storage to be moored dockside in way of Pier 15/16. This option requires marine civil works adequate to provide mooring for two vessels simultaneously in order to avoid feed gas interruption. This option provides storage of CNG aboard the vessel and discharge of the CNG to be sent from the vessel to an onshore pipeline co-located at the facility and then to a subsea pipeline crossing San Juan Bay to the San Juan power plant.

From its San Juan power plant riser, the pipeline would bifurcate to provide feed gas for San Juan power plant prime movers and an additional pipeline to be run to provide feed gas for the Palo Seco facility.

4.13 Option 13: CNG Barge Moored at Army Dock

This option comprises a non-self-propelled vessel with onboard CNG storage to be moored dockside in way of the Army Dock. This option requires marine civil works adequate to provide mooring for two vessels simultaneously in order to avoid feed gas interruption. This option provides storage of CNG aboard the vessel and discharge of the CNG to be sent from the vessel to an onshore pipeline co-located at the facility and bifurcated to provide feed gas to the San Juan power plant into a pipeline providing feed gas to Palo Seco.

4.14 Option 14: Storage and Vaporization at the San Juan Power Plant Extended

This option comprises “conventional” shoreside LNG receiving terminal with storage and vaporization to shore and cargo provided through LNG Carrier. LNG storage considered in this case is an aggregate of 160,000 m^3 through the use of two 80,000 m^3 full containment tanks.

Distribution of gas to the San Juan and Palo Seco power plants is as earlier described in the Army Dock options.

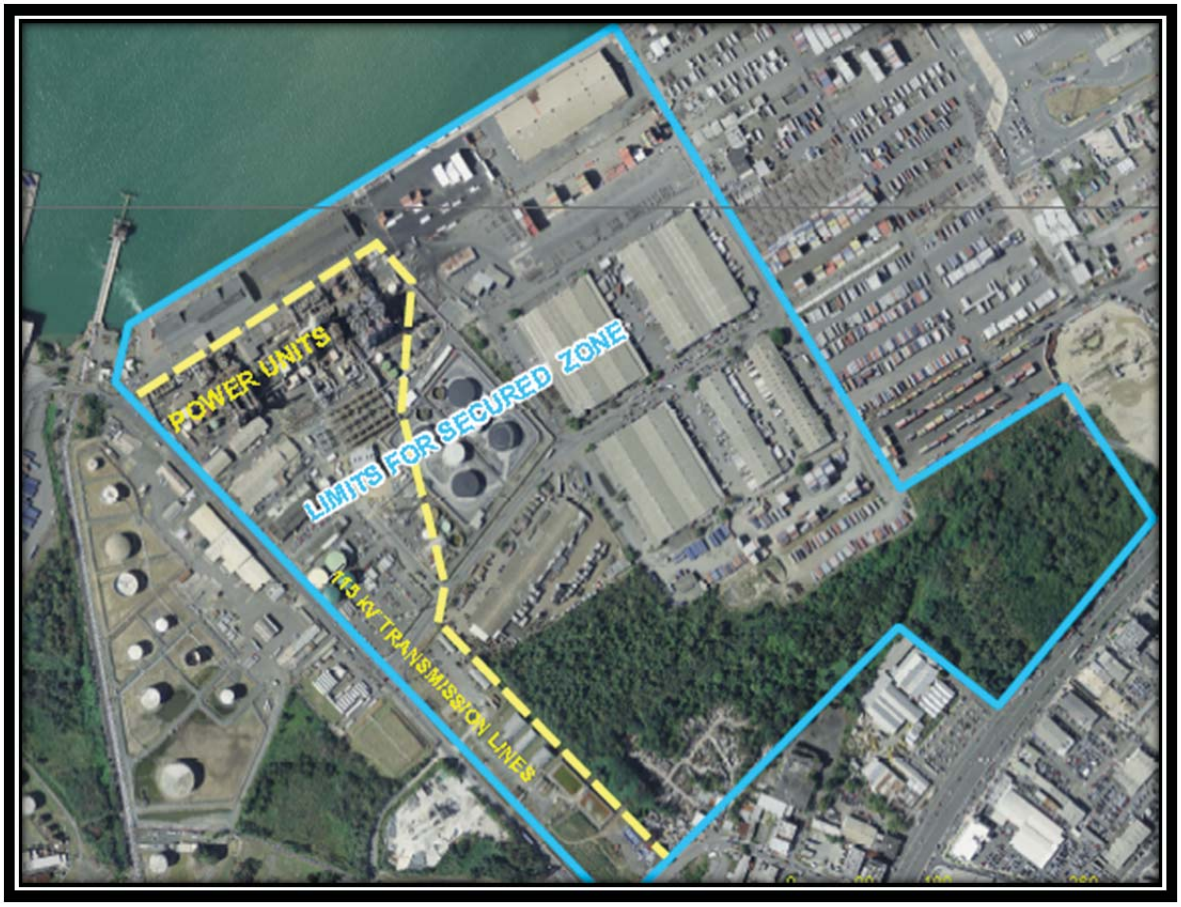

Figure 4.5: San Juan Power Plant Extended Location

5 REGULATORY CONSIDERATIONS

In assessing the feasibility of any project, it is critical to have a thorough working knowledge of the regulatory environment within which the project will be sited, constructed and operated in order to understand any risks associated with the suitability of the project proposed integrating into the regulatory environment.

The product as proposed would require the commercial latitude to receive LNG from non-US ports. As such, the facility would be FERC jurisdictional. This arrangement is viewed as a net positive for the project in that the FERC process has a long history, is well-established and predictable and is attended by relatively little uncertainty. Indeed, this arrangement is preferable as a non-jurisdictional facility would introduce the need to craft a "one-off" state and local government permitting process. With two notable exceptions, issues considered by other cooperating federal agencies typically participating in the FERC process are also predictable; the exceptions merit discussion and are:

- the application of 49 CFR Part 193 by the Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA);
- application of public impact/siting requirements (proscriptive versus advisory) for floating terminal infrastructure considered to be "permanently moored craft" under the US Coast Guard's 2009 policy.

5.1 Part 193 Applicability

49 CFR Part 193 includes the following applicability requirements:

§ 193.2001 Scope of part.

(a) This part prescribes safety standards for LNG facilities used in the transportation of gas by pipeline that is subject to the pipeline safety laws (49 U.S.C. 60101 et seq.) and Part 192 of this chapter.

(b) This part does not apply to:

(1) LNG facilities used by ultimate consumers of LNG or natural gas.

(2) LNG facilities used in the course of natural gas treatment or hydrocarbon extraction which do not store LNG.

(3) In the case of a marine cargo transfer system and associated facilities, any matter other than siting pertaining to the system or facilities between the marine vessel and the last manifold (or in the absence of a manifold, the last valve) located immediately before a storage tank.

(4) Any LNG facility located in navigable waters (as defined in Section 3(8) of the Federal Power Act (16 U.S.C. 796(8)).

Of particular interest is §193.2001 (b) (1) in bold text above. It is Project's intent to utilize all landed LNG solely as feed gas for its power generation prime movers. As such, the Project would likely satisfy §193.2001 (b) (1) and not be subject to the requirements of Part 193. This exemption from the requirements of Part 193 is, on its face, significant in that the Project would be under no explicit obligation to demonstrate compliance with the exclusion zone requirements described in §193.2057 and §193.2059 using the methodology and approaches currently required by DOT PHMSA. However, FERC staff routinely evaluates and determines public impacts for facilities of this type under their jurisdiction in accordance with Part 193; therefore, as a practical policy matter, it is anticipated that FERC staff would require, as they are empowered to do, that the Project demonstrate siting in a manner consistent with the requirements of §193.2057 and §193.2059 irrespective of any exemptions offered by

the regulation. Accordingly, this expectation has been considered in performing this Study.

5.2 Floating Infrastructure Issues

There are several issues involving floating infrastructure that add to regulatory uncertainty and raise questions about potential suitability to meet the Project's needs. One question relates to determination of public impacts of vapor dispersion and thermal radiation. The "traditional" methodology for determining potential areas under risk from an event occurring aboard LNG Carrier has been defined under the Coast Guard's Navigation, Vessel and Inspection Circular (NVIC) 01-11. The (partial) output from the process described therein has been to establish project – specific Zones of Concern that delineate particular areas of specific risk for advisory purposes to the public. The Zones of Concern, within the context of the NVIC, have been advisory and have not constituted a proscriptive siting constraint.

Recent developments, however, suggest that application of project – specific Zones of Concern may be changing for floating infrastructure that comprise part of the terminal. Noting that §193.2001 does not apply to an "LNG facility located in navigable waters", there are limited choices in evaluating public impacts for such facility infrastructure. One choice is the evaluation of impacts provided through NVIC 01-11 and the other option is to propose to the Authority Having Jurisdiction (AHJ) an alternative evaluation method, such as the use of Chapter 15 *"Performance (Risk Assessment) Based LNG Plant Siting" of NFPA 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)"* 2013 edition.

Whether the potential public impacts are determined through straight application of NVIC 01-11 or the output of a Quantitative Risk Assessment or a hybrid of each, it is felt that the project will be required to describe the Zones of Concern for the floating infrastructure and that those Zones of Concern will be used to determine the potential public impacts to be considered by FERC.

In addition, there are certain recent issues arising out of the US Coast Guard's "Permanently Moored Craft" policy. Information regarding this policy is attached in Appendix J. Although this permanently moored craft policy has been in place since 2009, it is only recently that LNG project development initiatives in the industry give rise to some of the regulatory gaps and issues attendant with the policy. Such issues include the requirement for robust mooring systems capable of handling permanently moored craft loadings in hurricane conditions (for non-self-propelled vessels or self-propelled vessels that are proposed to remain permanently on station), clarification of any Jones Act uncertainties surrounding the use of non-US constructed vessels in Regasification Barge, FSRU or FSU service, scope and application of non-marine codes, standards and regulations (such as those enforced by the Occupational Safety

and Health Administration) on vessels in Regasification Barge, FSRU or FSU service, and well defining the permitting, plan review and approval process and division of responsibilities between FERC, the US Coast Guard and the selected Class Society.

5.3 Summary

Depending on the infrastructure configuration selected by the Project, there may be several areas of regulatory uncertainty. It may be arguable that the requirements of 49 CFR Part 193 do not apply to the Project given the language of §193.2001; however, it is felt that the Project will be required as a matter of FERC staff policy to demonstrate a level of analysis equivalent to that under Part 193.

With respect to the floating infrastructure, as a conservative approach and reflecting what is felt to be the ultimate outcome, public impacts associated with floating infrastructure, whether nearshore or offshore, will present the Zones of Concern, as defined in NVIC 01-11.

6 HAZARD EVALUATION BASIS

Based on the specifics defined in Section 3.1 and 3.2 of this Report and of the discussions in Section 5, CH·IV has defined the following as the basis for calculating site-specific hazards.

6.1 LNG Marine Vessels Hazard Analysis

Due to increased demand for natural gas in the U.S., it was necessary to identify consistent methods and approaches to help ensure protection of public safety and property from a potential large scale LNG spill on water. Therefore, the U.S. Department of Energy (DOE), Office of Fossil Energy, requested that Sandia National Laboratories (Sandia) develop guidance on a risk-based analysis approach to assess and quantify potential threats to an LNG carrier, the potential hazards and consequences of a large spill from an LNG carrier, and review prevention and mitigation strategies that could be implemented to reduce both the potential for and the risks of an LNG spill over water.

In December 2004, Sandia issued a report titled "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water" [1] (2004 Sandia Report) which provided a methodology for assessing hazards and identified approaches to minimize the consequences of LNG spills from LNG carriers with capacities of 125,000 m^3 to 150,000 m^3 and defined three Hazard Zones which made up the "Zones of Concern". The Hazard Zones were defined as:

1 "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water", SAND2004-6258, December 2004.

- Zone 1: Distance to 37.5 kW/m^2 Thermal Flux
- Zone 2 : Distance to 5 kW/m^2 Thermal Flux
- Zone 3: Distance to Lower Flammability Limit

In May 2008, Sandia issued a report titled "Breach and Safety Analysis of Spills Over Water from Large Liquefied Natural Gas Carriers"[2] (2008 Sandia Report) which analyzed spills from LNG carriers up to 265,000 m^3 and re-assessed emerging accidental and intentional threat scenarios.

The distances to the Hazard Zones calculated in the 2004 and 2008 Sandia Reports were based on a "nominal case" and were not site-specific. Site-specific Hazard Zone distances will change depending on the location of the project (accidental vs. intentional breaches), environmental conditions (temperature, relative humidity, wind speed, etc.), storage tank configurations and storage volumes. The Hazard Zone distances calculated in the 2004 and 2008 Sandia Reports were intended to convey the scale of possible hazard distances for a large spill of LNG over water. Therefore, the 2004 and 2008 Sandia Reports recommended a site-specific analysis be performed to calculate site-specific Zones of Concern.

In December 2011, Sandia issued a report titled "Recommendations on the Prediction of Thermal Hazard Distances from Large Liquefied Natural Gas Pool Fires on Water for Solid Flame Models" [3] (2011 Sandia Report) which provided recommended parameters for solid flame models based on experimental data from "The Phoenix Series Large Scale LNG Pool Fire Experiments"[4] (Phoenix Series) performed by Sandia. The 2011 Sandia Report also updated the hazard distances calculated in the 2004 and 2008 Sandia Reports to include the recommended parameters. The 2011 Sandia Report emphasized that surrounding conditions will change the Hazard Zone distances and therefore again recommended that a site-specific analysis be performed to calculate the site-specific Zones of Concern.

CH·IV has calculated site-specific Zones of Concern for the FSRU, FSU, and LNG Vessel options being considered based on the methodology described in the Sandia Reports.

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2 "Breach and Safety Analysis of Spills Over Water from Large Liquefied Natural Gas Carriers", SAND2008-3153, May 2008.

3 "Recommendations on the Prediction of Thermal Hazard Distances from Large Liquefied Natural Gas Pool Fires on Water for Solid Flame Models", SAND2011-3342, December 2011.

4 "The Phoenix Series Large Scale LNG Pool Fire Experiments", SAND2010-8676, December 2010.

6.2 Onshore Facilities Hazard Analysis

As earlier stated, the basis of this Report considers that the Project will be required to perform siting analysis similar to those described in §193.2057 and §193.2059 of 49 CFR 193 as further described below:

- 49 CFR 193.2057 requires that "Each LNG container and LNG transfer system must have a thermal exclusion zone in accordance with section 2.2.3.2 of NFPA 59A (incorporated by reference)". Section 2.2.3.2 of NFPA 59A (2001 edition) requires that provisions shall be made to minimize the possibility of the damaging effects of fire reaching beyond a property line that can be built upon and that would result in a distinct hazard. This section of NFPA 59A and also 49 CFR 193.2057 require that thermal heat flux distances be determined by using the model described in Gas Research Institute report GRI 0176, "LNGFIRE: A Thermal Radiation Model for LNG Fires".
- 49 CFR 193.2059 requires that "Each LNG container and LNG transfer system must have a [vapor] dispersion exclusion zone in accordance with sections 2.2.3.3 and 2.2.3.4 of NFPA 59A (incorporated by reference)". Section 2.2.3.4 of NFPA 59A (2001 edition) requires that provisions shall be made to minimize the possibility of a flammable mixture of vapors from a design [LNG] spill reaching a property line that can be built upon and that would result in a distinct hazard. This section of NFPA 59A and also 49 CFR 193.2059 require that flammable gas dispersion distances be determined in accordance with the model described in Gas Research Institute report GRI 0242, "LNG Vapor Dispersion Prediction with the DEGADIS Dense Gas Dispersion Model".
- 49 CFR 193.2051, requires that "Each LNG facility designed, constructed, replaced, relocated or significantly altered after March 31, 2000 must be provided with siting requirements in accordance with the requirements of this part and of NFPA 59A (incorporated by reference)". Section 2.1.1.d of NFPA 59A (2001) states that "other factors applicable to the specific site that have a bearing on the safety of plant personnel and the surrounding public shall be considered. The review of such factors shall include an evaluation of potential incidents and safety measures incorporated in the design or operation of the facility".

6.2.1 Thermal Radiation Model

In accordance with 49 CFR 193.2057 and Section 2.2.3.2 of NFPA 59A (2001 edition), the Project used LNGFIREIII to calculate the thermal radiation exclusion zones associated with the LNG Storage Tank impoundment.

6.2.2 Vapor Dispersion Written Interpretation

Until early 2009, the DEGADIS model was the standard used within the LNG industry to calculate vapor dispersion distances to demonstrate that the resulting "exclusion zones" remain within property controlled by the facility owners or areas controlled by a government entity. However, in an effort to develop LNG dispersion model evaluation tools for the NFPA 59A Committee, the Fire Protection Research Foundation (FPRF) funded research on LNG spill source term modeling and, in March, 2009 its findings were included in a report entitled "LNG Source Term Models for Hazard Analysis: A review of the State-of-the-Art and an Approach to Model Assessment". The report presented a methodology for assessing the suitability of LNG source term models used in determining pool spread and vaporization and concluded that the source term model generally used within the industry to provide input to the DEGADIS dispersion model could result in under-prediction of hazard distances in some cases because it does not accurately represent vapor accumulation within impoundments, vapor flashing, and pool spreading. Subsequently, in July, 2010 U.S. DOT PHMSA issued written interpretations acknowledging the FPRF findings and described requirements that vapor dispersion exclusion zone analysis be performed for LNG facilities not yet in existence or under construction to demonstrate compliance with 49 CFR 193 and that the analysis should include vapor dispersion from:

- Jetting and flashing,
- Conveyance of LNG to impoundments; and
- LNG in impoundments.

Although the DEGADIS dispersion model was not a subject of concern for the FPRF, the model is not capable of solving the requirements to analyze the effects of jetting and flashing and the conveyance of LNG spills to impoundments. New models were required to perform this function and therefore, in its written interpretations, U.S. DOT PHMSA stated that applicants should provide an interpretation from PHMSA on the suitability of the specific source term model used to satisfy flammable vapor dispersion requirements.

Also note that for the purposes of this Report, vapor dispersion events surrounding conveyance of LNG to impoundments and LNG in impoundments were not considered as they are expected to be bounded by analysis associated with jet releases.

6.2.3 Vapor Dispersion Model

In late 2010, Model Evaluation Protocols and Model Evaluation Reports for two new vapor dispersion models were submitted to DOT PHMSA for review and approval. On October 7, 2011 U.S. DOT PHMSA issued final approvals allowing the models to be used (within certain conditions) to perform vapor dispersion analysis to demonstrate compliance with exclusion zones. The models currently being used to permit the construction of LNG facilities in the U.S.A are the FLACS (v9.1) model (developed by GexCon) and the PHAST (v6.6 or v6.7) model (developed by DNV).

For the non–marine infrastructure, the vapor dispersion analyses presented in this Report are based on results using the PHAST model.

6.3 CNG Marine Vessels Hazard Analysis

There are currently no CNG projects within U.S. territory and no such projects have been presented to FERC or USCG. Therefore, there are no specific rules, guidelines or precedent available that provides a basis for calculating hazard zones (or equivalent) for marine based CNG vessels in the U.S. However, examples of analysis performed for CNG solutions within other jurisdictions are available, along with vessel classification guidelines from ABS and rules from DNV.

While it is understood that there are currently no examples of CNG vessels in U.S territory and therefore no precedent regarding regulatory requirements to permit a CNG facility, the calculation of hazard zones using the same concepts used by Sandia for the determination of intentional and accidental release scenarios will allow for a reasonable comparison to the hazard zones calculated for LNG vessels. For the purposes of this analysis, CH·IV assumed a non-self-propelled vessel with an onboard inventory of a plurality of Composite Reinforced Pressure Vessels (CPRV). Baseline design information for the vessel is as follows:

- Propulsion: non-self-propelled
- CPRV maximum total common header inventory: 56
- CPRV maximum total single hold inventory: 306

CH·IV performed modeling for the following scenarios:

- Release Scenario 1: An intentional release which results in the rupture of the 6 inch header connected to a “gang” of 56 CPRVs;

- Release Scenario 2: An intentional release which results in the rupture of the 8 inch header connected to a total single hold space inventory of 306 CPRVs;
- Release Scenario 3: An intentional release which results in the rupture of a single 1 ¼ inch connection to an individual CRPV which results in releasing the contents of all 56 CPRVs connected to a common header; and,
- Release Scenario 4: An intentional release which results in a 5 m^2 hole in the side of the CNG vessel. Two CPRVs which are directly behind the 5 m^2 hole are damaged and their contents are released.

In order to calculate potential Hazard Zones associated with the CNG vessels, CH·IV used assumed baseline design information and the PHAST v6.7 software tool to calculate the potential extent of site specific Zones of Concern:

- Zone 1 - 12,000 Btu/ft^2-hr. (37 kW/m2).
- Zone 2 - 1,600 Btu/ft^2-hr. (5 kW/m2).
- Zone 3 - Lower Flammability Limit (LFL).

7 INFRASTRUCTURE-SPECIFIC HAZARD EVALUATIONS

Based on the specifics defined in Section 3.1 and 3.2 of this Report, CH·IV has calculated site-specific hazards associated with each option.

CH·IV has used the following weather data to be used in performing the thermal radiation analysis

Table 7-1: Thermal Radiation Weather Assumptions

Parameter	Value
Ambient Temperature	70°F
Wind Speed	Multiple wind speeds will be analyzed to determine longest thermal radiation distance.
Relative Humidity	50%

CH·IV has used the following weather data to be used in performing the vapor dispersion analysis

Table 7-2: Vapor Dispersion Weather Assumptions

Parameter	Value
Average Ambient Temperature	85°F
Wind Speed	Multiple wind speeds will be analyzed to determine longest cloud distance.
Relative Humidity	70% over water, 50% over land
Pasquill-Gifford Atmospheric Stability	F

7.1 Regasification Barge Hazard Analysis

For the Option 1, 2, 6 and 7 arrangements, the following assumptions were used in the analysis:

- Storage capacity of 125,000 m^3 via five vessel storage tanks at 25,000 m^3 each
- Initial liquid height of 15 meters in each tank
- Intentional release scenario resulting in a 5 m^2 breach of a single cargo tank

Using the methodology and recommended parameters in the Sandia Reports, CH·IV calculated the distances to the "Zones of Concern" for a 125,000 m^3 vessel so configured is as follows:

- Zone 1: Distance to 37.5 kW/m^2 Thermal Flux = 1,138 feet (347 m)
- Zone 2 : Distance to 5 kW/m^2 Thermal Flux = 3,337 feet (1,017 m)
- Zone 3: Distance to Lower Flammability Limit = 17,680 feet (5,389 m)

7.2 FSRU Hazard Analysis

For the Option 3, 8 and 11 arrangements, the following assumptions were used in the analysis:

- Storage capacity of 165,000 m^3 via five vessel storage tanks at 33,000 m^3 each
- Initial liquid height of 16 meters in each tank
- Intentional release scenario resulting in a 5 m^2 breach of a single cargo tank

Using the methodology and recommended parameters in the Sandia Reports, CH·IV calculated the distances to the "Zones of Concern" for a 165,000 m^3 vessel so configured is as follows:

- Zone 1: Distance to 37.5 kW/m^2 Thermal Flux = 1,154 feet (352 m)
- Zone 2 : Distance to 5 kW/m^2 Thermal Flux = 3,376 feet (1,029 m)
- Zone 3: Distance to Lower Flammability Limit = 18,024 feet (5,494 m)

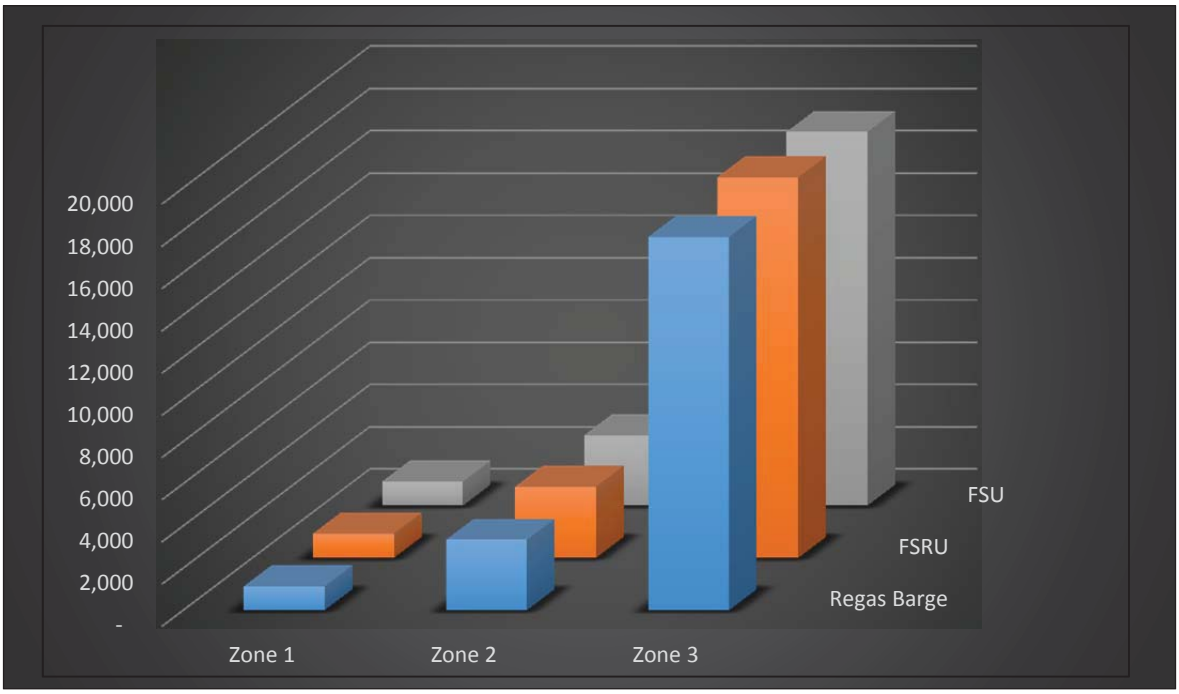


Figure 7.1: ZOC End Points

7.3 FSU Hazard Analysis

For the Option 4 and 9 arrangements, the following assumptions were used in the analysis:

- Storage capacity of 125,000 m^3 via five vessel storage tanks at 25,000 m^3 each
- Initial liquid height of 16 meters in each tank
- Intentional release scenario resulting in a 5 m^2 breach of a single cargo tank

Using the methodology and recommended parameters in the Sandia Reports, CH·IV calculated the distances to the "Zones of Concern" for a 125,000 m^3 vessel so configured is as follows:

- Zone 1: Distance to 37.5 kW/m^2 Thermal Flux = 1,138 feet (347 m)
- Zone 2 : Distance to 5 kW/m^2 Thermal Flux = 3,337 feet (1,017 m)
- Zone 3: Distance to Lower Flammability Limit = 17,680 feet (5,389 m)

7.4 LNG Storage Tank Hazard Analysis

As earlier discussed, 49 CFR Part 193 and Chapter 2 of NFPA 59A (2001 addition) specify distances to a property line for radiant heat flux. CH·IV has used LNGFIRE3 to calculate the distances to radiant heat fluxes. Although a plurality of LNG storage

tank options are available, given the circumstances of this project, CH·IV has considered only the full containment option as feasible. This is applicable to Options 5, 10, and 14.

The following assumptions were used in the analysis:

- Aggregate storage capacity of 160,000 m^3
- Each tank 80,000 m^3
- Full containment storage tank with outer diameter of 200 feet and height of 115 feet

The results of the analysis are as follows:

- Distance to 10,000 BTU/ft^2-hr = 330 feet
- Distance to 1,600 BTU/ft^2-hr = 724 feet

7.5 LNG Transfer Piping Vapor Dispersion Analysis

As earlier discussed, this Report presumes the project will be required to demonstrate compliance with 49 CFR Part 193. CH·IV has considered the following process conditions in determining representative dispersion distances:

Unloading line from the LNG Carrier to LNG Storage Tank:

- 28-inch line
- length ≤950 feet,
- 2-inch single accidental release source:
    - ½ LFL dispersion distance is 1,350 feet

Low pressure Sendout Pumps from the LNG Storage Tank to the High Pressure Sendout Pumps:

- 10-inch line
- length ≤500 feet,
- 2-inch single accidental release source:
    - ½ LFL dispersion distance is 1,132 feet

High Pressure Sendout Pumps to the Vaporizers:

- 10-inch line
- length ≤200 feet,
- 1-inch single accidental release source:

- ½ LFL dispersion distance is 587 feet

This is applicable to Options 5 10, and 14.

7.6 CNG Marine Vessel Hazard Analysis

The dynamics of a release of LNG from an LNG carrier compared to a CNG release from a CNG carrier are very different. The integral models described earlier used in the calculation of Hazard Zones for LNG releases for an FSRU or LNG Barge consider an LNG release through a hole which forms a pool on water and either ignites to form a pool fire or disperses. A release of CNG would not form a pool on water and therefore these models used for LNG are not appropriate for modeling a CNG release. Therefore, CH·IV used the PHAST v6.7 software tool to calculate the potential equivalent Zones of Concern for CNG releases. The jet fire model was used in PHAST to calculate the distance to Zones 1 and 2 and the dispersion model was used to calculate the distance to Zone 3. This analysis is applicable to Options 12 and 13.

Site specific conditions used in the analysis are as follows:

- Ambient temperature of 70 ºF.
- Ambient wind speed(s) up to 4.5 mph.
- Relative humidity of 50%.
- Surface roughness factor of $3e^{-3}$ m for spills on water.

The following modeling assumptions were made:

- The CNG vessel analyzed utilizing a plurality of Composite Reinforced Pressure Vessels (CRPV) to store CNG.
- Each cargo “hold” contains 306 CRPVs and the largest “gang” in each cargo hold contains 56 CRPVs connected to a common header.
- Each individual CPRV is connected with a 1 ¼ inch pipe to its header. A total of 28 CRPVs are connected to a 4 inch header. The 4 inch header from each bank of 28 CRPVs is connected to a 6 inch header to connect the entire “gang” of 56 CRPVs. The 6 inch header is then expanded to an 8 inch header.
- There are no isolation valves between each CRPV in the “gang”. Therefore, if there is a rupture of 1 CRPV, all 56 CRPV’s connected in the same “gang” will release through that rupture.
- Each CRPV is approximately 80 feet long and 42 inches in diameter with a container volume of 800 ft^3 (22.65 m^3), has a capacity of 178,000 scf and is designed for 3,400 psi.

- The release material for all scenarios will be 100% methane and each CRPV can store 9,072 lb. of methane at 3,400 psi and 30ºC.

7.6.1 CNG Release Scenario 1

Release Scenario 1 assumes that there is an incident which results in the rupture of the 6-inch header connected to all 56 CPRVs in the gang. This scenario uses conservative assumptions to calculate the worst-case hazard zones associated with the release of all 56 CRPV's in the gang. This scenario assumes that the 6-inch rupture discharges horizontally directly to atmosphere, therefore no obstructions or internal decking are taken into account.

It is assumed that a jet fire occurs for the calculation of the equivalent Zones of Concern 1 and 2. For the calculation of Zone of Concern 3, it is assumed that no ignition source is present and the methane is allowed to disperse un-ignited. For this scenario, the release duration is 308 seconds. The calculated Hazard Zones are as follows:

- Zone 1 (37.5 kW/ m^2) – 215 meters (705 feet);
- Zone 2 (5 kW/ m^2) – 391 meters (1,283 feet);
- Zone 3 (LFL) – 277 meters (909 feet).

7.6.2 CNG Release Scenario 2

Release Scenario 2 assumes that there is an incident which results in the rupture of the 8-inch header connected to all 306 CPRVs in the hold. This scenario uses conservative assumptions to calculate the worst-case hazard zones associated with the release of all 306 CPRV's in the hold. This scenario assumes that the 8-inch rupture discharges horizontally directly to atmosphere, therefore no obstructions or internal decking are taken into account.

It is important to note that information provided by Centrica stated that the CNG vessel will transit with all its shutdown valves closed which would keep each gang in the hold isolated. However, once the CNG vessel has been moored, all shutdown valves will be opened prior to start of offloading. Therefore, this scenario could not occur while the CNG vessel is in transit and could only occur once the CNG vessel is moored.

It is assumed that a jet fire occurs for the calculation of the equivalent Zones of Concern 1 and 2. For the calculation of Zone of Concern 3, it is assumed that no ignition source is present and the methane is allowed to

disperse un-ignited. For this scenario, the release duration is 947 seconds. The calculated Hazard Zones are as follows:

- Zone 1 (37.5 kW/ m^2) – 282 meters (925 feet).
- Zone 2 (5 kW/ m^2) – 509 meters (1,670 feet).
- Zone 3 (LFL) – 388 meters (1,273 feet).

7.6.3 CNG Release Scenario 3

Release Scenario 3 assumes that there is an incident which results in the rupture of one of the 1 ¼ inch connections to an individual CRPV which results in releasing the contents of all 56 CPRVs in the gang connected to the same header. This scenario uses conservative assumptions to calculate the worst-case hazard zones associated with this release. This scenario assumes that the 1 ¼ inch rupture discharges horizontally directly to atmosphere, therefore no obstructions or internal decking is taken into account.

It is assumed that a jet fire occurs for the calculation of the equivalent Zones of Concern 1 and 2. For the calculation of Zone of Concern 3, it is assumed that no ignition source is present and the methane is allowed to disperse un-ignited. For this scenario, the release duration is 7,103 seconds. The calculated Hazard Zones are as follows:

- Zone 1 (37.5 kW/ m^2) – 57 meters (187 feet).
- Zone 2 (5 kW/ m^2) – 94 meters (308 feet).
- Zone 3 (LFL) – 69 meters (226 feet).

7.6.4 CNG Release Scenario 4

Release Scenario 4 assumes that there is an intentional incident which results in a 5 m^2 hole in the side of the CNG vessel. Two CPRVs which are directly behind the 5 m^2 hole are damaged and their contents are released. This scenario assumes an instant failure of two CPRVs and the contents are released inside the cargo hold, allowed to expand, and directly release to atmosphere through the 5 m^2 hole.

For this scenario, it was assumed that the cargo hold has dimensions of 30 meters wide by 30 meters long by 19 meters tall for a total volume of 17,100 m^3 and each CPRV was has a volume of approximately 800 ft^3 with an additional 20% volume accounting for supports, piping, and walkways. Based on these assumptions, each CPRV and its associated supports, piping, and walkways will occupy approximately 27.18 m^3 and

all 306 CPRV's and their associated supports, piping, and walkways will occupy a total volume of 8,318 m^3. Therefore, the rupture of two CPRV's inside the cargo hold will allow the gas to depressurize to approximately 17.5 psi before releasing through the 5 m^2 hole.

It is assumed that a jet fire occurs for the calculation of the equivalent Zones of Concern 1 and 2. For the calculation of Zone of Concern 3, it is assumed that no ignition source is present and the methane is allowed to disperse un-ignited. For this scenario, the release duration is 5.65 seconds. The calculated Hazard Zones are as follows:

- Zone 1 (37.5 kW/ m^2) – 299 meters (981 feet).
- Zone 2 (5 kW/ m^2) – 536 meters (1,759 feet).
- Zone 3 (LFL) – 452 meters (1,490 feet).

8 FEASIBILITY AND OPTION STUDY RESULTS

The feasibility results for each area are described below.

8.1 Option 1: Regasification Barge at Pier 15/16 with Shuttle Delivery

8.1.1 Terminal Configuration

Option 1 includes a non-self-propelled vessel with onboard regasification capability and ≤125,000 m^3 storage capacity to be moored dockside in way of Pier 15/16. Cargo delivery would be provided by shuttle tanker through ship – to – ship (STS) transfer in the area of Guayanilla Canyon.

This option provides receipt and storage of LNG aboard the Regasification Barge and vaporization of the LNG to natural gas via onboard regasification. The natural gas from the onboard regasification process would be sent to an onshore pipeline co-located at the facility and then to a subsea pipeline crossing San Juan Bay to the San Juan power plant.

From its San Juan power plant riser, the pipeline would bifurcate to provide feed gas for San Juan power plant prime movers and an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be provided by LNG Shuttle Carriers of appropriate capacity operating on liner service shuttling between an LNG Carrier in the area of Guayanilla Canyon and San Juan Bay.

8.1.2 Site Evaluation

Site considerations include:

- Regasification Barge, and
- pipeline route including:
  - sub seabed crossing of San Juan Bay landing at San Juan power plant;
  - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- Regasification Barge,
- Marine Jetty suitable for loadings of a permanently moored vessel during hurricane events,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- Subsea Pipeline from the site crossing San Juan Bay to San Juan power plant, and
- Regasification Barge Support Network.

Although a general area is suggested for the STS transfer of LNG from the LNG delivery carrier to the LNG shuttle carrier, the STS area may be optimized upon a more detailed analysis of metocean conditions in order to find the most favorable location.

This arrangement requires pipeline crossing of San Juan Bay using horizontal directional drilling technique.

The "Zones of Concern" were calculated for the Regasification Barge in Section 7.1 of this Report. Appendix A presents a preliminary layout of key components of Option 1 illustrating the Zones of Concern.

8.1.3 Waterway Suitability

This option requires ongoing support from an LNG Shuttle Carrier of approximately 85,000 m³ capacity. In support of the Regasification Barge, the Shuttle Carrier will be required to navigate the Bar Channel, Anegado Channel, the Graving Dock Channel and the Graving Dock Turning Basin. The Shuttle Carrier is anticipated to require a depth of 36.9 feet; this

results in a requirement to dredge approximately 529,275 yd³ from the Graving Dock Channel and Turning Basin.

Pilotage is compulsory for all foreign vessels and U.S. vessels under register when entering or leaving San Juan Bay. Pilots board vessels 3 miles north of Lighted Buoy #2. Tugboats are available up to 6000 hp; this power range is felt appropriate for maneuvering and docking the LNG Shuttle Carrier.

From Coast Pilot 5 (2014), the following is noted:

- *Pier 15 (18°26'58"N., 66°05'21"W.): 1,000 feet long; 34 feet alongside; 1,000 ton floating drydock; ship repair facility; also known as Outfitting Pier on the south side operated by Puerto Rico Drydock and Marine Works,*
- *Pier 16 (18°27'01"N., 66°05'15"W.): marginal wharf, 525 feet long; 34 feet alongside; open storage; general and bulk cargoes, containers; operated by Puerto Rico Ports Authority.*

As may be seen from the following figure, the Port of San Juan has a dynamic waterway.[5] This option will require integration of the LNG Shuttle Carrier into the ongoing commercial vessel traffic. However, it needs to be noted that this is not a true differentiator among the remaining options to be discussed. Of the thirteen options presented in this report, twelve require marine transit of the San Juan Bay waterway.

[5] Vessel traffic chart downloaded from:
https://www.marinetraffic.com/en/ais/details/ports/1023/Puerto_Rico_port:SAN_JUAN

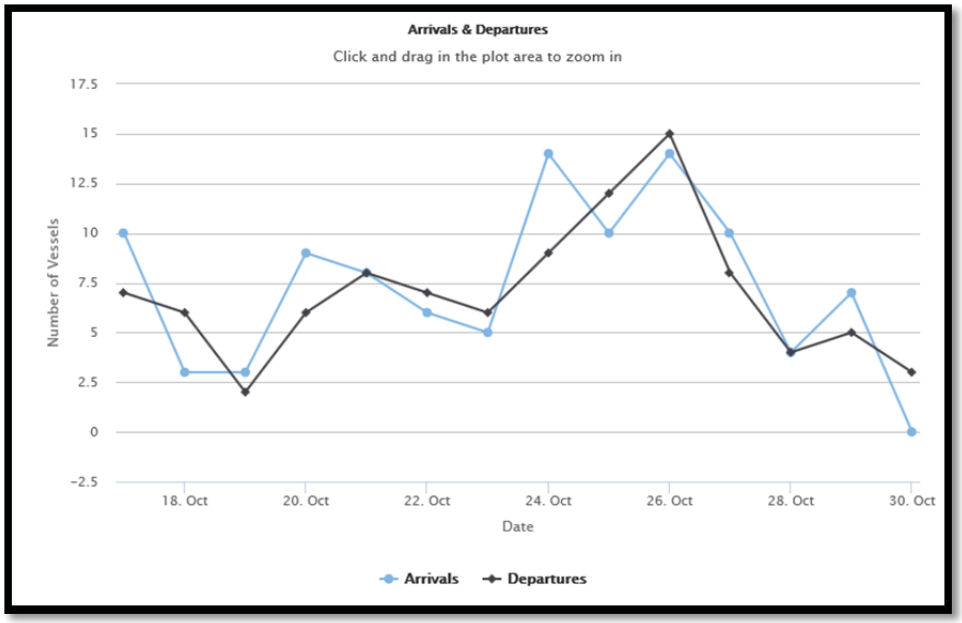


Figure 8.1: Arrivals and Departures – Port of San Juan

Each project subject to the jurisdiction of 33 CFR Part 127 is obligated to conduct a Waterway Suitability Assessment in accordance with the requirements set forth in NVIC 01 – 11. This process, in part, is intended to objectively identify and assess risks associated with the proposed operation facility (with respect to the marine component), offer mitigation measures to bring those risks to an acceptable level, and to do so in a process inclusive of the other waterway stakeholders. This process of identifying risk and mitigation measures incorporating input from the other stakeholders, will be determinative of the eventual suitability of the waterway for LNG vessel traffic.

8.1.4 Discussion

This option presents de minimus dredging requirements given the relatively low displacement of the LNG Shuttle Carriers and requires less tugboat horsepower for maneuvering and turning of the LNG Shuttle Carriers. However, discussed in sections 5.2 and 6.1, the Regasification Barge introduces potentially significant siting issues, permitting issues with the Coast Guard, FERC, OSHA and possibly other agencies.

This option requires LNG Carrier delivery in support of the Regasification Barge approximately every 16 days. This option requires use of a permanently moored craft, which introduces some particular challenges. In addition to the earlier discussion about uncertainty of the permitting path

and incorporation of general industrial shoreside practices and regulations into a quasi-marine facility, one issue that is less ambiguous is the requirement to provide a mooring system suitable for retaining the Regasification Barge in a 100-year hurricane event. Typically, it is expected that vessels will depart in advance of severe weather and that expectation serves as a nominal design basis for the marine civil works. For this option, there is expected to be a marine civil works arrangement that is significantly more robust than that typically found at an LNG facility; this additional robustness will be required to provide regulatory agency comfort that the permanently more craft will have a suitable mooring in severe weather events.

8.2 Option 2: Regasification Barge at Pier 15/16 with LNG Carrier Delivery

8.2.1 Terminal Configuration

Option 2 includes a non-self-propelled vessel with onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of Pier 15/16. Cargo delivery would be provided by conventional LNG Carrier.

This option provides receipt and storage of LNG aboard the FSRU and vaporization of the LNG to natural gas via onboard regasification. The natural gas from the onboard regasification process would be sent to an onshore pipeline co-located at the facility and then to a subsea pipeline crossing San Juan Bay to the San Juan power plant.

From its San Juan power plant riser, the pipeline would bifurcate to provide feed gas for San Juan power plant prime movers and an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be delivered by LNG Carriers of appropriate capacity operating on liner service.

8.2.2 Site Evaluation

Site considerations include:

- Regasification Barge, and
- pipeline route including:
    - sub seabed crossing of San Juan Bay landing at San Juan power plant;
    - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- Regasification Barge,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- Subsea Pipeline from the site crossing San Juan Bay to San Juan power plant, and
- Regasification Barge Support Network.

This arrangement requires pipeline crossing of San Juan Bay using horizontal directional drilling technique. The "Zones of Concern" were calculated for the Regasification Barge in Section 7.1 of this Report. Appendix A presents a preliminary layout of key components of Option 2 illustrating the Zones of Concern.

8.2.3 Waterway Suitability

This option requires LNG delivery through a conventional LNG Carrier of approximately 85,000 m^3 capacity. In support of the Regasification Barge, the LNG Carrier will be required to navigate the Bar Channel, Anegado Channel, the Graving Dock Channel and the Graving Dock Turning Basin. The Shuttle Carrier is anticipated to require a depth of 36.9 feet; this results in a requirement to dredge approximately 529,275 yd^3 from the Graving Dock Channel and Turning Basin.

All other waterway suitability issues remain the same as those discussed for Option 1.

8.2.4 Discussion

This option presents de minimus dredging requirements given the relatively low displacement of the LNG Carriers of this capacity and requires less tugboat horsepower for maneuvering and turning of the LNG Carriers. However, the siting issues discussed regarding Option 1 earlier with respect to the Regasification Barge remain attendant for this option. To restate, this option introduces potentially significant siting issues, permitting issues with the Coast Guard, FERC, OSHA and possibly other agencies.

This option requires LNG Carrier delivery in support of the Regasification Barge approximately every 16 days. As discussed in Option 1, the

Regasification Barge option requires use of a permanently moored craft, which introduces some particular challenges. In addition to the earlier discussion about uncertainty of the permitting path and incorporation of general industrial shoreside practices and regulations into a quasi-Marine facility, one issue that is less ambiguous is requirement to provide a mooring system suitable for retaining the Regasification Barge in a 100-year hurricane event. Typically, it is expected that vessels will depart in advance of severe weather and that expectation serves as a nominal design basis for the marine civil works. For this option, there is expected to be a marine civil works arrangement that is significantly more robust than that typically found at an LNG facility; this additional robustness will be required to satisfy regulatory agency comfort that the permanently more craft will have a suitable mooring in severe weather events.

8.3 Option 3: FSRU at Pier 15/16 with LNG Carrier Delivery

8.3.1 Terminal Configuration

This option comprises a self-propelled or non-self-propelled Floating Storage and Regasification Unit (FSRU) with onboard regasification capability and ≤165,000 m³ storage capacity to be moored dockside in way of Pier 15/16. In this option, cargo delivery would be provided by an LNG Carrier entering San Juan Bay to transfer cargo directly to FSRU through either STS or through plant piping arrangement at marine jetty suitable for simultaneous mooring of the FSRU and the delivery carrier.

The natural gas from the onboard regasification process would be sent to an onshore pipeline co-located at the facility and then to a subsea pipeline crossing San Juan Bay to the San Juan power plant.

From its San Juan power plant riser, the pipeline would bifurcate to provide feed gas for San Juan power plant prime movers and an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be delivered by LNG Carriers of appropriate capacity operating on liner service.

The FSRU may or may not be self-propelled; it is expected this project decision detail would be conducted on an evaluation of the availability and economics of each option.

8.3.2 Site Evaluation

Site considerations include:

- FSRU, and
- pipeline route including:
  - sub seabed crossing of San Juan Bay landing at San Juan power plant;
  - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- Regasification Barge,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- Subsea Pipeline from the site crossing San Juan Bay to San Juan power plant, and
- FSRU Support Network.

This arrangement requires pipeline crossing of San Juan Bay using horizontal directional drilling technique.

The "Zones of Concern" were calculated for the FSRU in Section 7.2 of this Report. Appendix B presents a preliminary layout of key components of Option 3 illustrating the Zones of Concern.

8.3.3 Waterway Suitability

This option requires LNG delivery through a conventional LNG Carrier of approximately 145,000 m^3 capacity. In support of the FSRU, the LNG Carrier will be required to navigate the Bar Channel, Anegado Channel, the Graving Dock Channel and the Graving Dock Turning Basin. The LNG Carrier is anticipated to require a depth of 40.2 feet; this results in an aggregate dredge volume requirement of approximately 1,056,019 $yd.^3$ from the Bar Channel to, and including, the Graving Dock Turning Basin.

All other waterway suitability issues remain the same as those discussed for Option 1. An incremental difference between the issues earlier discussed is at the LNG Carrier proposed to service the FSRU is larger than that proposed to service the previous options. This likely introduces requirement for tugboats of greater horsepower than is currently available at San Juan Bay.

Full bridge mission simulation studies would be required in order to determine final tugboat configurations and power ranges required to conduct safe navigation and maneuvering within the operational weather envelopes sought by the project. This effort would be part of the larger Waterway Suitability Assessment task.

8.3.4 Discussion

This option presents a substantial increase in dredging requirements given the larger LNG Carrier capacity to service the FSRU. The dredge volumes considers a 145,000 m³ LNG Carrier, which would be expected to provide LNG delivery approximately every 22 days. In addition, as mentioned, the larger LNG Carriers will almost certainly introduce the need for tugboats of greater horsepower than currently available; it is also almost certain that tractor tugs will be preferential over conventional tugboats.

The FSRU may or may not be self-propelled, depending on project preferences, opportunities and economics. An FSRU with an operational propulsion plant will present capital and operational expenses, however, a non-self-propelled FSRU will introduce the issues and uncertainties discussed earlier regarding the Regasification Barge in terms of the permanently moored craft. As discussed in Option 1, the Regasification Barge option requires use of a permanently moored craft, which introduces some particular challenges.

In addition to the uncertainty surrounding permitting issues with the Coast Guard, FERC, OSHA and possibly other agencies, additional capital expense for the non-self-propelled option would include meeting the requirement to provide a mooring system suitable for retaining the FSRU in a 100-year hurricane event. Typically, it is expected that vessels will depart in advance of severe weather and that expectation serves as a nominal design basis for the marine civil works. For this option, there is expected to be a marine civil works arrangement that is significantly more robust than that typically found at an LNG facility; this additional robustness will be required to satisfy regulatory agency comfort that the permanently more craft will have a suitable mooring in severe weather events.

8.4 Option 4: FSU at Pier 15/16 with Shuttle Delivery

8.4.1 Terminal Configuration

This option comprises a Floating Storage Unit (FSU), either self-propelled or non-self-propelled, with no onboard regasification capability and

≤125,000 m³ storage capacity to be moored dockside in way of Pier 15/16. Cargo delivery would be provided by shuttle tanker through STS transfer in the area of Guayanilla Canyon.

The LNG from the FSU would be sent at low pressure to high-pressure send out pumps located on the facility that would increase the liquid pressure to pipeline pressure and send the LNG to vaporizers located on the facility. Natural gas from the facility regasification process would be sent via a subsea pipeline crossing San Juan Bay to the San Juan power plant.

From its San Juan power plant riser, the pipeline would bifurcate to provide feed gas for San Juan power plant prime movers and an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be delivered by LNG Carriers of appropriate capacity operating on liner service.

The FSU may or may not be self-propelled; it is expected this project decision detail would be conducted on an evaluation of the availability and economics of each option.

8.4.2 Site Evaluation

Site considerations include:

- FSU, and
- pipeline route including:
    - sub seabed crossing of San Juan Bay landing at San Juan power plant;
    - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- FSU,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- Subsea Pipeline from the site crossing San Juan Bay to San Juan power plant, and
- high-pressure send out pumps on the facility,

- LNG vaporizers on the facility,
- FSU Support Network.

The "Zones of Concern" were calculated for the FSRU in Section 7.3 of this Report. Appendix B presents a preliminary layout of key components of Option 4 illustrating the Zones of Concern.

8.4.3 Waterway Suitability

This option requires ongoing support from an LNG Carrier of approximately 85,000 m^3 capacity and requires an LNG delivery approximately every 16 days. In support of the FSU, the LNG Carrier will be required to navigate the Bar Channel, Anegado Channel, the Graving Dock Channel and the Graving Dock Turning Basin. The LNG Carrier is anticipated to require a depth of 36.9 feet; this results in a requirement to dredge approximately 529,275 $yd.^3$ from the Graving Dock Channel and Turning Basin.

8.4.4 Discussion

Similar to Options 1 and 2, this option presents de minimus dredging requirements given the relatively low displacement of the LNG Carriers of this capacity and requires less tugboat horsepower for maneuvering and turning of the LNG Carriers. However, the siting issues regarding Option 3 discussed earlier with respect to the FSRU remain attendant for this option. To restate, this option may well choose between a self-propelled or non-self-propelled vessel as the FSU. The choice raises potential issues with respect to permitting through various agencies and design basis changes for the marine civil works to satisfy agency expectations of hurricane impacts.

8.5 Option 5: Storage and Vaporization at Pier 15/16

8.5.1 Terminal Configuration

This option comprises a shoreside LNG receiving terminal with storage and vaporization ashore and cargo provided through LNG Carrier. LNG storage considered in this case is an aggregate of 160,000 m^3 through the use of two 80,000 m^3 full containment tanks.

The LNG from the storage tank(s) would be sent by low pressure pumps within each tank to high-pressure send out pumps located external to the tank that would increase the liquid pressure to pipeline pressure and send the LNG to vaporizers located on the facility. Natural gas from the

regasification process would be sent via a subsea pipeline crossing San Juan Bay to the San Juan power plant.

From its San Juan power plant riser, the pipeline would bifurcate to provide feed gas for San Juan power plant prime movers and an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be delivered by LNG Carriers of appropriate capacity operating on liner service.

8.5.2 Site Evaluation

Site considerations include:

- LNG Receiving and Regasification Terminal,
- pipeline route including:
    - sub seabed crossing of San Juan Bay landing at San Juan power plant;
    - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- LNG Receiving and Regasification Terminal,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- Subsea Pipeline from the site crossing San Juan Bay to San Juan power plant, and
- high-pressure send out pumps on the facility,
- LNG vaporizers on the facility,
- LNG facility Support Network.

The hazards associated with full containment LNG storage tanks are presented in Section 7.5 of this Report. Due to size limitations at this site, a full containment LNG storage tank was chosen over a single containment LNG storage tank to reduce the thermal radiation exclusion zones. Appendix D presents a preliminary layout of key components of Option 5 illustrating the thermal radiation associated with the LNG storage tanks and vapor dispersion exclusion zones associated with the LNG process piping.

8.5.3 Waterway Suitability

This option requires ongoing support from an LNG Carrier of approximately 85,000 m³ capacity and requires an LNG delivery approximately every 16 days; this frequency can be reduced through the use of larger carriers. For example, the use of 145,000 m³ vessel could reduce the frequency to an LNG delivery approximately every 22 days. However this provides for a minimum facility LNG inventory pending receipt of cargo and additionally introduces the need for larger dredging volumes.

In support of the facility, the LNG Carrier will be required to navigate the Bar Channel, Anegado Channel, the Graving Dock Channel and the Graving Dock Turning Basin. The 85,000 m³ LNG Carrier is anticipated to require a depth of 36.9 feet; this results in a requirement to dredge approximately 529,275 yd.³ from the Graving Dock Channel and Turning Basin whereas a 145,000 m³ LNG Carrier, anticipated to require a depth of 40.2 feet; this results in an aggregate dredge volume requirement of approximately 1,056,019 yd.³ from the Graving Dock Channel and Turning Basin.

8.5.4 Discussion

This option is quite favorable given a number of considerations. This option represents a "standard industry solution" to the landing, regasification and sendout of natural gas to consumers. As such, efforts surrounding permitting, agency consultations, engineering design and development, financing and underwriting, acquisition of supply commitment, project execution and operations are attended with de minimus uncertainty. In addition, the hazard analysis conducted strongly suggest public impacts associated with siting criteria to be manageable.

The foregoing is firmly based on the assumption that the project can acquire control over the property indicated in section 4.1 and the appropriate appendices.

8.6 Option 6: Regasification Barge at Army Dock with Shuttle Delivery

8.6.1 Terminal Configuration

Option 6 largely mirrors Option 1 except for location and the subsea pipeline requirement. This option includes a non-self-propelled vessel with onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of Pier 15/16. Cargo delivery would be

provided by shuttle tanker through ship – to – ship (STS) transfer in the area of Guayanilla Canyon.

This option provides receipt and storage of LNG aboard the Regasification Barge and vaporization of the LNG to natural gas via onboard regasification. The natural gas from the onboard regasification process would be sent to an onshore pipeline at the San Juan power plant and then to an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be provided by LNG Shuttle Carriers of appropriate capacity operating on liner service shuttling between an LNG Carrier in the area of Guayanilla Canyon and San Juan Bay.

8.6.2 Site Evaluation

Site considerations include:

- Regasification Barge, and
- pipeline route including:
    - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- Regasification Barge,
- Marine Jetty suitable for loadings of a permanently moored vessel during hurricane events,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- Regasification Barge Support Network.

Although a general area is suggested for the STS transfer of LNG from the LNG delivery carrier to the LNG shuttle carrier, the STS area may be optimized upon a more detailed analysis of medicine conditions in order to find the most favorable location.

This arrangement requires pipeline crossing of San Juan Bay using horizontal directional drilling technique.

The “Zones of Concern” were calculated for the Regasification Barge in Section 7.1 of this Report. Appendix E presents a preliminary layout of key components of Option 6 illustrating the Zones of Concern.

8.6.3 Waterway Suitability

This option requires ongoing support from an LNG Shuttle Carrier of approximately 85,000 m³ capacity. In support of the Regasification Barge, the Shuttle Carrier will be required to navigate the Bar Channel, Anegado Channel, the Army Terminal Channel and the Army Terminal Turning Basin. The Shuttle Carrier is anticipated to require a depth of 36.9 feet; this results in a requirement to dredge approximately 226,357 yd.³ from the Army Terminal Channel and Turning Basin.

8.6.4 Discussion

This option presents a substantial dredging requirement and the Regasification Barge introduces potentially significant siting issues, permitting issues with the Coast Guard, FERC, OSHA and possibly other agencies as earlier discussed.

This option requires LNG Carrier delivery in support of the Regasification Barge approximately every 16 days. As also earlier discussed, this option requires use of a permanently moored craft, which introduces some particular challenges. In addition to the earlier discussion about uncertainty of the permitting path and incorporation of general industrial shoreside practices and regulations into a quasi-marine facility, one issue that is less ambiguous is the requirement to provide a mooring system suitable for retaining the Regasification Barge in a 100-year hurricane event. Typically, it is expected that vessels will depart in advance of severe weather and that expectation serves as a nominal design basis for the marine civil works. For this option, there is expected to be a marine civil works arrangement that is significantly more robust than that typically found at an LNG facility; this additional robustness will be required to provide regulatory agency comfort that the permanently more craft will have a suitable mooring in severe weather events.

8.7 Option 7: Regasification Barge at Army Dock with LNG Carrier Delivery

8.7.1 Terminal Configuration

Similar to Option 2 excluding location and subsea pipeline, this Option includes a non-self-propelled vessel with onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of Pier 15/16. Cargo delivery would be provided by conventional LNG Carrier.

This option provides receipt and storage of LNG aboard the Regasification Barge and vaporization of the LNG to natural gas via onboard

regasification. The natural gas from the onboard regasification process would be sent to an onshore pipeline at the San Juan power plant and then to an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be provided by LNG Carriers of appropriate capacity operating on liner service.

8.7.2 Site Evaluation

Site considerations include:

- Regasification Barge, and
- pipeline route including:
    - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- Regasification Barge,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- Regasification Barge Support Network.

The "Zones of Concern" were calculated for the Regasification Barge in Section 7.1 of this Report. Appendix E presents a preliminary layout of key components of Option 7 illustrating the Zones of Concern.

8.7.3 Waterway Suitability

This option requires ongoing support from an LNG Shuttle Carrier of approximately 85,000 m^3 capacity. In support of the Regasification Barge, the Shuttle Carrier will be required to navigate the Bar Channel, Anegado Channel, the Army Terminal Channel and the Army Terminal Turning Basin. The Shuttle Carrier is anticipated to require a depth of 36.9 feet; this results in a requirement to dredge approximately 226,357 $yd.^3$ from the Army Terminal Channel and Turning Basin.

All other waterway suitability issues remain the same as those discussed for Option 6.

8.7.4 Discussion

This option presents permitting issues as described in Option 6 and a more substantial dredging requirement.

This option requires LNG Carrier delivery in support of the Regasification Barge approximately every 16 days. As discussed in Option 1, the Regasification Barge option requires use of a permanently moored craft, which introduces some particular challenges. In addition to the earlier discussion about uncertainty of the permitting path and incorporation of general industrial shoreside practices and regulations into a quasi-Marine facility, one issue that is less ambiguous is requirement to provide a mooring system suitable for retaining the Regasification Barge in a 100-year hurricane event. Typically, it is expected that vessels will depart in advance of severe weather and that expectation serves as a nominal design basis for the marine civil works. For this option, there is expected to be a marine civil works arrangement that is significantly more robust than that typically found at an LNG facility; this additional robustness will be required to satisfy regulatory agency comfort that the permanently more craft will have a suitable mooring in severe weather events.

8.8 Option 8: FSRU at Army Dock with LNG Carrier Delivery

8.8.1 Terminal Configuration

This option comprises a self-propelled or non-self-propelled Floating Storage and Regasification Unit (FSRU) with onboard regasification capability and ≤165,000 m³ storage capacity to be moored dockside in way of the Army Dock. In this option, cargo delivery would be provided by an LNG Carrier entering San Juan Bay to transfer cargo directly to FSRU through either STS or through plant piping arrangement at marine jetty suitable for simultaneous mooring of the FSRU and the delivery carrier.

The natural gas from the onboard regasification process would be sent to an onshore pipeline at the San Juan power plant and then to an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be provided by LNG Carriers of appropriate capacity operating on liner service. The FSRU may or may not be self-propelled; it is expected this project decision detail would be conducted on an evaluation of the availability and economics of each option.

8.8.2 Site Evaluation

Site considerations include:

- FSRU, and
- pipeline route including:
  - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- FSRU,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- FSRU Support Network.

The "Zones of Concern" were calculated for the FSRU in Section 7.2 of this Report. Appendix F presents a preliminary layout of key components of Option 8 illustrating the Zones of Concern.

8.8.3 Waterway Suitability

This option requires ongoing support from an LNG Carrier of approximately 145,000 m^3 capacity. In support of the Regasification Barge, the LNG Carrier will be required to navigate the Bar Channel, Anegado Channel, the Army Terminal Channel and the Army Terminal Turning Basin. The LNG Carrier is anticipated to require a depth of 40.2 feet; this results in a requirement to dredge approximately 394,655 $yd.^3$ from the Army Terminal Channel and Turning Basin.

All other waterway suitability issues remain the same as those discussed for Option 6. As previously mentioned it Option 3, an incremental difference between the issues earlier discussed is at the LNG Carrier proposed to service the FSRU is larger than that proposed to service the previous options. This likely introduces requirement for tugboats of greater horsepower than is currently available at San Juan Bay.

Full bridge mission simulation studies would be required in order to determine final tugboat configurations and power ranges required to conduct safe navigation and maneuvering within the operational weather

envelopes sought by the project. This effort would be part of the larger Waterway Suitability Assessment task.

8.8.4 Discussion

This option presents a substantial increase in dredging requirements given the larger LNG Carrier capacity to service the FSRU. The dredge volumes considers a 145,000 m³ LNG Carrier, which would be expected to provide LNG delivery approximately every 22 days. In addition, as mentioned earlier, the larger LNG Carriers will almost certainly introduce the need for tugboats of greater horsepower than currently available; it is also almost certain that tractor tugs will be preferential over conventional tugboats.

The FSRU may or may not be self-propelled, depending on project preferences, opportunities and economics. An FSRU with an operational propulsion plant will present capital and operational expenses, however, a non-self-propelled FSRU will introduce the issues and uncertainties discussed earlier regarding the Regasification Barge in terms of the permanently moored craft. As discussed in Option 1, the Regasification Barge option requires use of a permanently moored craft, which introduces some particular challenges.

Again as earlier discussed, in addition to the uncertainty surrounding permitting issues with the Coast Guard, FERC, OSHA and possibly other agencies, additional capital expense for the non-self-propelled option would include meeting the requirement to provide a mooring system suitable for retaining the FSRU in a 100-year hurricane event. Typically, it is expected that vessels will depart in advance of severe weather and that expectation serves as a nominal design basis for the marine civil works. For this option, there is expected to be a marine civil works arrangement that is significantly more robust than that typically found at an LNG facility; this additional robustness will be required to satisfy regulatory agency comfort that the permanently more craft will have a suitable mooring in severe weather events.

8.9 Option 9: FSU at Pier Army Dock with Shuttle Delivery

8.9.1 Terminal Configuration

This option comprises a Floating Storage Unit (FSU), either self-propelled or non-self-propelled, with no onboard regasification capability and ≤125,000 m³ storage capacity to be moored dockside in way of the Army

Dock. Cargo delivery would be provided by shuttle tanker through STS transfer in the area of Guayanilla Canyon.

The LNG from the FSU would be sent at low pressure to high-pressure send out pumps located on the facility that would increase the liquid pressure to pipeline pressure and send the LNG to vaporizers located on the facility. Natural gas from the facility regasification process would be sent to an onshore pipeline at the San Juan power plant and then to an additional pipeline to be run to provide feed gas for the Palo Seco facility. LNG supply would be provided by LNG Shuttle Carriers of appropriate capacity operating on liner service. The FSU may or may not be self-propelled; it is expected this project decision detail would be conducted on an evaluation of the availability and economics of each option.

8.9.2 Site Evaluation

Site considerations include:

- FSU, and
- pipeline route including:
    - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- FSU,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- high-pressure send out pumps on the facility,
- LNG vaporizers on the facility,
- FSU Support Network.

The “Zones of Concern” were calculated for the FSU in Section 7.3 of this Report. Appendix G presents a preliminary layout of key components of Option 9 illustrating the Zones of Concern.

8.9.3 Waterway Suitability

This option requires ongoing support from an LNG Shuttle Carrier of approximately 85,000 m^3 capacity. In support of the FSU, the LNG

Shuttle Carrier will be required to navigate the Bar Channel, Anegado Channel, the Army Terminal Channel and the Army Terminal Turning Basin. The Shuttle Carrier is anticipated to require a depth of 36.9 feet; this results in a requirement to dredge approximately 226,357 yd.³ from the Army Terminal Channel and Turning Basin.

8.9.4 Discussion

Similar to Options 6 and 7, this option presents a substantial dredging requirement and the FSU introduces potentially significant siting issues, permitting issues with the Coast Guard, FERC, OSHA and possibly other agencies as earlier discussed given decision made regarding self-propelled or non-self-propelled.

This option requires LNG Carrier delivery in support of the FSU approximately every 16 days. As also earlier discussed, this option requires use of a permanently moored craft, which introduces some particular challenges. In addition to the earlier discussion about uncertainty of the permitting path and incorporation of general industrial shoreside practices and regulations into a quasi-marine facility, one issue that is less ambiguous is the requirement to provide a mooring system suitable for retaining the Regasification Barge in a 100-year hurricane event. Typically, it is expected that vessels will depart in advance of severe weather and that expectation serves as a nominal design basis for the marine civil works. For the non-self-propelled option, there is expected to be a marine civil works arrangement that is significantly more robust than that typically found at an LNG facility; this additional robustness will be required to provide regulatory agency comfort that the permanently more craft will have a suitable mooring in severe weather events.

8.10 Option 10: Storage and Vaporization at Army Dock

8.10.1 Terminal Configuration

Similar to Option 5 excluding location and subsea pipeline, this option comprises a shoreside LNG receiving terminal with storage and vaporization ashore and cargo provided through LNG Carrier. LNG storage considered in this case is an aggregate of 160,000 m³ through the use of two 80,000 m³ full containment tanks.

The LNG from the storage tank(s) would be sent by low pressure pumps within each tank to high-pressure send out pumps located external to the tank that would increase the liquid pressure to pipeline pressure and send the LNG to vaporizers located on the facility. Sendout gas from the

vaporization system would be sent to prime movers at San Juan power plant and also to an additional pipeline to be run to provide feed gas for the Palo Seco facility.

LNG supply would be delivered by LNG Carriers of appropriate capacity operating on liner service.

8.10.2 Site Evaluation

Site considerations include:

- LNG Receiving and Regasification Terminal,
- pipeline route including:
    - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- LNG Receiving and Regasification Terminal,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- high-pressure send out pumps on the facility,
- LNG vaporizers on the facility,
- LNG facility Support Network.
- The hazards associated with full containment LNG storage tanks are presented in Section 7.5 of this Report. Due to size limitations at this site, a full containment LNG storage tank was chosen over a single containment LNG storage tank to reduce the thermal radiation exclusion zones. Appendix H presents a preliminary layout of key components of Option 5 illustrating the thermal radiation associated with the LNG storage tanks and vapor dispersion exclusion zones associated with the LNG process piping.

8.10.3 Waterway Suitability

Similar to the discussion in Option 5, this option requires ongoing support from an LNG Carrier of approximately 85,000 m^3 capacity and requires an LNG delivery approximately every 16 days; this frequency can be reduced through the use of larger carriers. For example, the use of 145,000 m^3 vessel could reduce the frequency to an LNG delivery approximately

every 22 days. However this provides for a minimum facility LNG inventory pending receipt of cargo and additionally introduces the need for larger dredging volumes.

In support of the facility, the LNG Carrier will be required to navigate the Bar Channel, Anegado Channel, the Army Terminal Channel and the Army Terminal Turning Basin. The 85,000 m^3 LNG Carrier is anticipated to require a depth of 36.9 feet; this results in a requirement to dredge approximately 226,357 $yd.^3$ from the Army Terminal Channel and Turning Basin. A 145,000 m^3 LNG Carrier, anticipated to require a depth of 40.2 feet, would result in an aggregate dredge volume requirement of approximately 394,655 $yd.^3$ from the Army Terminal Channel and Turning Basin.

8.10.4 Discussion

This Option is less favorable than Option 5 given a number of considerations. Although this Option represents a "standard industry solution" to the landing, regasification and sendout of natural gas to consumers as described in the discussion and Option 5, the hazard analysis conducted strongly suggests difficulty in successfully managing public impacts associated with siting criteria.

8.11 Option 11: Offshore FSRU Solution

8.11.1 Terminal Configuration

This option comprises an FSRU of ≤165,000 m^3 storage capacity moored at approximately 3 miles offshore northwest of Bahía de Toa. The moored FSRU would send out natural gas through a riser/PLEM assembly to a sub-seabed pipeline landing in the vicinity of the western tip of Ensenada de Boca Vieja and from there the pipeline would be horizontally directionally drilled to a pipeline riser at the Palo Seco site. At the Palo Seco site, the pipeline would bifurcate with one line providing feed gas to the Palo Seco prime movers and the other providing feed gas to a pipeline to run to the San Juan power plant.

8.11.2 Site Evaluation

Site considerations include:

- FSRU
- offshore anchorage,
- pipeline route including:

- subsea crossing of northwest of Bahía de Toa and Ensenada de Boca Vieja landing at the Palo Seca power plant;
- Overland or buried pipeline from the Palo Seco to the San Juan power plant.

Key site attributes and infrastructure include the following:

- FSRU,
- Turret Mooring Arrangement,
- Pipeline End Manifold,
- Subsea Pipeline to Landfall at Palo Seco power plant,
- Cross-Country Pipeline to san Juan power plant, and
- FSRU Shoreside Support Network.

Although the mooring location is indicated, there is flexibility in its precise location considering the water depth constraint. The precise moorage position would be optimized in consideration of optimum pipeline landfall and routing, fisheries location and practices, commercial vessel traffic patterns and frequency, and logistics supply lines. This optimization would be conducted in consultation with relevant agencies, FSRU operators, supply chain providers and other stakeholders.

Similarly, the shoreside pipeline route from landfall to the Palo Seco power plant would be optimized in consideration of environmental and social impacts, most expeditious routing and constructability with respect to existing infrastructure, topographical and geophysical characteristics. This optimization would be conducted in consultation with relevant stakeholders. It is also assumed that this pipeline crossing to the Palo Seco plant would be an HDD installation to protect from anchor dragging or grounding events and to otherwise minimize in environmental impacts.

The “Zones of Concern” were calculated for the FSRU in Section 7.2 of this Report. Appendix I presents the Option 11 Zones of Concern.

8.11.3 Waterway Suitability

This option presumes moorage of the FSRU offshore Bahía de Toa, approximately 3 nautical miles north of Bahía de Toa in no more than 300 m water depth.

Although this option’s distance off the coast suggests pilotage would not be compulsory, it is nevertheless likely that either shippers or the FSRU

owners, or more likely all parties, would require tugboat assisted mooring operations as well as "private pilotage", or a Mooring Master, in order to mitigate marine risks typically associated with open ocean close maneuvering and docking evolutions.

Weather

The following information is presented from Coast Pilot 5 (2014)

> *Puerto Rico is a tropical, hilly island that lies directly in the path of the E trade winds. Bathed by waters whose temperatures seldom drop below 80°F, the coastal climate is mild year round, with a small daily and annual temperature range. The rugged topography does cause a wide variation over short distances in wind, temperature, and rainfall. ODAS weather buoys are at San Juan, Ponce, and Rincon. For more information, visit www.caricoos.org.*
>
> *(23) The outstanding feature of the marine weather is the steadiness of the E trade winds. NE through SE winds blow about 80 percent of the time year round. Easterlies are particularly dominant in summer when the Bermuda High has shifted N. From November through April, northeasterlies are the secondary direction, but give way to southeasterlies in spring. The trade-wind regime is occasionally interrupted by cold fronts that have survived a journey from the United States and by easterly waves. As the cold front approaches, winds shift toward the S, and then as the front passes they gradually shift through the SW and NW quadrants back to the NE. The easterly wave passage is characterized by winds out of the ENE ahead of it, followed by an ESE wind.*
>
> *(24) Gale-force winds are unlikely but can occur with a strong front, thunderstorm, or tropical cyclone. Summer gales usually blow from the E semicircle, while winter gales are more likely in the NE quadrant. Windspeeds of 17 to 33 knots blow about 30 percent of the time. In summer, the trades tend to strengthen during the day, and average windspeeds are highest during this season. Morning averages of 12 to 13 knots give way to 13- to 15-knot averages during the afternoon.*
>
> *(25) Near the coast, a land-sea breeze effect helps exert a diurnal influence on the wind. If the pressure gradients are weak, a land breeze may develop during the night; northeasterly on the S coast*

and southeasterly on the N coast. The sea breeze develops during the morning hours and reinforces the trades on all but the W coast. Along the W coast, it opposes the trades and tends to weaken them.

(26) Seas in the area usually run less than 8 feet. Waters are roughest off the N and W coasts in winter and midsummer. For example, waves of 8 feet or more are encountered off these coasts 10 to 12 percent of the time in July. High seas are usually associated with strong winds out of the NE through SE blowing over a long fetch of water. Extreme wave heights are generated by hurricanes and can reach 40 feet or more in deep water.

(27) The tropical cyclone season extends from June through November. The most active period in this region is from August through the first half of October, although "off-season" storms occasionally brush the area. Most tropical cyclones affecting this area develop E of the Lesser Antilles and move toward the W or NW. They usually pass N or S of the island; occasionally they pass directly over it as was the case of hurricane Georges in September 1998. In addition to strong winds and rough seas, these storms can bring torrential rains and flooding to the island. Georges raked the island from E to W causing at least $2 billion in damages, 12 deaths, destroyed at least 33,000 homes, and caused power and water loss to nearly 80% of the island.

(28) Another navigational weather hazard in these waters are thunderstorms. While they can occur in winter, they are most likely from May through November. At sea, they are encountered 2 to 7 percent of the time during this period, while shore stations report thunder on an average of 5 to 15 days each month during the summer. In addition to strong gusty winds, heavy rains may briefly reduce visibilities to near zero. However, visibility problems are infrequent in these waters since fog is a rarity.

(234) Puerto Rico is in the tropical hurricane region of the E Caribbean where the season for these storms begins June 1 and ends November 30. Several hurricanes affect this area every season, usually passing the area to the N. In 1928, the National Weather Service's anemometer blew away after recording an extreme wind speed of 139 knots, the highest value in Puerto Rico to date. A hurricane caused considerable loss of life and great property damage in San Juan in 1932 and in 1956 Hurricane Betsy passed over Puerto Rico. Hurricane winds were felt at San Juan,

but there was no loss of life reported, and property damage was not great. Hurricane Hugo passed very close to the city in 1989 with 110-knot wind gusts causing significant damage.

8.11.4 Discussion

This option, like many offshore solutions, is attractive for several reasons. The facility is relatively remote in comparison with inner San Juan Bay and its operations will be unseen by most. Terminal operations are for the most part not within the public's view shed. In the event of an LNG release scenario or other operational upset, there may, depending on the nature of the event, be diminished public exposure to the event impacts. That said, there are constraints on the ability to deploy emergency response resources in such a case.

This option additionally presents a practical requirement to establish an enforceable safety and security zone around the FSRU and the subsea pipeline route.

However, this Option is less favorable than some of the shoreside options with respect to potential public impacts as determined through the analysis in Section 7.2 of this Report. That analysis strongly suggests difficulty in successfully managing public impacts associated with siting criteria. Moreover, the discussion of weather conditions presented by Coast Pilot suggests metocean conditions local to that site may be challenging and unfavorably influence terminal availability.

8.12 Options 12 & 13: CNG Marine Vessel at Army Dock and Pier 15/16

8.12.1 Terminal Configuration

Each option comprises a non-self-propelled barge approximately 400 feet LOA by 150 foot beam characterized by discrete cargo tanks in the carriage of compressed natural gas stored in a plurality of CPRVs. The vessel would more at Pier 15/16 (Option 12) or the Army Dock (Option 13) and discharge CNG from the vessel onto an onshore pipeline for downstream distribution. A relief vessel of equivalent size and capacity would be simultaneously moored at the facility to provide uninterrupted supply.

8.12.2 Site Evaluation

Site considerations include:

- CNG Vessel

- pipeline route including (Option 12):
  - sub seabed crossing of San Juan Bay landing at San Juan power plant;
  - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.
- pipeline route including (Option 13):
  - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Key site attributes and infrastructure include the following:

- FSRU,
- Turret Mooring Arrangement,
- Pipeline End Manifold,
- Subsea Pipeline to Landfall at Palo Seco power plant,
- Cross-Country Pipeline to san Juan power plant, and
- FSRU Shoreside Support Network.

The "Zones of Concern" were calculated for the CNG Marine Vessel for all four Release Scenarios in Section 7.3 of this Report. Appendix I presents the Options 12 & 13 Zones of Concern.

8.13 Option 14: Storage and Vaporization at San Juan Power Plant Extended

8.13.1 Terminal Configuration

Similar to Option 10, this option comprises a shoreside LNG receiving terminal with storage and vaporization ashore and cargo provided through LNG Carrier. LNG storage considered in this case is an aggregate of 160,000 m^3 through the use of two 80,000 m^3 full containment tanks.

The LNG from the storage tank(s) would be sent by low pressure pumps within each tank to high-pressure send out pumps located external to the tank that would increase the liquid pressure to pipeline pressure and send the LNG to vaporizers located on the facility. Sendout gas from the vaporization system would be sent to prime movers at San Juan power plant and also to an additional pipeline to be run to provide feed gas for the Palo Seco facility.

LNG supply would be delivered by LNG Carriers of appropriate capacity operating on liner service.

8.13.2 Site Evaluation

Site considerations include:

- LNG Receiving and Regasification Terminal,
- pipeline route including:
    - Overland or buried pipeline from San Juan power plant to the Palo Seco facility.

Principal infrastructure comprises:

- LNG Receiving and Regasification Terminal,
- Marine Jetty,
- Dredged Turning/Maneuvering Basin,
- Cross-Country Pipeline from San Juan power plant to Palo Seco,
- high-pressure send out pumps on the facility,
- LNG vaporizers on the facility,
- LNG facility Support Network.
- The hazards associated with full containment LNG storage tanks are presented in Section 7.5 of this Report. Due to size limitations at this site, a full containment LNG storage tank was chosen over a single containment LNG storage tank to reduce the thermal radiation exclusion zones. Appendix L presents a preliminary layout of key components of Option 14 illustrating the thermal radiation associated with the LNG storage tanks and vapor dispersion exclusion zones associated with the LNG process piping.

8.13.3 Waterway Suitability

Similar to the discussion in Option 10, this option requires ongoing support from an LNG Carrier of approximately 85,000 m^3 capacity and requires an LNG delivery approximately every 16 days; this frequency can be reduced through the use of larger carriers. For example, the use of 145,000 m^3 vessel could reduce the frequency to an LNG delivery approximately every 22 days. However this provides for a minimum facility LNG inventory pending receipt of cargo and additionally introduces the need for larger dredging volumes.

In support of the facility, the LNG Carrier will be required to navigate the Bar Channel, Anegado Channel, the Army Terminal Channel and the Army Terminal Turning Basin. The 85,000 m^3 LNG Carrier is anticipated to require a depth of 36.9 feet; this results in a requirement to dredge approximately 226,357 $yd.^3$ from the Army Terminal Channel and Turning Basin. A 145,000 m^3 LNG Carrier, anticipated to require a depth of 40.2 feet, would result in an aggregate dredge volume requirement of approximately 394,655 $yd.^3$ from the Army Terminal Channel and Turning Basin.

8.13.4 Discussion

This Option is more favorable than Option 10. Similar to Option 10, this Option represents a "standard industry solution" to the landing, regasification and sendout of natural gas to consumers and therefore represents a lower risk in the permitting timeline and efforts over hybrid or floating solutions. This Option also provides a better plot of land over Option 10 allowing the siting of the facility and management of exclusion zones to be better managed. The proximity of Option 14 to the San Juan Power Plant allows for reduced challenges in transporting natural gas from the LNG facility to the San Juan Power Plant.

It is understood that there may be some desire for the project site to effectively have LNG operations and "typical" dry bulk/packaged cargo operations effectively co-located, with logistics scheduling being established such that LNG transfer operations and cargo loading/unloading operations occur at the same location but not contemporaneously. This multipurpose arrangement would differ from standard LNG facility operations in the US. It is an arrangement that would require specific and in-depth detailed discussion with the authorities having jurisdiction to fully understand the risks, uncertainties and potential conditions required for such an arrangement.

9 COMMERCIAL EVALUATION

Each of the options considered in this Study presents differing commercial considerations which must be considered. Table 9.1 illustrates the differing critical commercial considerations for each option. A more quantitative discussion will be included in Phase 2.

Table 9.1: Commercial Evaluation

Option	Note	Offshore Mooring System	Marine Jetty	100 Year Storm Marine Jetty	Channel and Basin Dredging	Subsea Pipeline	Full Containment Storage Tank
1	Non-self-propelled			X	X	X	
2	Non-self-propelled			X	X	X	
3	Non-self-propelled			X	X	X	
	Self-propelled		X		X	X	
4	Non-self-propelled			X	X	X	
	Self-propelled		X		X	X	
5			X		X	X	X
6	Non-self-propelled			X	X		
7	Non-self-propelled			X	X		
8	Non-self-propelled			X	X		
	Self-propelled		X		X		
9	Non-self-propelled			X	X		
	Self-propelled		X		X		
10			X		X		X
11		X				X	
12	Non-self-propelled			X	X	X	
13	Non-self-propelled			X	X		
14			X		X		X

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

A number of terminal configuration options were considered and a number evidenced potential significant issues with meeting siting requirements equivalent to 49 CFR Part 193 or the application of Zones of Concern as practical siting requirements. All options require either subsea pipeline runs or overland pipeline runs, or a combination of both to provide feed gas distribution to the facilities requiring support.

Similarly, all options with the exception of Option 11 require dredging. For inshore options using FSU or FSRU, options for self-propelled or not self-propelled may be allowed to be considered depending on available vessels, conversion times and other factors. The outcome of this decision will influence the scope and nature of the marine civil works supporting the FSU or FSRU and, similarly, application of typically non-maritime regulatory standards and requirements may come into play. It is arguable that the use of a Regasification Barge, FSRU or FSU potentially introduces uncomfortable uncertainty into the permitting and engineering design process.

10.2 Recommendations

It is recommended that Options 6 through 10 be determined as non-preferential. These options present apparent Part 193 siting challenges that will be difficult to overcome.

It is recommended that Option 11 be determined as non-preferential. This option requires horizontal directional drilling of a subsea pipeline through a likely highly environmentally sensitive area. In addition, Coast Pilot 5 suggests suboptimal availability to the prevailing wind and weather conditions.

It is recommended that Options 1 through 4 be determined as non-preferential. The use of innovative arrangements with these technologies, coupled with the uncertainty surrounding application of general industrial requirements, such as through OSHA, on shipshape floating infrastructure in addition to the potential issues in demonstrating an acceptable level of public impacts with respect to dispersion distances is felt to introduce high uncertainty into the development process.

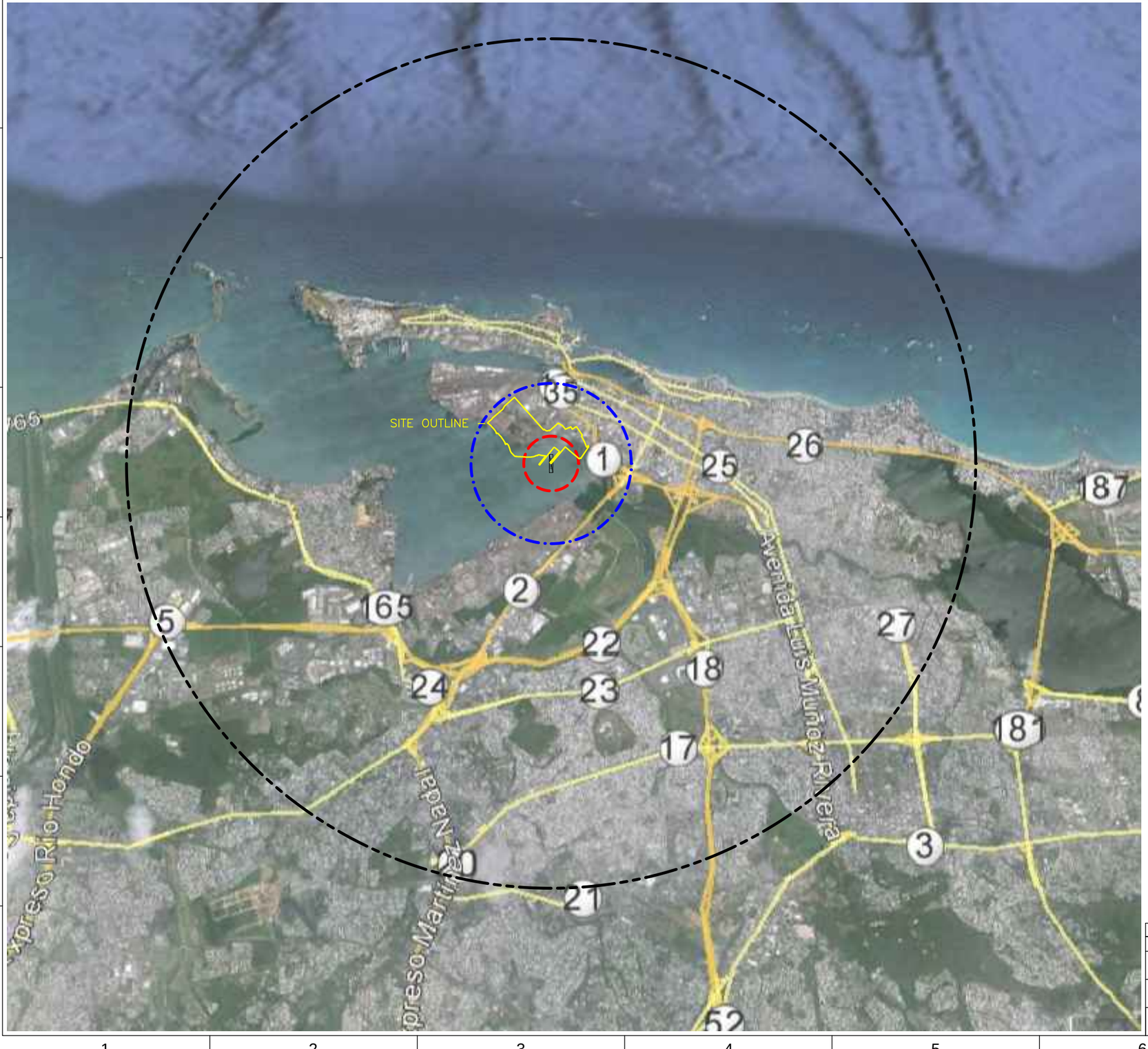
It is recommended that Options 12 and 13 be determined as non-preferential. The use of CNG in this application requires innovative arrangements with these technologies, which introduces uncertainty in the permitting process. In addition, this arrangement introduces high logistics and marine transit requirements.

It is recommended that Option 5 be determined as secondary preferential conditioned on the assumption that the property as indicated can be acquired. This location and terminal arrangement appears to be consistent with current existing terminal solutions

and is one which preliminary hazard analysis suggest presents manageable challenges in meeting regulatory siting requirements.

It is recommended that Option 14 be determined as primary preferential conditioned on the assumption that the property as indicated can be acquired. This location and terminal arrangement clearly appears to be the most consistent with current existing terminal solutions and is one which preliminary hazard analysis suggest presents manageable challenges in meeting regulatory siting requirements. Option 14 has the benefit of being closer to the San Juan Power Plant making the installation of the natural gas sendout line to the San Juan Power Plant less challenging than Option 5.

APPENDIX A: OPTIONS 1 AND 2



APPENDIX A	
REGASIFICATION BARGE	230m x 45m
ZONE 1	347m
ZONE 2	1,017m
ZONE 3	5,389m

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 11/19/14	MWS 11/19/14	MWS 11/19/14	

CH·IV
THE LNG SPECIALISTS

Project Title:
SAN JUAN, PUERTO RICO

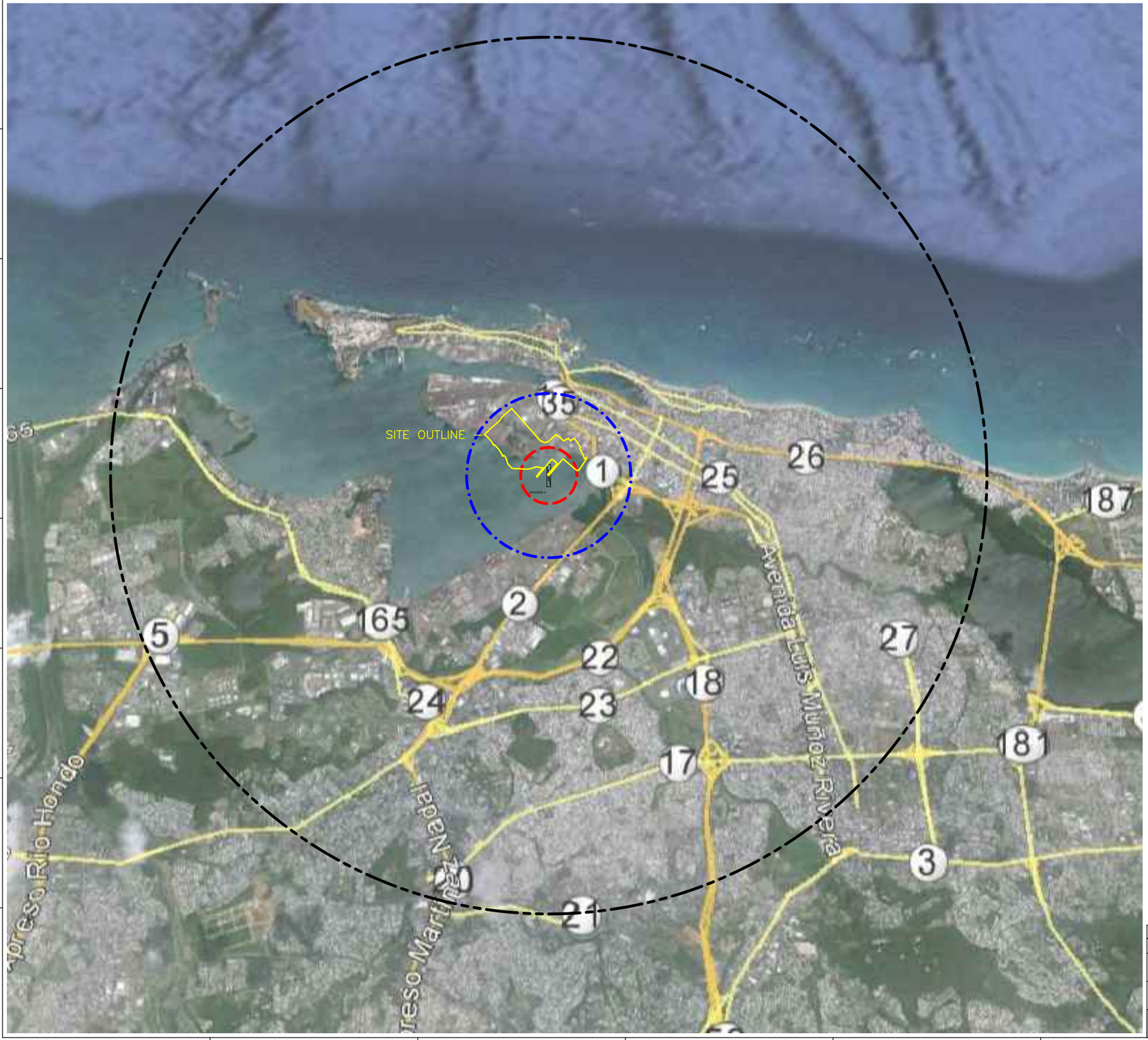
Drawing Title:
APPENDIX A
OPTIONS 1 & 2

Drawn By:	Scale:	Date:
JJP	N/A	11/18/14

Drawing No: 14909-DG-000-002

Sheet: 1 OF 10

APPENDIX B: OPTION 3



APPENDIX B	
FSRU	280m x 48m
ZONE 1	352m
ZONE 2	1,029m
ZONE 3	5,494

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 11/19/14	MWS 11/19/14	MWS 11/19/14	

CH·IV THE LNG SPECIALISTS

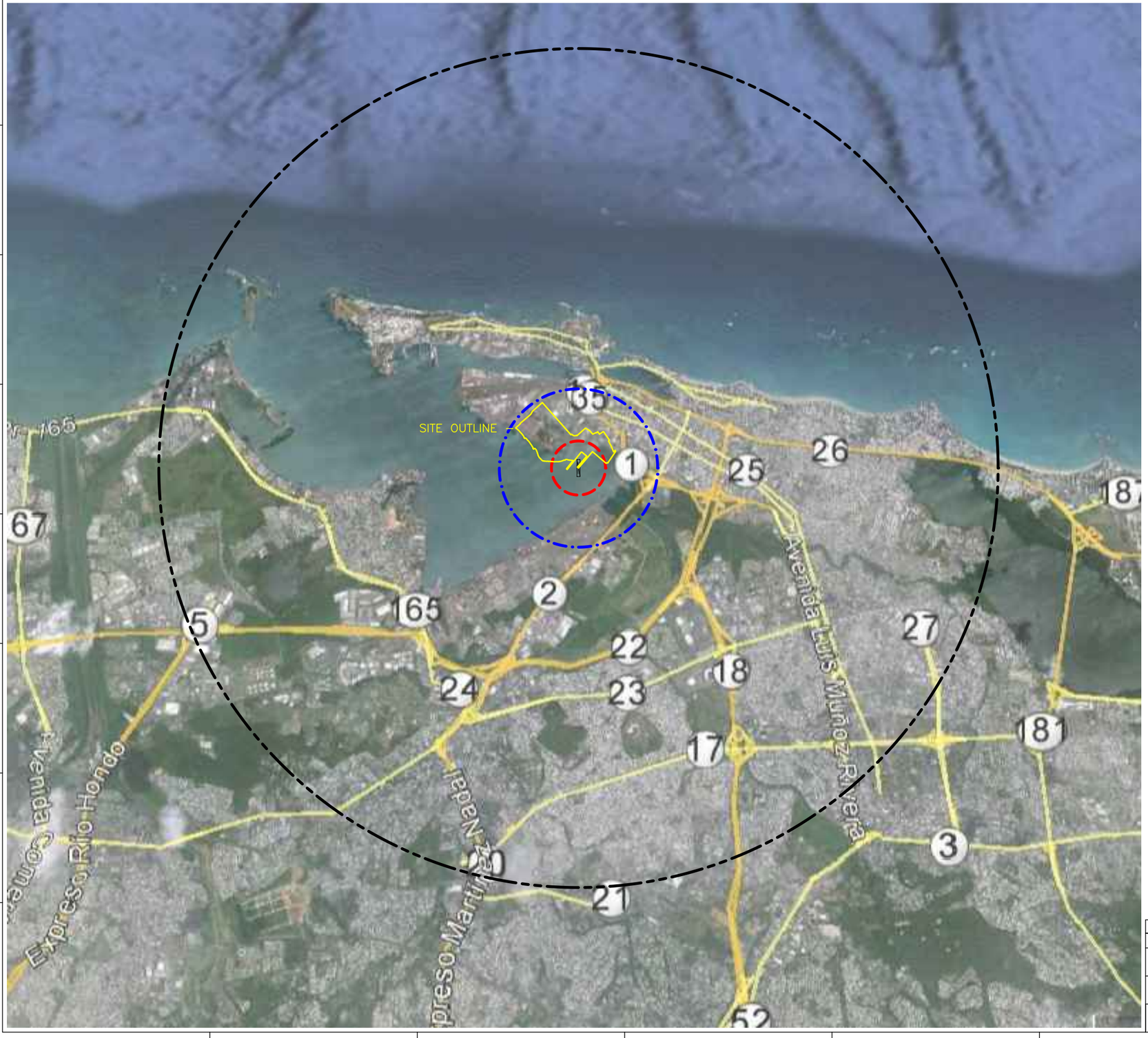
Project Title: SAN JUAN, PUERTO RICO

Drawing Title: APPENDIX B OPTION 3

Drawn By:	Scale:	Date:
JJP	N/A	11/18/14

Drawing No:	Sheet:
14909-DG-000-002	2 OF 10

APPENDIX C: OPTION 4



APPENDIX C	
FSU	220m x 40m
ZONE 1	347m
ZONE 2	1,017m
ZONE 3	5,389m

CH·IV
THE LNG SPECIALISTS

Project Title:

SAN JUAN, PUERTO RICO

Drawing Title:

APPENDIX C
OPTION 4

REVISIONS						
Rev.	Description	Designed & Date	Checked & Date	Approved & Date		
					Drawn By:	Scale:	Date:
					JJP	N/A	11/18/14
					Drawing No:		Sheet:
A	FOR CLIENT REVIEW	PJS 11/19/14	MWS 11/19/14	MWS 11/19/14	14909-DG-000-002		3 OF 10

APPENDIX D: OPTION 5

APPENDIX D		
1	LNG TANKS	80,000 (2)
2	THERMAL DISPERSION 1	10,000 Btu/hrft² 383ft
3	THERMAL DISPERSION 2	10,000 Btu/hrft² 877ft
4	LNG CARRIER	700ft LOA
5	VAPOR DISPERSION	UNLOADING LINE 1,350ft
6	VAPOR DISPERSION	LP SENDOUT 1,132ft
7	VAPOR DISPERSION	HP SENDOUT 587ft

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 11/19/14	MWS 11/19/14	MWS 11/19/14	

CH·IV
THE LNG SPECIALISTS

Project Title:
SAN JUAN, PUERTO RICO

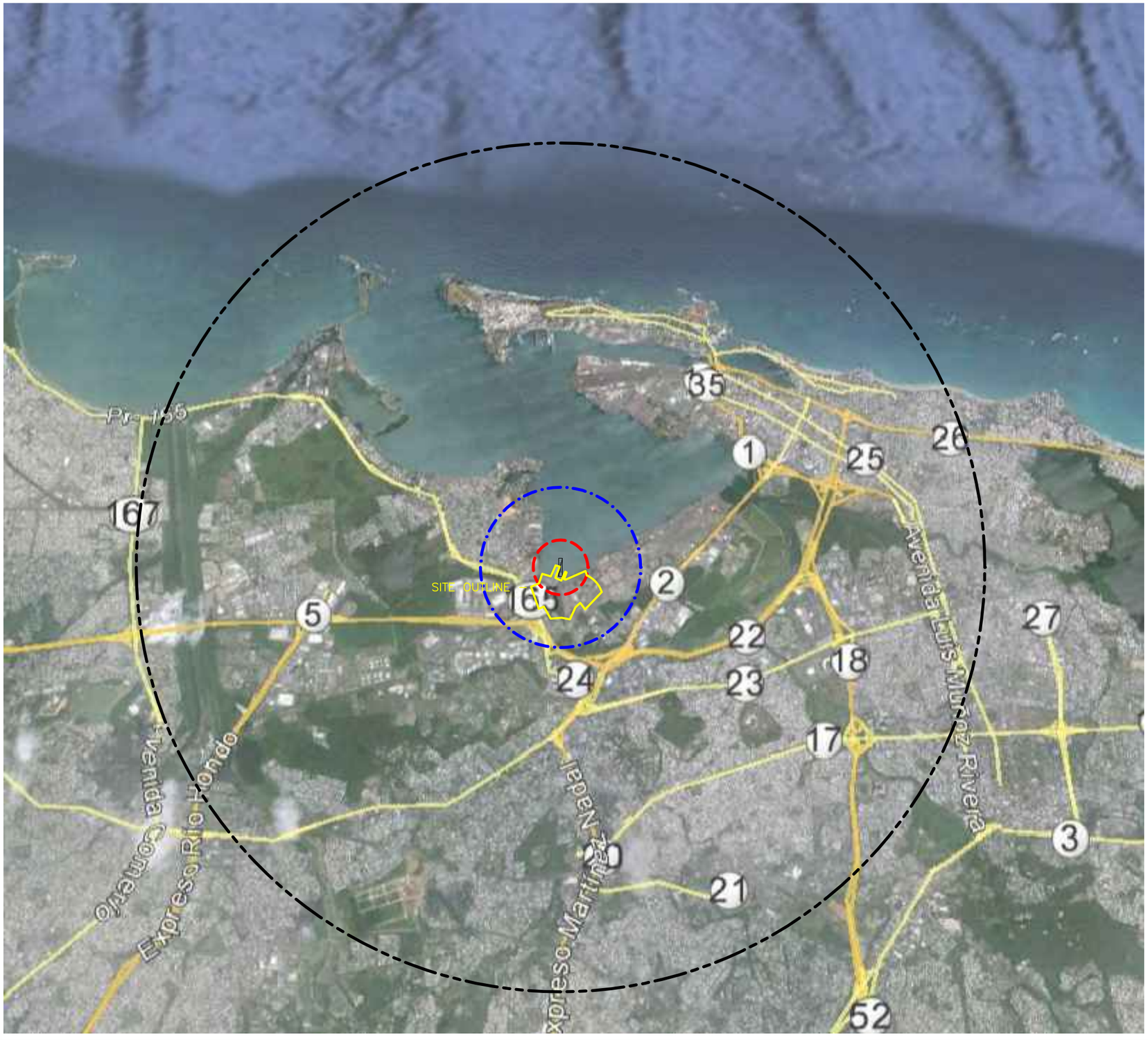
Drawing Title:
APPENDIX D
OPTION 5

Drawn By:	Scale:	Date:
JJP	N/A	11/18/14

Drawing No: 14909-DG-000-002

Sheet: 4 OF 10

APPENDIX E: OPTIONS 6 AND 7



APPENDIX E	
REGASIFICATION BARGE	230m x 45m
ZONE 1	347m
ZONE 2	1,017m
ZONE 3	5,389m

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS	MWS	MWS	
		11/19/14	11/19/14	11/19/14	

CH·IV THE LNG SPECIALISTS

Project Title:

SAN JUAN, PUERTO RICO

Drawing Title:

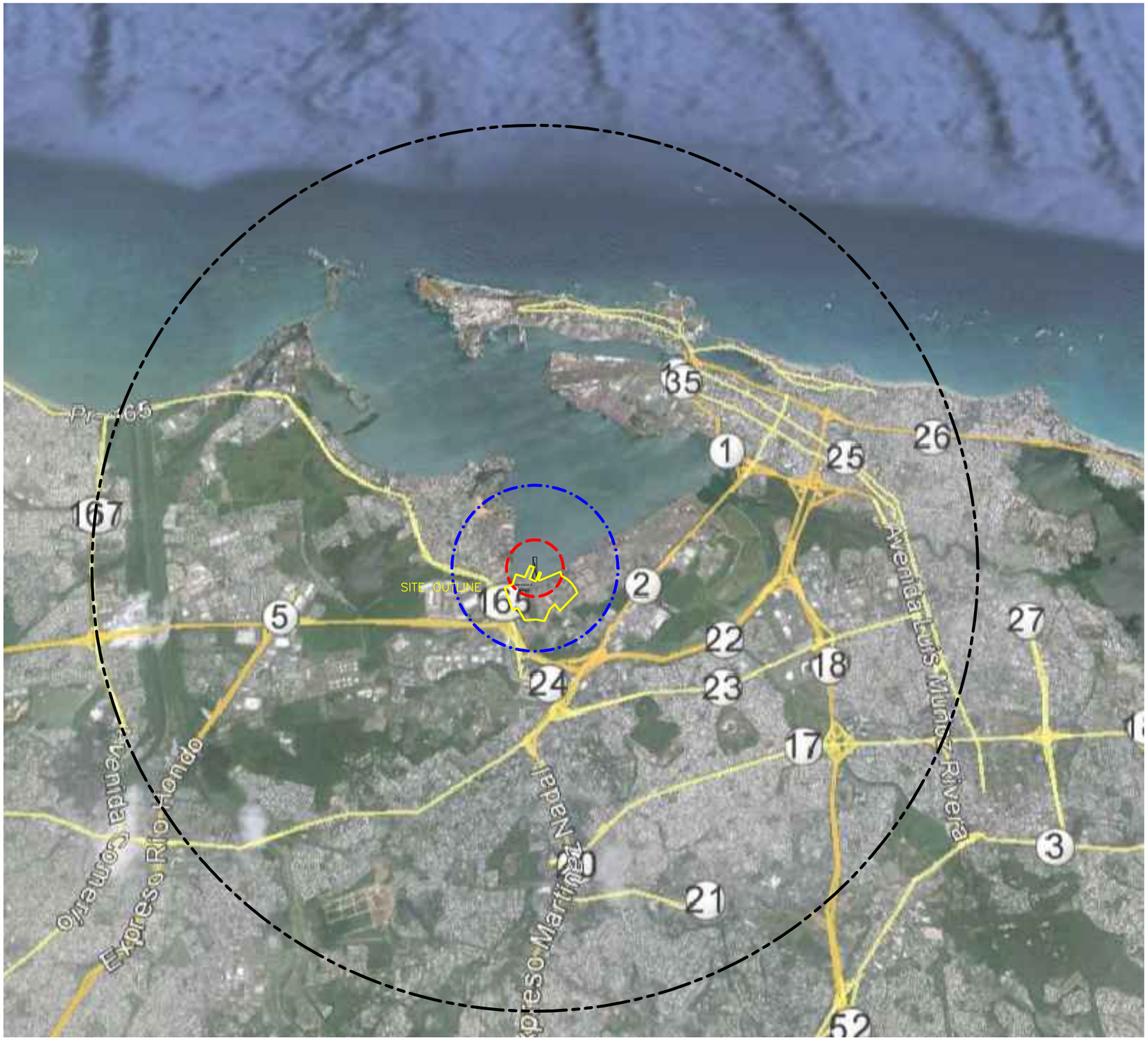
APPENDIX E
OPTIONS 6 & 7

Drawn By:	Scale:	Date:
JJP	N/A	11/18/14

Drawing No:	Sheet:
14909-DG-000-002	5 OF 10

APPENDIX F: OPTION 8

APPENDIX F	
FSRU	280m x 48m
ZONE 1	352m
ZONE 2	1,029m
ZONE 3	5,494

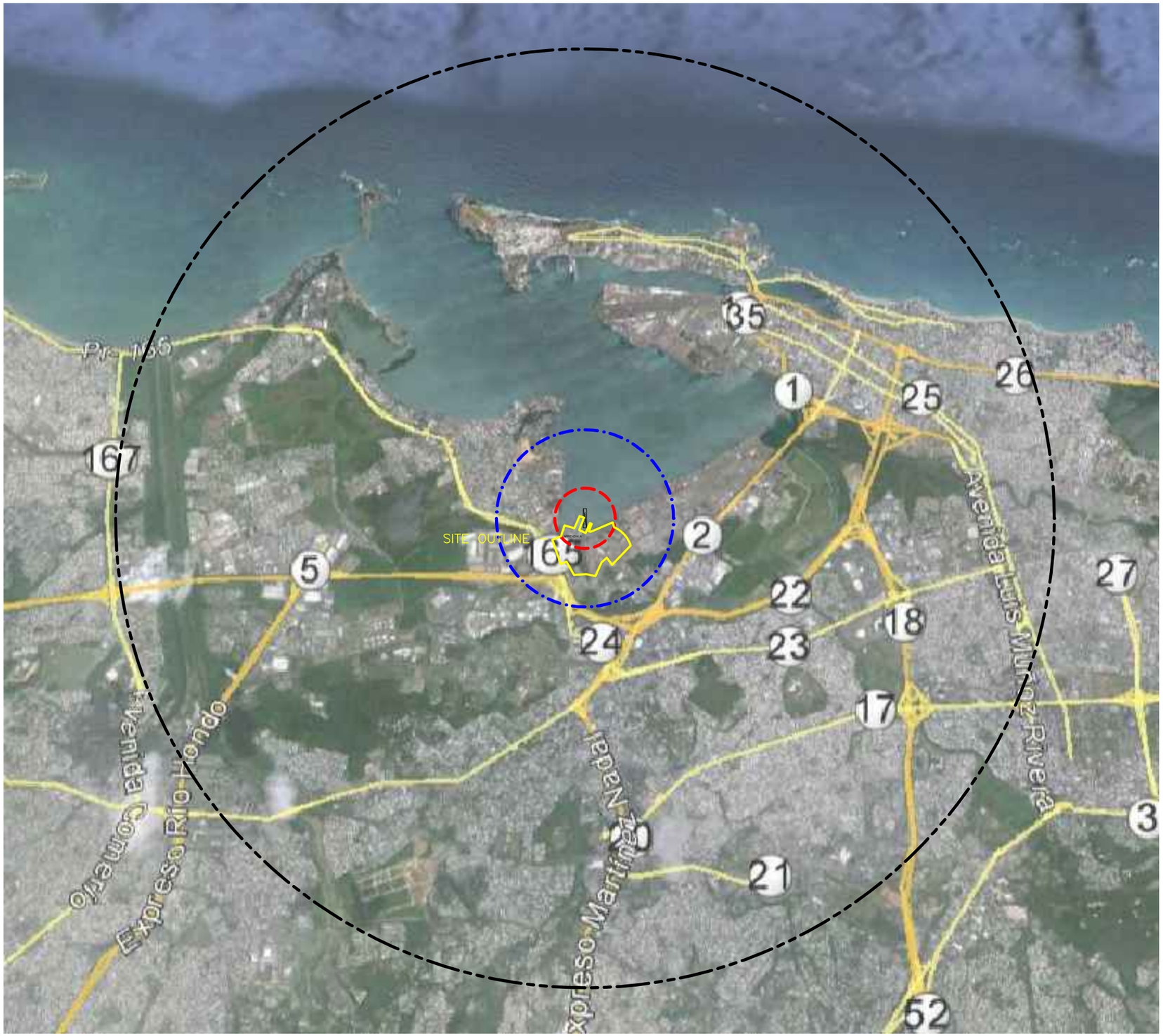


REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 11/19/14	MWS 11/19/14	MWS 11/19/14	

CH·IV THE LNG SPECIALISTS

Project Title: SAN JUAN, PUERTO RICO		
Drawing Title: APPENDIX F OPTION 8		
Drawn By: JJP	Scale: N/A	Date: 11/18/14
Drawing No: 14909-DG-000-002		Sheet: 6 OF 10

APPENDIX G: OPTION 9



APPENDIX G	
FSU	220m x 40m
ZONE 1	347m
ZONE 2	1,017m
ZONE 3	5,389m

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS	MWS	MWS	
		11/19/14	11/19/14	11/19/14	

CH·IV
THE LNG SPECIALISTS

Project Title:		
SAN JUAN, PUERTO RICO		
Drawing Title:		
APPENDIX G OPTION 9		
Drawn By:	Scale:	Date:
JJP	N/A	11/18/14
Drawing No:		Sheet:
14909-DG-000-002		7 OF 10

APPENDIX H: OPTION 10

APPENDIX H		
1	LNG TANKS	80,000 (2)
2	THERMAL DISPERSION 1	10,000 Btu/hrft² 724ft
3	THERMAL DISPERSION 2	10,000 Btu/hrft² 330ft
4	LNG CARRIER	700ft LOA
5	VAPOR DISPERSION	UNLOADING LINE 1,350ft
6	VAPOR DISPERSION	LP SENDOUT 1,132ft
7	VAPOR DISPERSION	HP SENDOUT 587ft

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 11/19/14	MWS 11/19/14	MWS 11/19/14	

CH·IV
THE LNG SPECIALISTS

Project Title:
SAN JUAN, PUERTO RICO

Drawing Title:
APPENDIX H1
OPTION 10

Drawn By:	Scale:	Date:
JJP	N/A	11/18/14

Drawing No:	Sheet:
14909-DG-000-002	8 OF 10

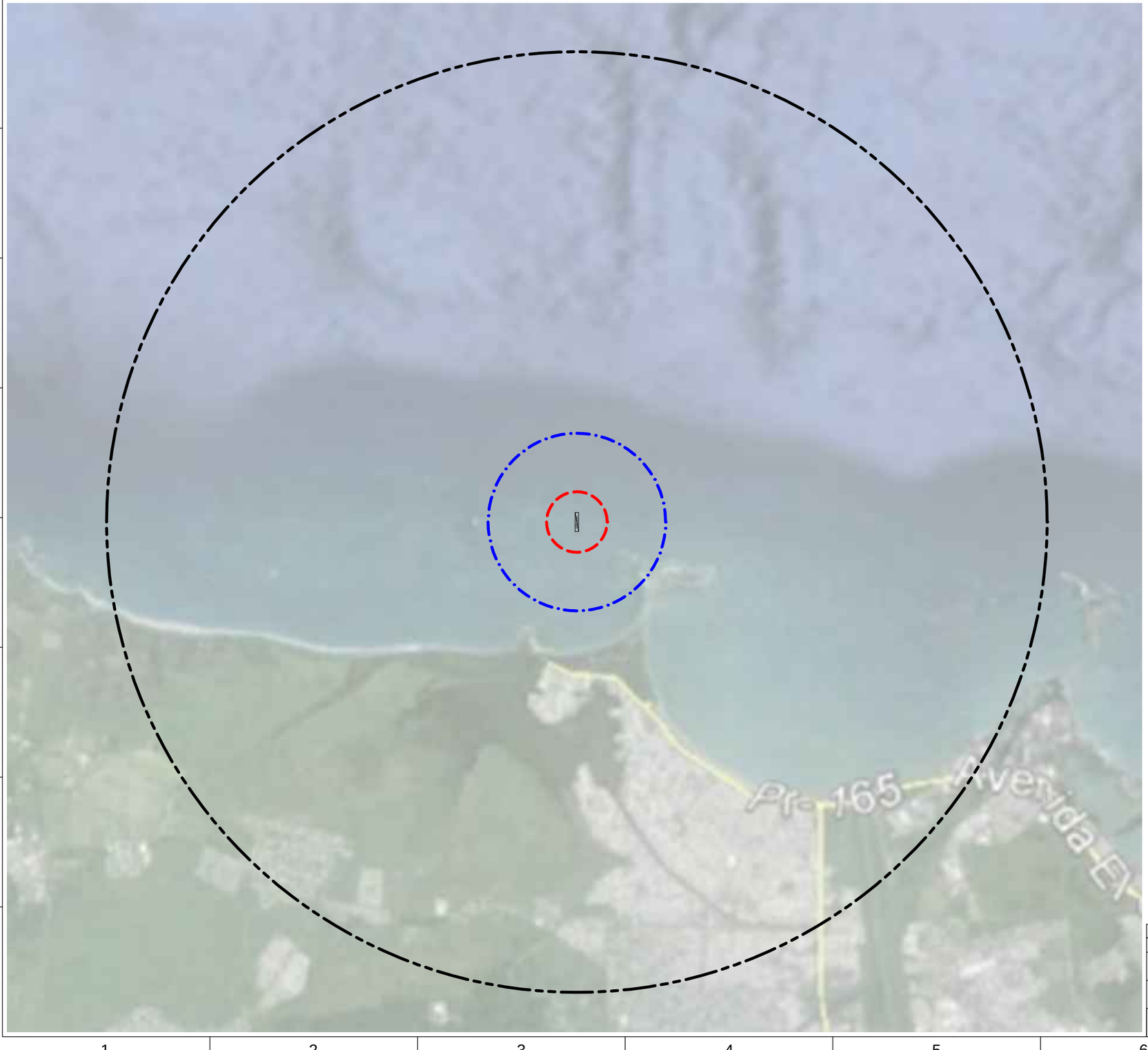
APPENDIX H		
1	LNG TANKS	80,000 (2)
2	THERMAL DISPERSION 1	10,000 Btu/hrft² 724ft
3	THERMAL DISPERSION 2	10,000 Btu/hrft² 330ft
4	LNG CARRIER	700ft LOA
5	VAPOR DISPERSION	UNLOADING LINE 1,350ft
6	VAPOR DISPERSION	LP SENDOUT 1,132ft
7	VAPOR DISPERSION	HP SENDOUT 587ft

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 11/19/14	MWS 11/19/14	MWS 11/19/14	

CH·IV
THE LNG SPECIALISTS

Project Title: SAN JUAN, PUERTO RICO		
Drawing Title: APPENDIX H2 OPTION 10		
Drawn By: JJP	Scale: N/A	Date: 11/18/14
Drawing No: 14909-DG-000-002		Sheet: 9 OF 10

APPENDIX I: OPTION 11



APPENDIX I	
FSRU	280m x 48m
ZONE 1	347m
ZONE 2	1,017m
ZONE 3	5,389m

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 11/19/14	MWS 11/19/14	MWS 11/19/14	

CH·IV
THE LNG SPECIALISTS

Project Title:
SAN JUAN, PUERTO RICO

Drawing Title:
APPENDIX I
OPTION 11

Drawn By:	Scale:	Date:
JJP	N/A	11/18/14

Drawing No:	Sheet:
14909-DG-000-002	10 OF 10

APPENDIX J: OPTION 12

CASE 12A: RELEASE SCENARIO 1	
VESSEL	400ft x 200ft
ZONE 1	215m
ZONE 2	391m
ZONE 3	277m

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 12/08/14	MWS 12/08/14	MWS 12/08/14	

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THE LNG SPECIALISTS

Project Title:

SAN JUAN, PUERTO RICO

Drawing Title:

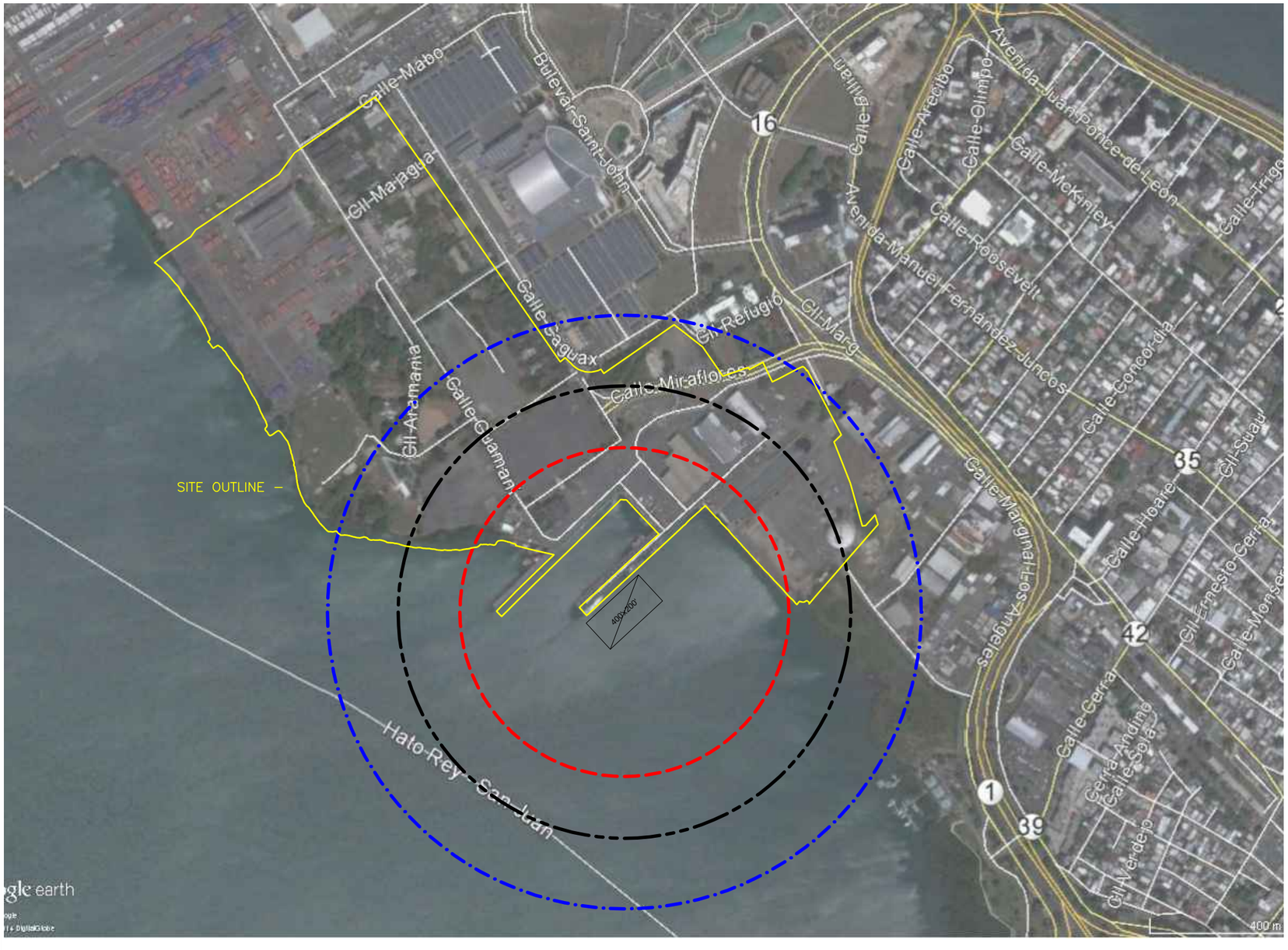
CASE 12A: RELEASE SCENARIO 1

Drawn By:	Scale:	Date:
JJP	N/A	12/04/14

Drawing No: 14909-DG-000-003

Sheet: 1 OF 8

CASE 12B: RELEASE SCENARIO 2	
VESSEL	400ft x 200ft
ZONE 1	282m
ZONE 2	509m
ZONE 3	388m



REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 12/08/14	MWS 12/08/14	MWS 12/08/14	

CH·IV
THE LNG SPECIALISTS

Project Title:
SAN JUAN, PUERTO RICO

Drawing Title:
CASE 12B: RELEASE SCENARIO 2

Drawn By:	Scale:	Date:
JJP	N/A	12/04/14

Drawing No: 14909-DG-000-003

Sheet: 2 OF 8

CASE 12C: RELEASE SCENARIO 3	
VESSEL	400ft x 200ft
ZONE 1	57m
ZONE 2	94m
ZONE 3	69m

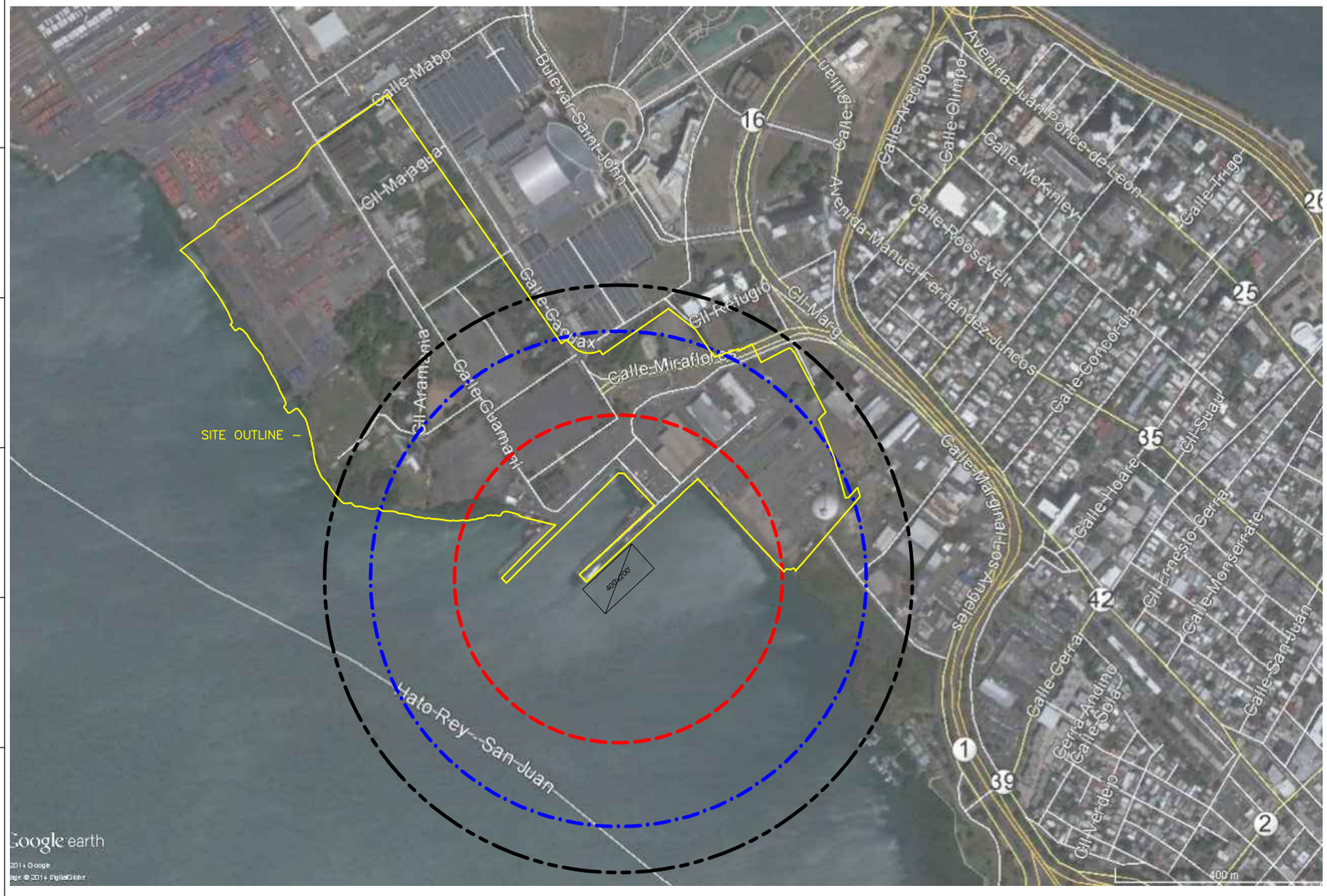
CH·IV
THE LNG SPECIALISTS

Project Title:		
SAN JUAN, PUERTO RICO		
Drawing Title:		
CASE 12C: RELEASE SCENARIO 3		
Drawn By:	Scale:	Date:
JJP	N/A	12/04/14
Drawing No:		Sheet:
14909-DG-000-003		3 OF 8

REVISIONS

Rev.	Description	Designed & Date	Checked & Date	Approved & Date
A	FOR CLIENT REVIEW	PJS 12/08/14	MWS 12/08/14	MWS 12/08/14

CASE 12D: RELEASE SCENARIO 4	
VESSEL	400ft x 200ft
ZONE 1	299m
ZONE 2	536m
ZONE 3	452m



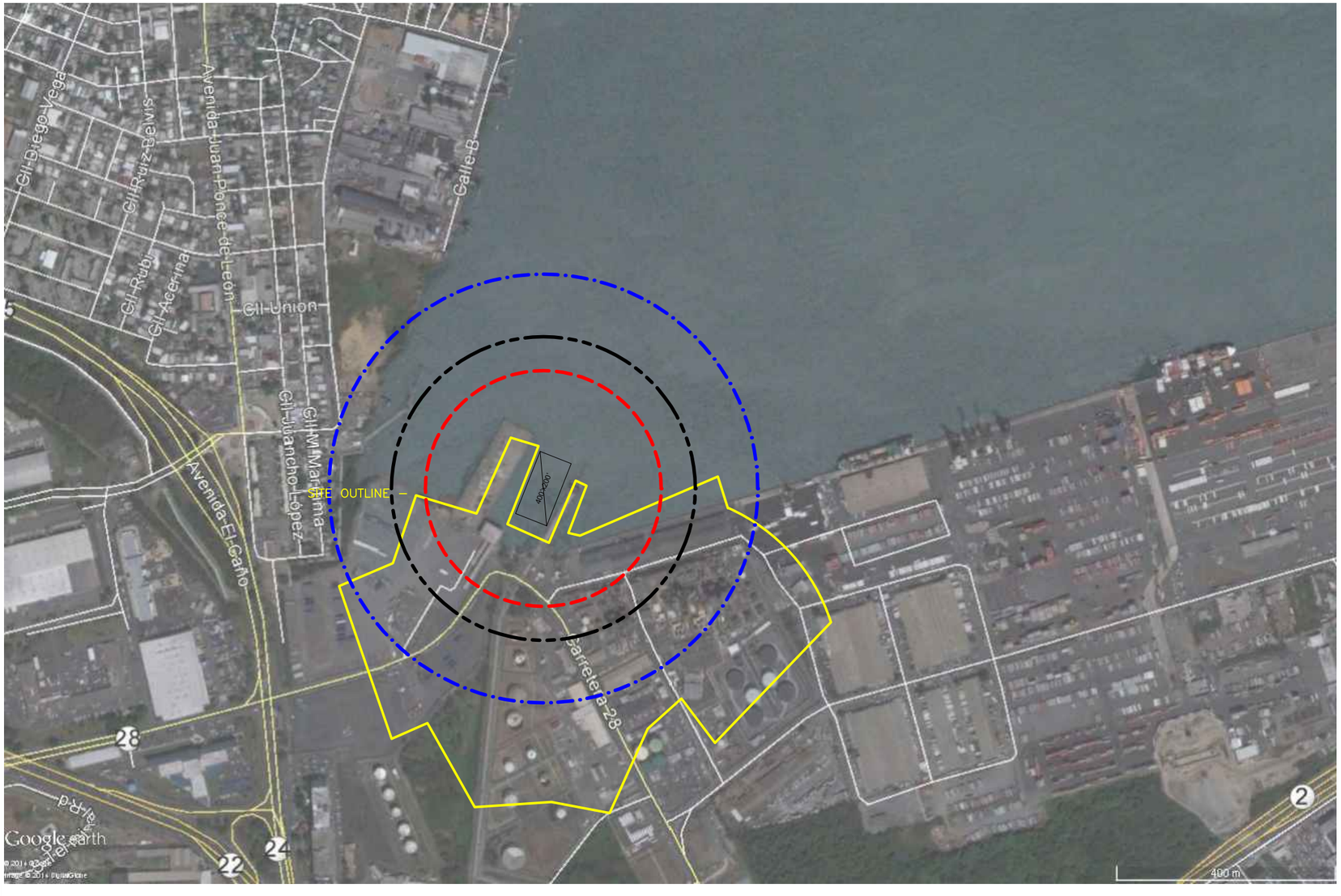
REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 12/08/14	MWS 12/08/14	MWS 12/08/14	

CH·IV
THE LNG SPECIALISTS

Project Title:		
SAN JUAN, PUERTO RICO		
Drawing Title:		
CASE 12D: RELEASE SCENARIO 4		
Drawn By:	Scale:	Date:
JJP	N/A	12/04/14
Drawing No:		Sheet:
14909-DG-000-003		4 OF 8

APPENDIX K: OPTION 13

CASE 13A: RELEASE SCENARIO 1	
VESSEL	400ft x 200ft
ZONE 1	215m
ZONE 2	391m
ZONE 3	277m

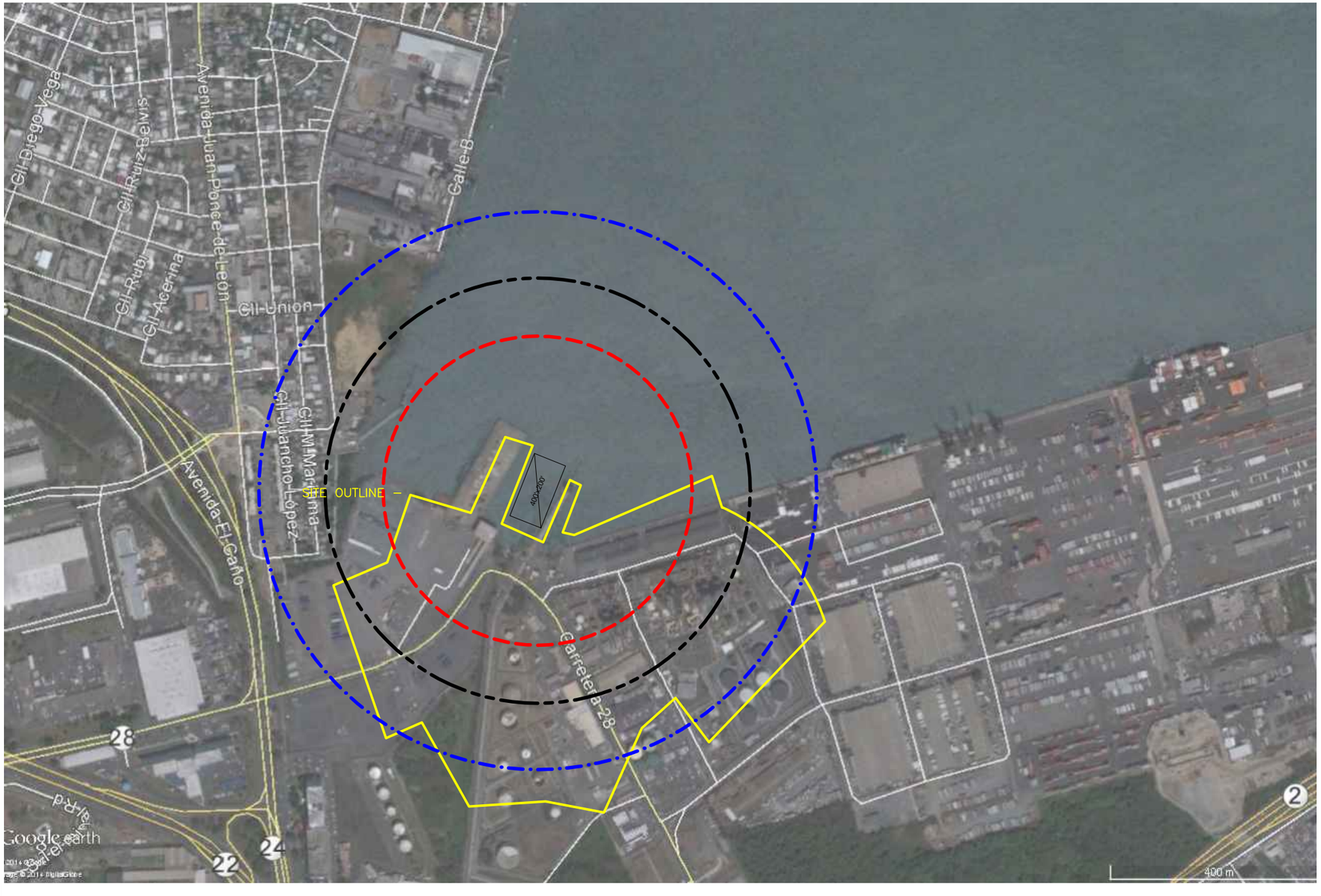


REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 12/08/14	MWS 12/08/14	MWS 12/08/14	

CH·IV THE LNG SPECIALISTS

Project Title:		
SAN JUAN, PUERTO RICO		
Drawing Title:		
CASE 13A: RELEASE SCENARIO 1		
Drawn By:	Scale:	Date:
JJP	N/A	12/04/14
Drawing No:		Sheet:
14909-DG-000-003		5 OF 8

CASE 12B: RELEASE SCENARIO 2	
VESSEL	400ft x 200ft
ZONE 1	282m
ZONE 2	509m
ZONE 3	388m



REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 12/08/14	MWS 12/08/14	MWS 12/08/14	

CH·IV THE LNG SPECIALISTS

Project Title: SAN JUAN, PUERTO RICO		
Drawing Title: CASE 13B: RELEASE SCENARIO 2		
Drawn By: JJP	Scale: N/A	Date: 12/04/14
Drawing No: 14909-DG-000-003		Sheet: 6 OF 8

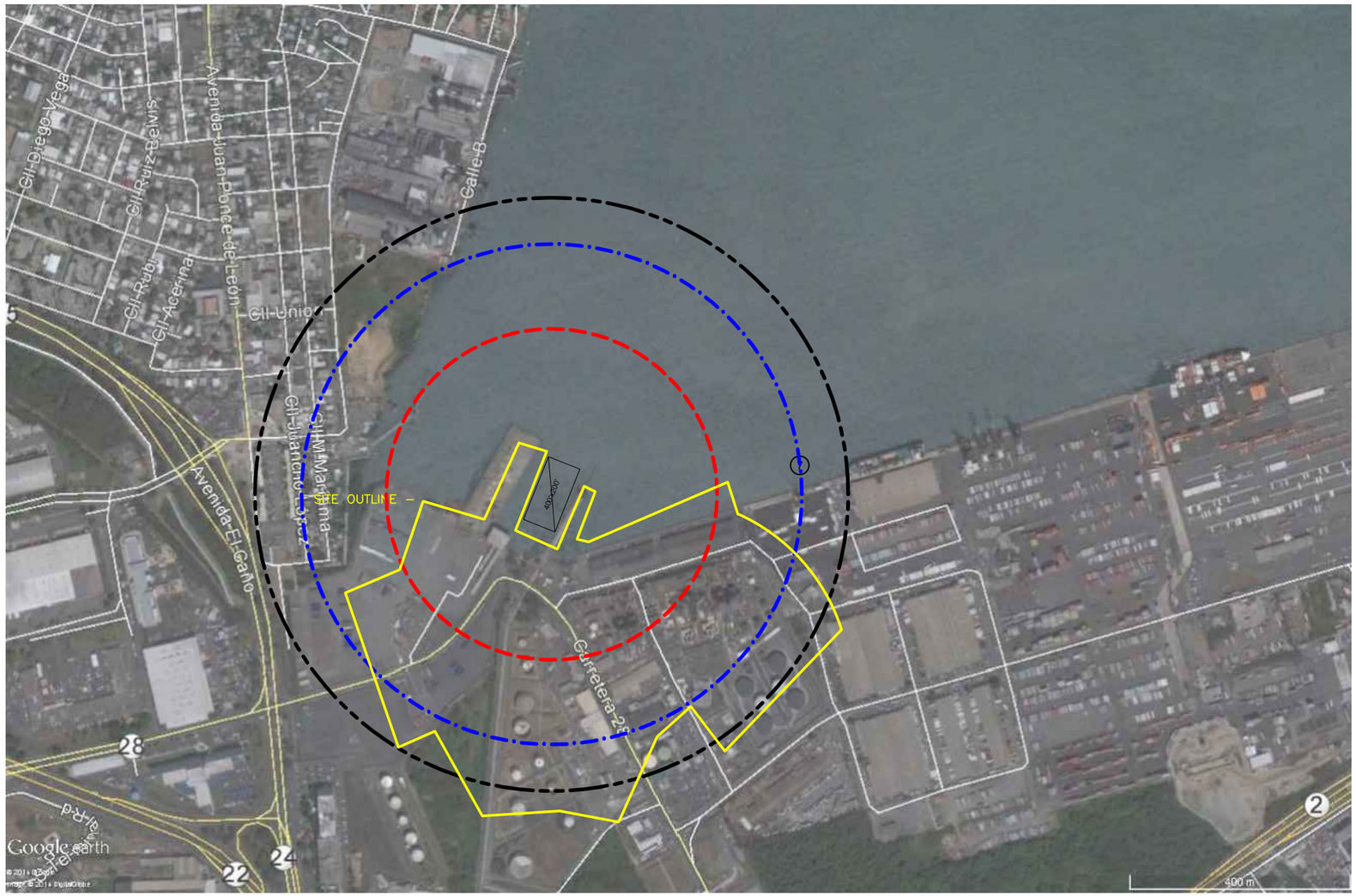
CASE 13C: RELEASE SCENARIO 3	
VESSEL	400ft x 200ft
ZONE 1	57m
ZONE 2	94m
ZONE 3	69m

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 12/08/14	MWS 12/08/14	MWS 12/08/14	

CH·IV THE LNG SPECIALISTS

Project Title: SAN JUAN, PUERTO RICO		
Drawing Title: CASE 13C: RELEASE SCENARIO 3		
Drawn By: JJP	Scale: N/A	Date: 12/04/14
Drawing No: 14909-DG-000-003		Sheet: 7 OF 8

CASE 13D: RELEASE SCENARIO 4	
VESSEL	400ft x 200ft
ZONE 1	299m
ZONE 2	536m
ZONE 3	452m

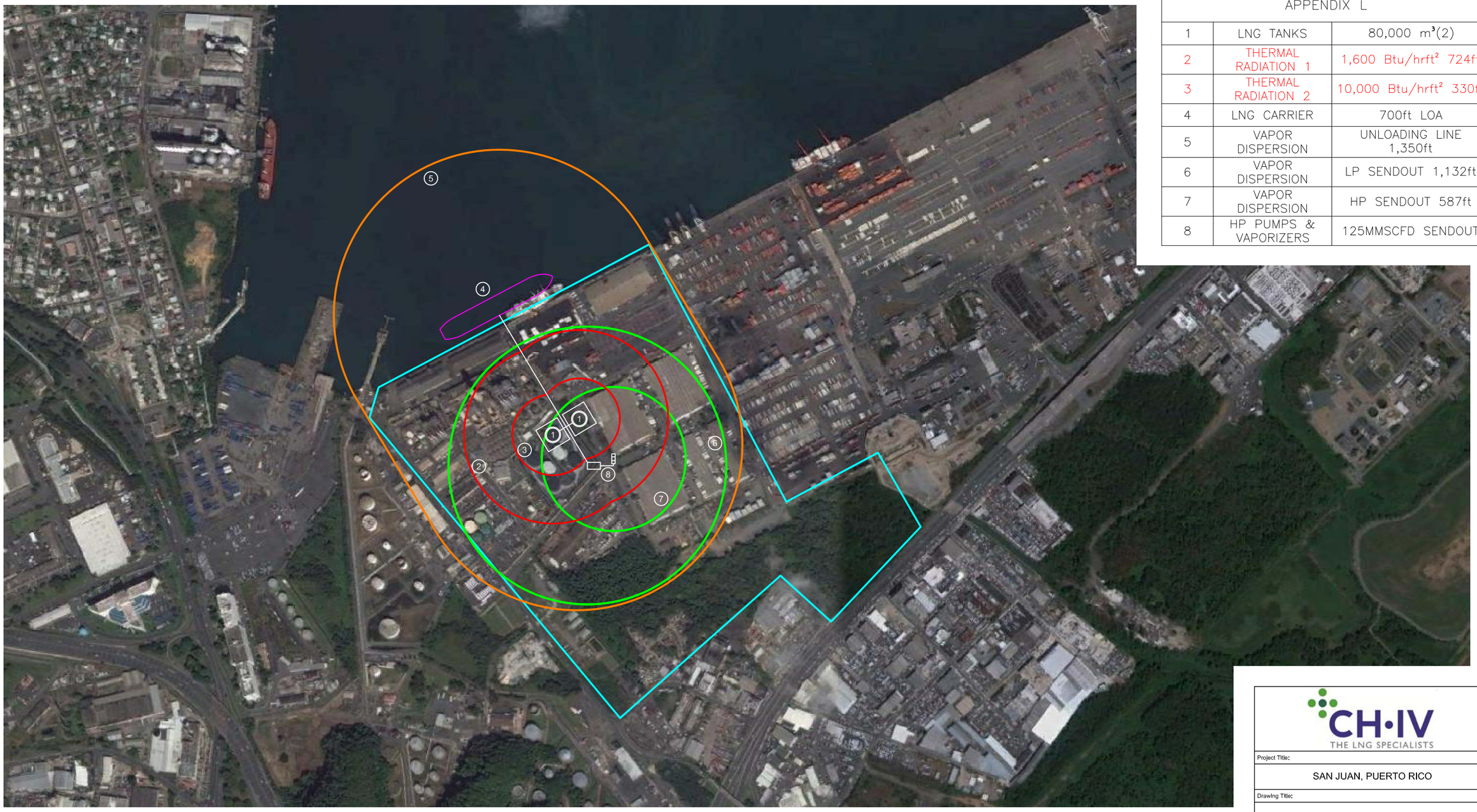


REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 12/08/14	MWS 12/08/14	MWS 12/08/14	

CH·IV THE LNG SPECIALISTS

Project Title:		
SAN JUAN, PUERTO RICO		
Drawing Title:		
CASE 13D: RELEASE SCENARIO 4		
Drawn By:	Scale:	Date:
JJP	N/A	12/04/14
Drawing No:		Sheet:
14909-DG-000-003		8 OF 8

APPENDIX L: OPTION 14



APPENDIX L		
1	LNG TANKS	80,000 m^3(2)
2	THERMAL RADIATION 1	1,600 Btu/hrft² 724ft
3	THERMAL RADIATION 2	10,000 Btu/hrft² 330ft
4	LNG CARRIER	700ft LOA
5	VAPOR DISPERSION	UNLOADING LINE 1,350ft
6	VAPOR DISPERSION	LP SENDOUT 1,132ft
7	VAPOR DISPERSION	HP SENDOUT 587ft
8	HP PUMPS & VAPORIZERS	125MMSCFD SENDOUT

0 200 400 800 1200 1600 2000

GRAPHIC SCALE
(FEET)

REVISIONS					
Rev.	Description	Designed & Date	Checked & Date	Approved & Date	
A	FOR CLIENT REVIEW	PJS 05/13/15	MWS 05/13/15	MWS 05/13/15	

CH·IV
THE LNG SPECIALISTS

Project Title:
SAN JUAN, PUERTO RICO

Drawing Title:
APPENDIX L
OPTION 14

Drawn By:	Scale:	Date:
KPB	N/A	05/13/15

Drawing No:	Sheet:
14909-DG-000-002	8 OF 10

APPENDIX M: CRAFT ROUTINELY OPERATED DOCKSIDE

Craft Routinely Operated Dockside

In accordance with a recent Supreme Court Decision, the Coast Guard will no longer inspect permanently moored craft or issue Certificates of Inspection to such craft unless a craft demonstrates that it is a vessel, capable of being used as a means of transportation on the water. The Federal Register dated May 11, 2009 discusses the implications of the Supreme Court decision and responds to comments received in response to a 2004 Federal Register notice that proposed a policy for permanently moored vessel.

The Coast Guard recently determined the number of large passenger vessels (subchapter H) and the number of small passenger vessels (both subchapters K and T) it inspects and the number of inspected passenger barges on May 3, 2012. That information is provided here for information in connection with our C-ROD policy. We did this by sorting the information in our Marine Safety and Information and Law Enforcement System (MISLE) data base as indicated in the header of the document titled: Passenger Vessel Population 3 May 2012.

Since the promulgation of the C-ROD Policy in May 2009, an estimated 21 passenger craft have been deemed permanently moored craft and determined not to meet the definition of vessel as defined in this policy. These craft ceased to be inspected by the Coast Guard and oversight was handed over to the appropriate state authorities.

The Coast Guard also recently estimated the number of permanently moored tank barges operated as floating storage tanks and that do not meet the definition of vessel as defined in the C-ROD policy. These craft are limited to use in the Eighth Coast Guard District located along the Gulf of Mexico coast and the inland river system. The Coast Guard conservatively estimates this number to be 149. This estimate is based upon a survey of Coast Guard field units in the Eighth Coast Guard District conducted between May 4th and 7th 2012. As there are no requirements for operators of these craft to report to the Coast Guard and many are located in remote areas, it is likely the number of such craft is higher than the estimate.

including taxicabs, hotel, and airport shuttles will be inspected before being allowed on campus. Visitors will be asked to show one form of identification (for example, a government-issued photo ID, driver's license, or passport) and to state the purpose of their visit.

Information is also available on the Institute's/Center's home page: *http://www.nichd.nih.gov/about/bsd/htm,* where an agenda and any additional information for the meeting will be posted when available.

(Catalogue of Federal Domestic Assistance Program Nos. 93.864, Population Research; 93.865, Research for Mothers and Children; 93.929, Center for Medical Rehabilitation Research; 93.209, Contraception and Infertility Loan Repayment Program, National Institutes of Health, HHS)

Dated: May 4, 2009.

Jennifer Spaeth,

Director, Office of Federal Advisory Committee Policy.

[FR Doc. E9–10801 Filed 5–8–09; 8:45 am]

BILLING CODE 4140–01–P

DEPARTMENT OF HEALTH AND HUMAN SERVICES

National Institutes of Health

National Institute on Alcohol Abuse and Alcoholism; Notice of Closed Meeting

Pursuant to section 10(d) of the Federal Advisory Committee Act, as amended (5 U.S.C. App.), notice is hereby given of the following meeting.

The meeting will be closed to the public in accordance with the provisions set forth in sections 552b(c)(4) and 552b(c)(6), Title 5 U.S.C., as amended. The grant applications and the discussions could disclose confidential trade secrets or commercial property such as patentable material, and personal information concerning individuals associated with the grant applications, the disclosure of which would constitute a clearly unwarranted invasion of personal privacy.

Name of Committee: National Institute on Alcohol Abuse and Alcoholism, Special Emphasis Panel, The Effects of Alcohol on Glial Cells (RFA–AA–09–003/004).

Date: July 8–9, 2009.

Time: 8:30 a.m. to 5 p.m.

Agenda: To review and evaluate grant applications.

Place: Legacy Hotel, 1775 Rockville Pike, Rockville, MD 20852.

Contact Person: Beata Buzas, PhD, Scientific Review Officer, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, 5635 Fishers Lane, Rm 2081, Rockville, MD 20852. 301–443–0800. *bbuzas@mail.nih.gov.*

(Catalogue of Federal Domestic Assistance Program Nos. 93.271 Alcohol Research Career Development Awards for Scientists and Clinicians; 93.272, Alcohol National Research Service Awards for Research Training; 93.273, Alcohol Research Programs; 93.891, Alcohol Research Center Grants, National Institutes of Health, HHS)

Dated: May 4, 2009.

Jennifer Spaeth,

Director, Office of Federal Advisory Committee Policy.

[FR Doc. E9–10783 Filed 5–8–09; 8:45 am]

BILLING CODE 4140–01–M

DEPARTMENT OF HOMELAND SECURITY

Coast Guard

[USCG–2004–17674]

Craft Routinely Operated Dockside

AGENCY: Coast Guard, DHS.

ACTION: Notice of policy.

SUMMARY: The Coast Guard gives notice that, in accord with a recent Supreme Court decision, it will no longer inspect permanently moored craft or issue Certificates of Inspection to such craft unless a craft demonstrates that it is a vessel, capable of being used as a means of transportation on water. This notice discusses the implications of the Supreme Court decision and responds to comments received in response to a 2004 notice that proposed a policy for permanently moored vessels.

DATES: The policy announced in this notice is effective May 11, 2009. Inspection services will continue, with State concurrence, until May 11, 2011, for permanently moored craft that currently possess a Coast Guard-issued Certificate of Inspection, and that have been designed to Coast Guard regulations, and that may not be acceptable for regulation immediately by the State having jurisdiction.

ADDRESSES: Comments and material received from the public, as well as documents mentioned in this preamble as being available in the docket, are part of docket USCG–2004–17674 and are available for inspection or copying at the Docket Management Facility, U.S. Department of Transportation, West Building Ground Floor, Room W12–140, 1200 New Jersey Avenue, SE., Washington, DC 20590–0001, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays. You may also find this docket on the Internet at *http://www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT: For questions on this policy, contact Lieutenant Commander David Webb of the Coast Guard's Office of Vessel Activities (CG–543), telephone 202–372–1216. For questions on viewing the docket call Renee V. Wright, Program Manager, Docket Operations, telephone 202–366–9826.

SUPPLEMENTARY INFORMATION:

Background

This notice is issued under the authority of 46 U.S.C. 3306, which conveys authority to the Secretary of Homeland Security to implement the vessel inspection provisions of 46 U.S.C. 3301.

On June 21, 2004, the Coast Guard published a notice of proposed policy in the **Federal Register** (69 FR 34385), regarding the inspection of permanently moored vessels (PMVs). We proposed a policy of no longer issuing Certificates of Inspection (COI) to PMVs and no longer inspecting PMVs that currently have a COI, and invited public comments. In response, we received letters from 27 commenters, containing 62 comments.

While we were considering those public comments, the Supreme Court issued its decision in *Stewart* v. *Dutra Construction Company, Inc.,* 543 U.S. 481, 125 S.Ct. 1118 (2005). That case held that a dredge was a ''vessel'' under 1 U.S.C. 3. The Court decided that 1 U.S.C. 3 provides the defining criteria for determining what constitutes a vessel, wherever the U.S. Code refers to ''vessel'' as a jurisdictional criterion. In determining whether a particular craft is also a vessel, the ''question remains in all cases whether the watercraft's use 'as a means of transportation on water' is a practical possibility or merely a theoretical one.'' 543 U.S. at 496.

The Supreme Court's decision ended the prior situation, under which various circuit courts of appeal had applied different tests to determine whether a particular craft constituted a vessel, depending on the statute to be construed and the facts of the case. Under the prior situation, we attempted to apply the different tests so as to provide maximum flexibility in achieving the purpose of the particular statute being administered. After *Stewart,* however, it is clear that we must apply the single test of whether a craft is used, or is practically capable of being used, as a means of transportation on water. *Stewart* implies that a ''permanently moored vessel'' is an oxymoron, since such a craft is neither used nor practically capable of being used as transportation on water, and therefore cannot be considered a vessel. Only a vessel can be inspected by the Coast Guard under the authority of 46 U.S.C. 3301. Thus, in order to conform to *Stewart,* we have concluded that we will issue Certificates of Inspection to